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Koşuyolu Heart Journal is a peer-reviewed, open access journal that has been published three times a year in April, August and December. This is the scientific journal of the Health Sciences University, Koşuyolu High Specialization Health Application and Research Center (namely in Turkish, Sağlık Bilimleri Üniversitesi, Kartal Koşuyolu Yüksek İhtisas Sağlık Uygulama ve Araştırma Merkezi, İstanbul, Türkiye). The official languages of the journal are English and Turkish.

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Example: Parsonnet V, Lean D, Bernstein AD. A method of uniform stratification of risk for evaluating the results of surgery in acquired adult heart disease. Circulation 1989;79(Suppl 1):S3-S12.

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Evaluation of Saphenous Vein with or Without Valve and Radial Artery Patency Via Tomography in Patients Who Underwent Coronary Artery Bypass Grafting

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ABSTRACT

Introduction: This prospective study investigated the effect of the valves of saphenous veins, which were used as conduits, on patency and the 2-year rate of remaining patency of saphenous vein with valve, saphenous vein without valve, and radial artery (RA) via multislice computerized tomography (MSCT) angiography.

Patients and Methods: Between 2014 and 2015, the patients that underwent coronary artery bypass grafting (CABG) using cardiopulmonary bypass (CPB) and cross-clamp (on-pump with cross-clamp) in our clinic were grouped into three groups depending on the graft type. The first group (Group 1) was RA group, the second group (Group 2) was great saphenous vein with valve group, and the third group (Group 3) was great saphenous vein without valve group.

Results: The 2-year rates of the remaining patency of these grafts in the decreasing order was as following: RA (87.5%), great saphenous vein without valve (82.4%), and great saphenous vein with valve (78.8%).

Conclusion: The rate of remaining patency was not statistically significant among the RA, saphenous vein without valve, and saphenous vein with valve conduits ($p > 0.05$; RA vs. vein without valve, $p = 0.737$; RA vs. saphenous vein with valve, $p = 0.321$; and saphenous vein without valve vs. saphenous vein with valve, $p = 0.465$).

Key Words: CABG; saphenous vein; radial artery; computerized tomography

Koroner Arter Baypas Operasyonu Olan Olgularda Kapaklı Kapaksız Safen Ven ve Radiyal Arter Açıklığının Tomografi ile Araştırılması

ÖZET

Giriş: Çalışmamız prospektif bir çalışma olup yalnızca konduit olarak kullanılmış safen venlerin kapakçıklarının açık kalma üzerine etkisi değil, aynı zamanda kapaklı safen venin, kapaksız safen venin, radyal arterin iki yıllık açık kalma oranı çok kesitli bilgisayarlı tomografi (ÇKBT) anjiyografi kullanılarak araştırılmıştır.

Hastalar ve Yöntem: Kliniğimizde 2014-2015 yılları arasında koroner arter baypas greft operasyonu (KABGO) yapılmış hastalar üç farklı grefte göre gruplandı. Gruplar kalp akciğer makinası ve X-klemp (On-Pump X-klempli) kullanılarak KABGO yapılan hastalarda kullanılan greftlere göre oluşturuldu. Birinci grup (Grup 1); radiyal arter grubu, ikinci grup (Grup 2); valvli safen ven grubu, üçüncü grup (Grup 3); valv içermeyen safen ven grubu olarak belirlendi.

Bulgular: Greftlerde iki yıllık açık kalma oranı, radiyal arter için %87.5, kapaksız safen ven için %82.4 ve kapaklı safen ven için %78.8 bulunmuştur.

Sonuç: Radiyal arter, kapaksız safen ven, kapaklı safen ven arasında iki yıllık açık kalma oranları, istatistiksel olarak anlamlı değildir ($p > 0.05$; radiyal arter vs. valvsiz ven için $p = 0.737$; radiyal arter vs. valvli ven için $p = 0.321$; valvsiz ven vs. vavli ven için $p = 0.465$).

Anahtar Kelimeler: KABGO; safen ven; radiyal arter; bilgisayarlı tomografi

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INTRODUCTION

Coronary artery diseases are the leading causes of death observed among the people of the developed countries. Therefore, coronary artery bypass (CABG) surgery is one of the operations most frequently performed worldwide; approximately, > 800.000 patients annually undergo this surgery[1] Conventional CABG is performed using cardiopulmonary bypass device (CPB; heart–lung machine) and is called as on-pump CABG.

In CABG, various autogenous grafts are used to bypass the coronary arteries. Besides ITA (Internal thoracic artery/Internal mammary artery), the other choices of graft has always been a matter of debate. The patency of ITA graft used in coronary bypass surgeries is better than that of other grafts as per almost all studies and periods. Here, many factors, including the structure of the coronary artery that is undergoing grafting, the degree of stenosis, the graft structure, resection technique, and the quality of anastomosis, play important roles. The great saphenous vein and radial artery (RA) are the second and third, respectively, most frequently used grafts. The fact that the RA is most commonly used as an arterial graft depends on the suitability of the diameter and length and the ease of harvesting.

This prospective study investigated the effect of the valves of saphenous veins, which were used as conduits, on patency and the 2-year rates of the remaining patency of the saphenous vein with valve, saphenous vein without valve, and RA via multislice computerized tomography (MSCT) angiography.

PATIENTS and METHODS

An approval of the Başkent University Clinical Research Ethics Committee was obtained as ID KA14/121.

Clinical Characteristics of Patients

In the present study, all study participants were Caucasians and did not represent any other ethnic group. The study comprised the patients that underwent CABG surgery and postoperative MSCT angiography in our clinic between 2014 and 2015. The data were prospectively collected from the patients. This study included the conduits of 50 participants.

All patients were questioned about their medical history, and they underwent detailed physical examination. In the preoperative period, standard preoperative laboratory analyses, transthoracic echocardiography (TTE; Acuson, Mountain View, California, USA), pulmonary function test (Spirobank Spirometry, MIR medical IRR), and bilateral carotid artery Doppler ultrasonography (Toshiba Xario Prime Ultrasound) were performed in our clinic. The thorax, ascending aorta, and aortic arch calcifications were evaluated by standard telegram prior to the surgery. During the surgery, the entrances of the ascending aorta and aortic arch were carefully evaluated by manipulation. The procedure was amended for the patients in whom plaque was detected by manipulation, and they were excluded.

In the preoperative period, the use of clopidogrel (if applicable) was discontinued five days prior to the surgery and the use of acetylsalicylic acid was discontinued one day prior to the surgery in the cases undergoing on-pump (cross-clamping) CABG. In the preoperative period, blood glucose regulation in the patients with type 2 diabetes mellitus was performed with regular insulin before and after the surgery. The blood glucose concentration of the patients was maintained below 200 mg/dL. In the preoperative period, the blood samples of the study participants were collected into standard tubes containing ethylene diamine tetra-acetic acid as the anticoagulant agent. These samples were analyzed using Cell-Dyne 3700 (Abbott, Abbott Park, IL, USA) device. Prothrombin time, activated partial thromboplastin time (aPTT), and international normalized ratio were measured.

Dyslipidemia in the study participants was described as fasting serum low-density lipoprotein cholesterol ≥ 160 mg/dL, triglyceride ≥ 200 mg/dL, total cholesterol ≥ 240 mg/dL, and/or high-density lipoprotein cholesterol < 40 mg/dL and as receiving/not receiving active drug therapy for it[2]. The serum cholesterol concentration was measured by enzymatic method. Staged approach was adopted and saved for the post-CABG period for the patients in whom carotid artery disease was detected to be > 70% or < 100% before the surgery.

Surgical Procedure

All study participants were operated by the same surgery team, and they initially underwent isolated CABG surgery. Fentanyl, midazolam, and pancuronium bromide were used for the induction of anesthesia. Standard median sternotomy was further performed. Left internal mammary artery and other vascular conduits (saphenous vein and RA) were prepared. Heparin sodium (Nevparin® flakon 25.000 IU/5 mL) was administered at a dose of 300 IU/kg. CPB, cross-clamp, standard aortic, and two stage venous cannulas were used, and Jostra–Cobe (Model 043213 105, VLC 865, Sweden) heart–lung machine was used. Crystalloid cardioplegia was administered to all patients during the surgery, and hot-shot cardioplegia was administered at the end of the surgery. While the LIMA was used in all cases, the right internal mammary artery was not used. The great saphenous vein and RA were used as grafts. The valve control of the conduit segments of the saphenous vein was performed by administering physiological serum through the distal end using an olive-tip injector. LIMA was preferred as the conduit for the left anterior descending (LAD) coronary artery, RA was preferred for circumflex coronary artery, and the great saphenous vein (with or without valve) was preferred for right coronary artery or diagonal coronary arteries of LAD. The graft type for each coronary artery was recorded. Meticulous aseptic technique was performed during the surgery. The entrances of the ascending aorta and aortic arch were precisely examined by

manipulation during the surgery. The procedure was amended for the patients in whom plaque was detected by manipulation, and these patients were excluded. Unnecessary electrocautery usage and luxury perfusion in CPB were avoided. Hematocrit (Hct) and hemoglobin (Hb) values were checked every 20 min after the induction of anesthesia until the completion of the surgery. Intraoperative blood transfusion was performed when the Hct value decreased to 20%. Full revascularization was performed. Mediastinum and chest drains were subxyphoidally placed. Proximal anastomoses to the aorta were performed using side clamp. At the end of the surgery, the patients that underwent CABG received protamine hydrochloride (Protamin® ampoule 1000 IU/L mL) at appropriate doses for full-dose neutralization, and activated clotting time was maintained between 100 and 120 s. Some data relevant to the surgery are demonstrated in Table 1.

Graft patency was evaluated by cardiac tomography angiography performed two years after the discharge. For the present study, the patients were selected among those aged between 50 and 70 years and who underwent multiple artery coronary bypass surgeries, regardless of the sex. It was stipulated that all patients must have undergone bypass surgery as supported by the heart-lung machine that indicated stopped heart and that the RA and saphenous vein must have been used as grafts in all patients. The patients that were discharged without any complication were enrolled.

Postoperative Care

At the end of surgery, the patients were admitted to the cardiovascular surgery (CVS) intensive care unit (ICU). They were monitored in the ICU for Hct and Hb every four hours. We attempted to maintain the Hct level at 28% in all patients in the ICU.

In the postoperative period, acetylsalicylic acid (Coraspin 300®) at a dose of 300 mg/day was commenced along with enteral nutrition for all patients to reduce the risk of stroke after CABG. Cefazolin sodium (1 g; Cefamezin®-IM/IV), which is used as a standard prophylactic antibiotic in our clinic, was administered as a single dose for 30 min before the surgery and after every 8 hours after the surgery and was continued for 72 hours. Blood

Table 1. Data according to the groups

	Group 1 (n= 40) (radial artery)	Group 2 (n= 33) (saphenous vein with valve)	Group 3 (n= 51) (saphenous vein without valve)	p
Age (± SD) (year)	60.4 ± 9.7	63.9 ± 8.8	60.9 ± 11.5	0.308[A]
Gender (male)	33 (82.5%)	24 (72.7%)	40 (78.4%)	0.602[P]
PAD	2 (5%)	3 (9.1%)	3 (5.9%)	0.923[S]
Right carotid artery				
Stenosis < 50%	11 (27.5%)	14 (51.5%)	18 (35.3%)	
50% < stenosis ≤ 70%	0	2 (6.1%)	2 (3.9%)	*0.169[S]
70% ≤ stenosis < 100%	0	0	2 (3.9%)	
Stenosis= 100%	0	0	0	
Left carotid artery				
Stenosis < 50%	3 (7.5%)	2 (6.1%)	4 (7.8%)	
50% < stenosis ≤ 70%	1 (2.5%)	2 (6.1%)	0	*0.109[S]
70% ≤ stenosis < 100%	0	0	0	
Stenosis = 100%	2 (5%)	1(3%)	0	
Body surface area	1.8 ± 0.1	1.8 ± 0.1	1.8 ± 0.1	0.693[A]
BMI	39.7 ± 7.1	38.8 ± 6.6	39.8 ± 6.9	0.796[A]
Preoperative ejection fraction	49.3 ± 9.5	38.8 ± 6.6	39.8 ± 6.9	0.478[A]
The period from CABG to MSCT angiography (m)	34.9 ± 5.4	35 ± 4.9	34.4 ± 4.3	1[A]
Ejection fraction (before MSCT angiography)	62.6 ± 9.6	57.3 ± 9.9	60.3 ± 9.8	0.074[A]
Graft patency	35 (87.5%)	26 (78.8%)	42 (82.4%)	0.604[P]

[A]: p-value was presented as a result of one-way ANOVA test,
[P]: p-value was presented as a result of the Pearson chi-square test,
[S]: p-value was presented as a result of the Spearman correlation test,
* p-value was calculated according to no carotid artery stenosis.
BMI: Body mass index, SD: Standard deviation, PAD: Peripheral artery disease, CABG: Coronary artery bypass grafting, MSCT: Multislice computerized tomography.

glucose regulation in diabetic patients was strictly conducted with 100 IU/mL insulin glargine (Lantus® flacon) and 100 IU/mL human soluble (regular) insulin (Humulin-R® flacon) after the surgery. Insulin infusion was permitted in case of necessity. The blood glucose concentration was maintained below 200 mg/dL in all diabetic patients. RA grafts are more spasmodic than other grafts, particularly than saphenous grafts. Therefore, after harvesting, all radial arteries were kept in moderate warm solutions such as diltiazem, papaverine, and heparin.

After staying at the CVS ICU for 48 h in the postoperative period, the patients were then transferred to the CVS clinic within the third 24 hours. The patients were discharged from the hospital between days 6 and 11 after the surgery.

Statistical Analysis

Statistical analyses were performed using SPSS program (SPSS Inc., Chicago, IL, USA). Statistical significance of nonparametric data between the groups was analyzed by chi-square and Fisher's exact tests (because the observed values were below the expected values). Parametric data are shown as minimum, maximum, and mean ± standard deviation. Statistical significance of the parametric data between the groups was analyzed using the Kaplan-Meier test. The result was considered statistically significant if two-tailed p-value was < 0.05 (Table 1).

MSCT Image Reconstruction and Occlusion Evaluation

MSCT angiography was performed using Somatom Sensation 64 (Siemens, Forchheim, Germany) tomography device, and scanning parameters were selected as following: gantry rotation time, 330 ms; tube voltage, 120 kW and 250 mA; and detector collimation, 0.6 mm. Images were obtained at a single breath in approximately 8.4-13.1 s and in the cranio-caudal direction from the carina to the subcostal level. During MSCT angiography, 80-110 mL of non-ionized contrast agent (Iomeron 400, Bracco s.p.a., Milan, Italy), depending on the patient's body weight, was rapidly provided through the antecubital vein at a speed of 5.0 mL/second followed by 40 mL normal saline given as bolus infusion. Automatic peak contrasting density obtained from the ascending aorta was specified as +140 Hounsfield units. Reconstruction was obtained according to the retrospective electrocardiography synchronization technique enhancing 0.6 mm artifact free image sections by 0.6 mm images in the multiplanar reformat; three-dimensional volumetric display (volume rendering) format were created from axial thin sections, and coronary artery anatomy was evaluated.

All coronary artery segments and grafts were visually examined. Stenoses were classified as total occlusion (100% stenosis), severe stenosis (≥ 70% stenosis), and mild stenosis-complete patency (< 0% stenosis). MSCT angiography examinations were performed by independent radiologists, cardiovascular surgeons, and cardiologists (Figures 1-4).

Study Groups

The patients that underwent CABG were grouped depending on the graft type. The groups were established according to the grafts used in the patients that underwent CABG using CPB and cross-clamp (on-pump with cross-clamp). The first group (Group 1) was RA group, the second group (Group 2) was great saphenous vein with valve group, and the third group (Group 3) was great saphenous vein without valve group. In all patients, CABG was performed in ≥ 3 coronary arteries on CPB. Left internal mammary artery, RA, and saphenous vein were used as the grafts in the subjects participated in the study. The graft choice and coronary anastomosis sites were recorded in these patients. Unlike the standard procedure, the presence of a valve in the saphenous vein used was also reported. Proximal anastomoses were performed using side clamp. The duration of the cross-clamp did not exceed 90 min, and the duration of cardiopulmonary bypass did not exceed 120 min in the patients that underwent CABG by CPB with the cross-clamp technique. To create a homogeneous group, the dialysis patients or the patients with creatinine level > 2 g/dL, with aortic pathology detected during the surgery, and those in whom the surgery was amended, and the patients who underwent surgery in emergency status, redo CABG, or CABG without touching the ascending aorta (no-touch) or LIMA-LAD (single vascular disease patients) CABG were excluded from the study. Moreover, the patients that underwent second CABG surgery, those in whom the valve and coronary artery surgeries were performed in the same session, those who needed postoperative IABP support, those who were re-explored due to any postoperative reason, those who underwent CABG in an emergency status, and dialysis patients were also excluded to create more homogeneous and similar groups.

The patients who were allergic to contrast agent and who had chronic obstructive pulmonary disease, atrial fibrillation, tachycardia, or rhythm disorders, which would hinder MSCT angiography imaging, were also excluded. Among the eligible patients as per the study criteria, those who accepted the risk of coronary CT angiography, who agreed to participate in the study, and had appropriate pulse for coronary CT angiography were selected. Accordingly, 50 patients were enrolled. MSCT angiography was performed approximately 34.9 ± 4.8 m after the surgery to assess graft patency in the patients that were discharged from the hospital following on-pump CABG surgery.

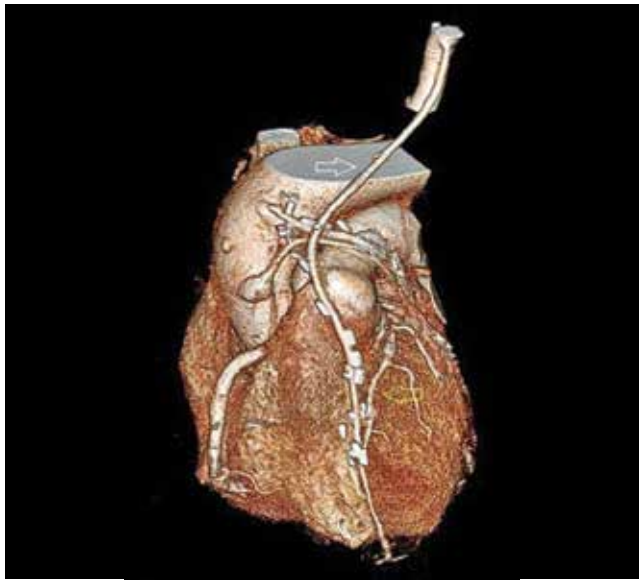

Figure 1. LIMA-LAD anastamosis. The white arrow is points out LIMA, and the yellow arrow is points out LAD.

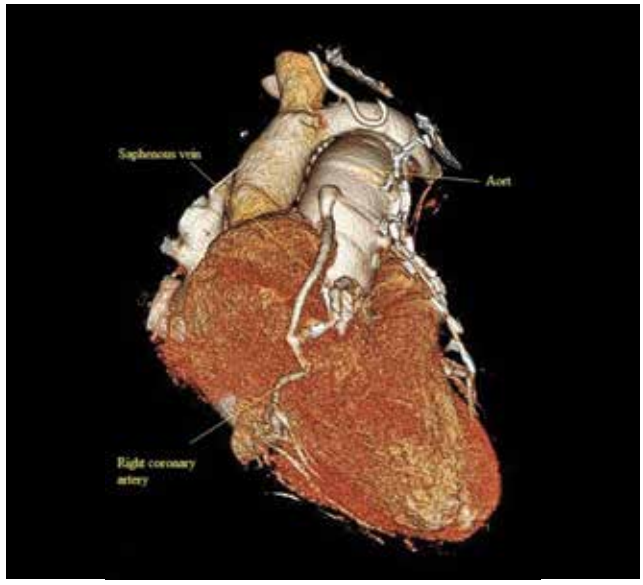

Figure 3. Right coronary artery anastamosis with saphen vein is shown.

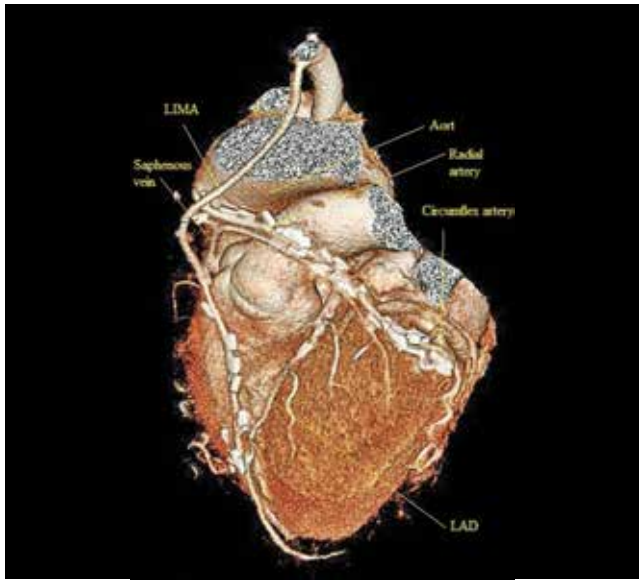

Figure 2. All anastamoses including saphenous vein, radial artery, and LIMA.

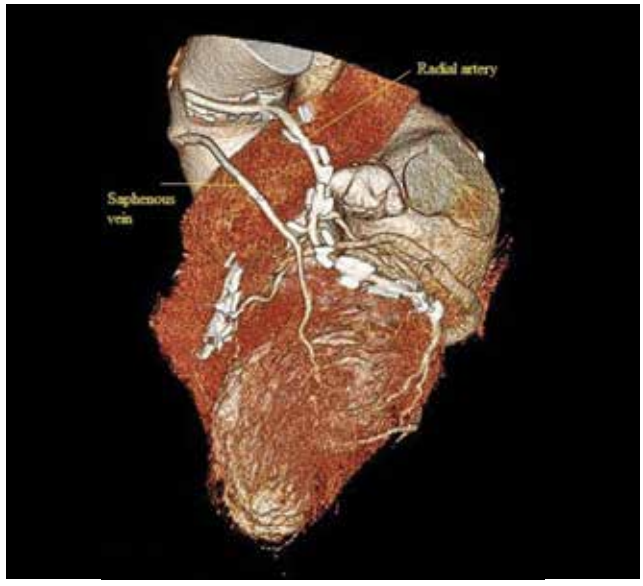

Figure 4. Circumflex artery anastamosis with radial artery and the branch of LAD anastamosis with saphenous vein.

RESULTS

Group 1 Characteristics

There were 40 patients in Group 1, and 33 (82.5%) of them were male with a mean age (± standard deviation) of 60.2 ± 10.2 y; the mean BMI (± standard deviation) was 39.8 ± 7.2 kg/m^2, mean preoperative EF (± standard deviation) was 50 ± 9.1%, the number of patients with stenosis (≥ 70% or < 100%) in the right carotid artery was 0 (0%), and the number of patients with stenosis (≥ 70% or < 100%) in the left carotid artery was 0 (0%). Further, there were 2 (6.1%) subjects with peripheral arterial disease (PAD).

For the females of Group 1, it was determined that the number was 7 (17.5%), mean age (± standard deviation) was 61.4 ± 7.6 years, mean BMI (± standard deviation) was 38.8 ± 7.4 kg/m^2, mean preoperative EF (± standard deviation) was 45.5 ± 11.2, the number of patients with stenosis (≥ 70% or < 100%) in the right carotid artery was 0 (0%), and the number of patients with stenosis (≥ 70% or < 100%) in the left carotid artery was 0 (0%). Further, there was no (0%) subject with PAD.

Group 2 Characteristics

For the males of Group 2, it was determined that the number was 24 (72.7%), mean age (± standard deviation) was 64 ± 9.1

years, the mean BMI (± standard deviation) was 39.4 ± 6.3 kg/m^2, mean preoperative EF (± standard deviation) was 50.4 ± 7.9, the number of patients with stenosis (≥ 70% or < 100%) in the right carotid artery was 0 (0%), and the number of patients with stenosis (≥ 70% or < 100%) in the left carotid artery was 0 (0%). Further, it was observed that there were 3 (12.5%) subjects with PAD.

Group 2 Characteristics

For the females of Group 2, it was determined that the number was 9 (27.3%), mean age (± standard deviation) was 63.4 ± 8.2 y, the mean BMI (± standard deviation) was 37.2 ± 7.4 kg/m^2, mean preoperative EF (± standard deviation) was 46.7 ± 10.9, the number of patients with stenosis (≥ 70% or < 100%) in the right carotid artery was 0 (0%), and the number of patients with stenosis (≥ 70% or < 100%) in the left carotid artery was 0 (0%). Further, there was no (0%) subject with PAD.

Group 3 Characteristics

For the males of Group 3; it was determined that the number was 40 (78.4%), mean age (± standard deviation) was 60.2 ± 12.4 y, the mean BMI (± standard deviation) was 40.9 ± 6.1 kg/m^2, mean preoperative EF (± standard deviation) was 52.7 ± 8.4, the number of patients with stenosis (≥ 70% or < 100%) in the right carotid artery was 0 (0%), and the number of patients with stenosis (≥ 70% or < 100%) in the left carotid artery was 0 (0%). Further, there were 3 (7.5%) subjects with PAD.

For the males of Group 3, it was determined that the number was 11 (21.6%), the mean age (± standard deviation) was 63.4 ± 7.5 y, mean BMI (± standard deviation) was 35.9 ± 8.5 kg/m^2, mean preoperative EF (± standard deviation) was 46.7 ± 11.6, the number of patients with stenosis (≥ 70% or < 100%) in the right carotid artery was 0 (0%), and the number of patients with stenosis (≥ 70% or < 100%) in the left carotid artery was 0 (0%). Further, there was no (0%) subject with PAD.

DISCUSSION

Conventional coronary angiography is the gold standard technique for evaluating coronary artery diseases[3]. Although its invasiveness and serious complications are rare, it necessitates the development of noninvasive, effective, and reliable alternative diagnostic methods. Along with the development of multislice computed tomography (MSCT) systems, CT coronary angiography has become one of the most common fields of practice[4]. The most significant advantages of CT coronary angiography as compared with those of the conventional angiography are the ease of application, the elimination of preparation period, follow-up, or hospitalization, patient comfort, and the most important being the absence of risk for serious complication as it is noninvasive. Owing to their large diameters, less prevalence of calcification, and it being relatively motionless, bypass grafts, compared with coronary arteries, are the configurations that can be visualized more easily by CT. Venous grafts in particular can be clearly visualized. The sensitivity and specificity of MSCT in detecting graft occlusion are 100% for each[4]. The sensitivity and specificity of MSCT angiography in detecting severe stenosis in graft was reported to be 96% and 100%, respectively[4]. Although there are differences between the studies in general, there are studies and information that in the early-phase (first one-year period), saphenous vein patency is similar to that of RA, but in the late-phase (after one year), RA patency is better[5]. While choosing the conduit, surgeons should consider the suitability for anatomic structure, the patient characteristics, the availability for grafting, and his/her own surgical experience.

Limited long-term patency of the veins used in coronary bypass surgery has been very clearly demonstrated[6-8]. Veins are prone to early atherosclerosis due to their flow characteristics and exposure to aortic pressure. In addition, they are different from the arteries as they contain valve and due to their endothelium and wall structure. The definite cause of early atherosclerosis, however, is unclear. Standardly, the resistance and elasticity of the valves reversely interposed in the veins against arterial pressure and their effect on thrombosis is not well documented.

The studies demonstrating RA patency are inadequate or superficial. While early studies have reported the patency rate of RA between ITA and saphenous vein, recent studies emphasize the opposite. In a recent study, based on angiography results, Khot et al. reported that RA patency is poorer than that of ITA and saphenous vein[8,9]. All studies reported that LIMA patency is higher in all periods. The duration of remaining patency in the postoperative period for RA and great saphenous vein, which are used as the second and third choices of graft, respectively, has always been a matter of debate. Although early studies emphasized that the rate of patency is better for RA, recent studies opine that the rate of patency is better for great saphenous vein.

Whitney et al. demonstrated that reversely interposed valve areas of saphenous vein cause turbulent flow and dilation[10]. Chaux et al. conducted an experimental study in the valve area of jugular veins of hypercholesterolemic rabbits and demonstrated that the valve area created turbulent and a focus for atherosclerosis, and atrophied valve area posed a potential for endothelial injury, the formation of microthrombi, and thrombocyte aggregation[11]. Based on the experimental and clinical data, Lojas et al. called the veins without valve as "good veins", recommended their use in bypass surgeries, and suggested that there is long patency in arterial grafts, except for ITA[12].

On combining their findings with those of earlier publications, Cohen et al. suggested that RA graft is better than saphenous vein in coronary bypass surgeries and that it has higher rate of patency comparable with that of the right ITA[13]. Athanasiou et al. performed a meta-analysis and systematic review between 1965 and 2009 comprising 35 publications and stated that

early-phase (before the first one year) patency rates of RA and saphenous vein are similar, but late-phase (1-5 years) patency is better for RA; they also stated that RA graft should be the first choice in coronary bypass surgeries[5].

In a study conducted in 2004, RA occlusion was detected by 8.2% and saphenous vein occlusion was detected by 13.6%[14]. The rate of string sign appearance was 7% in RA and 0.9% in saphenous vein. In the same study, it was observed that RA occlusion was equal in males and females and that the patency of RA that bypassed to the circumflex coronary artery is similar to that bypassed to the right coronary artery. Saphenous vein occlusion was reported to be more prevalent in females. The rate of RA patency was determined to be higher in diabetic patients and in those with peripheral vascular disease[14].

Modine et al. conducted a study in > 65-year-old elderly patients and reported that using RA in such patients is practical and harmless, and it does not enhance morbidity or mortality[15]. Engoren et al. reported that RA outcomes were better in elderly at the end of a 12-year period than those in the other age groups[16]. Georghiou et al. reviewed many studies and suggested that saphenous vein patency ranks second after RA and that the RA can be readily used for stenosis with thin native coronary structure[17].

As per the result of angiography performed a week after and a year after the CABG surgery, Goldman et al. indicated no difference between saphenous vein and RA groups in terms of the rate of remaining patency[18]. The same study reported that the rate of remaining patency is better in the saphenous veins removed by open surgery as compared to the veins endoscopically removed and that the rate of remaining patency was better at the end of one year for the saphenous veins implemented by on-pump surgery. String sign appearance due to the degree of coronary artery stenosis was observed to be more prevalent in the RA grafts[18]. While there was no difference between the radial arteries removed by endoscopic or open surgical methods in terms of the rate of remaining patency, the rates of remaining patency were the same also between the subjects who underwent on-pump or off-pump CABG surgery. The study emphasized that the rate of remaining patency at the end of one year was better for RA versus that of saphenous vein in type 2 diabetic patients[18]. Acar et al. reported the late-phase rate of the remaining patency at the end of 5 years to be 83% for the left internal mammary artery, 87% for the right internal mammary artery, 83% for RA, and 81% for great saphenous vein. The rate of remaining patency for the RA anastomosed to the LAD branches was 93%, anastomosed to the circumflex coronary artery was 82.5%, and anastomosed to the right coronary artery was 77.6%. The most significant finding of this study is that the rate of remaining patency was better for RIMA than that for LIMA, which was not found in any study[19]. Yie et al. conducted a study between 2002 and 2006 in 123 patients and reported RA patency to be 92% at the end of 32 weeks and stated that RA patency is better in the coronary arteries with serious degree of stenosis[20].

Considering the studies up to now, LIMA patency is better in coronary bypass surgeries and is independent of time. As the second choice graft, it is observed that RA patency in the intermediate- and late-phases is superior to saphenous vein patency.

CONCLUSION

The rate of remaining patency for the other grafts in decreasing order was as following: RA (87.5%), great saphenous vein without valve (82.4%), and great saphenous vein with valve (78.8%).

The fact that the rate of remaining patency is the highest for LIMA is consistent with the results of the studies conducted until today. However, the superiority of RA and great saphenous vein with or without valve conduits in terms of remaining patency has not been clearly identified. We believe that the mentioned outcome may be supported in large-scale studies.

Study Limitations

In the present study, all study participants were Caucasians and did not represent any other ethnic groups. The patients that would impair the similarity between the groups, including those with renal insufficiency, dialysis patients, and redo CABG cases, have not been included in the study. This study did not include power analysis. Statistical insignificance was observed because of the low number of participants.

CONFLICT of INTEREST

The authors reported no conflict of interest related to this article.

AUTHORSHIP CONTRIBUTIONS

Concept/Design: MÖ
Analysis/Interpretation: MÖ
Data Acquisition: BEÇ
Writting: MÖ
Critical Revision: FA
Final Approval: All of authors

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The Effect of Pump on Early Postoperative Mortality and Cerebrovascular Accident in Coronary Bypass Surgery Patients

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ABSTRACT

Introduction: This study investigated the mortality rates during the postoperative early period (one month) in patients who underwent on- or off-pump coronary artery bypass grafting (CABG) and explored the effects of cardiopulmonary bypass (CPB) on early mortality and cerebral accident.

Patients and Methods: This study comprises a total of 260 subjects that underwent CABG surgery in our clinic. Patients who underwent CABG were grouped according to two different surgical techniques: the first group (Group 1) consisted of patients who underwent CABG using CPB and cross-clamp (on-pump); the second group (Group 2) consisted of patients who underwent CABG by beating heart (off-pump) technique. Proximal anastomoses were performed using side clamps in all cases.

Results: Postoperative follow-up was conducted on patients until Day 30 for mortality. We encountered four dead cases and six cerebrovascular accidents.

Conclusion: The rates of cerebral accidents (2.4% vs. 2.1%) and deaths (1.8% vs. 1%) have the same ratios and are not statistically significant in on-pump CABG surgeries compared with off-pump CABG surgeries.

Key Words: Coronary artery disease; coronary artery bypass; off-pump coronary artery bypass; heart-lung machine; mortality; stroke

Açık Kalp Cerrahisinde, Pompanın Erken Postoperatif Mortalite ve Serebrovasküler Olay Üzerine Etkisi

ÖZET

Giriş: Bu çalışma, son gelişmelerle pompalı/pompasız koroner arter baypas grafting (KABGO) uygulanan hastalarda, postoperatif erken dönemde (bir ayda), kardiyopulmoner baypas (KPB)'ın erken mortalite ve serebral olay üzerine etkileri araştırıldı.

Hastalar ve Yöntem: Çalışmamız, kliniğimizde koroner arter baypas greftleme ameliyatı yapılan toplam 260 olguyu içermektedir. KABGO uygulanan hastalar iki farklı cerrahi tekniğe göre gruplandırıldı. Birinci grup (Grup 1), CPB ve X klemp (on-pump) kullanılarak KABGO uygulanan hastalardan oluştu. İkinci grup (Grup 2), atan kalp (off-pump) tekniği ile KABGO uygulanan hastalardan oluştu. Proksimal anastomozlar tüm olgularda yan klemp kullanılarak yapıldı.

Bulgular: Hastalar postoperatif otuzuncu güne kadar mortalite açısından takip edildi. Dört ölüm olgusu ve altı serebrovasküler olayla karşı karşıya kaldık.

Sonuç: On-pump KABGO ameliyatlarında off-pump KABGO ameliyatlarına kıyasla serebral kaza oranları (%2.4'e karşı %2.1) ve ölüm (%1'e karşı %1.8) benzer oranda görülürken istatistiksel olarak anlamlı değildir.

Anahtar Kelimeler: Koroner arter hastalığı; koroner arter baypas operasyonu; off pump koroner arter baypas operasyonu; kalp akciğer makinası; mortalite; felç

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INTRODUCTION

Coronary artery bypass grafting (CABG) surgery is one of the most frequently performed surgeries in the world. It has risks for central nervous system complications and mortality. Conventional CABG is performed using a cardiopulmonary bypass (CPB) device and is called as on-pump CABG, whereas the CABG performed without CPB is called off-pump CABG (beating heart).

On-pump CABG is considered the gold standard, but this method has physiological outcomes including the activation of the complement system, as well as thrombocytopenia, immune suppression, and inflammatory response, which can lead to organ dysfunction. Nevertheless, the manipulation of ascending aorta during cannulation (cannulation and cross-clamping) poses a risk for embolization and stroke.

Some studies emphasize that the mortality and morbidity rates of off-pump and on-pump coronary artery bypass surgeries are different, particularly in high-risk patients[1]. There are studies reporting the differences between these two CABG techniques in terms of the incidence of renal insufficiency, postoperative cognitive exposure, prolonged mechanical ventilation, blood loss, and prolonged duration of hospital and intensive care unit stays (2-5 days). However, in recent years, developments in CPB have led to improvements in surgical experience and patient management. We have encountered improvements in cooperation among specialists, such as cardiac surgeons, clinical perfusionists, anesthetists, and other technicians.

This study investigated the mortality and cerebral accident rates in the postoperative early period (one month) in patients who underwent on/off- pump CABG and explored the effects of CPB on early mortality and cerebral accidents.

PATIENTS and METHODS

This study has been approved by Institutional Review Board.

Clinical Characteristics of Patients

This study comprises a total of 260 subjects that underwent CABG surgery in our clinic. Their medical history was questioned, and detailed physical examination was performed in all patients. Transthoracic echocardiography (TTE) (Acuson, Mountain View, Acuson Sequoia C256, Siemens, GERMANY), standard preoperative laboratory analyses, pulmonary function test (Spirobank Spirometry, MIR medical International Research Product, ITALY), and bilateral carotid artery Doppler ultrasonography (Toshiba XARIO prime ultrasound, JAPAN) were performed in our clinic. Ascending aorta, thorax, and aortic arch calcification were evaluated by standard telegram prior to the surgery. During surgery, the ascending aorta and the beginning of the aortic arch were examined by manipulation. Patients with plaque detected during manipulation were not included in this study because their medical treatments were changed.

Clopidogrel (Plavix® 75 mg, Sanofi Aventis, FRANCE) and acetylsalicylic acid were respectively discontinued five and three days before surgery in patients who will undergo on-pump (with cross-clamp) CABG. Clopidogrel and acetylsalicylic acid (Coraspin® 100,150, 200 mg, Bayer Turk, TURKEY) were respectively discontinued five days and one day before surgery in patients who will undergo off-pump CABG.

Blood glucose concentration in patients with type 2 diabetes was regulated using regular insulin before and after surgery. The blood glucose levels of the patients were kept below 200 mg/dL.

Dyslipidemia in study participants was defined as fasting serum total cholesterol level ≥ 40 mg/dL, triglyceride level ≥ 200 mg/dL, low-density lipoprotein cholesterol level ≥ 160 mg/dL, and/or high-density lipoprotein cholesterol level < 40 mg/dL, as well as receiving or not receiving active drug therapy[6]. Serum cholesterol level was measured by enzymatic methods.

Serum samples were collected in standard tubes containing ethylenediaminetetraacetic acid as anticoagulant. These serum samples were analyzed via Cell-Dyne 3700 (Abbott, Abbott Park, IL, USA) device. The weight (SECA, Vogel & Holke, Hamburg, GERMANY) and height (SECA, Vogel & Holke, Hamburg, GERMANY) of the participants were measured, and body mass index (BMI) was calculated prior to the surgery. The distribution of BMI according to ages in groups is presented in Figures 1 and 2.

Patients who underwent CABG under emergency conditions, CABG surgery for the second time, CPB-supported off-pump CABG, and valvular and coronary artery surgeries in the same session, as well as and those with chronic renal insufficiency and

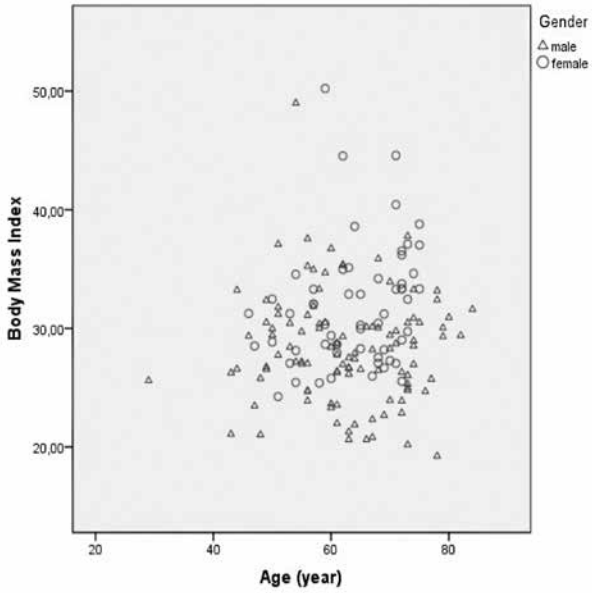

Figure 1. Distribution of BMI according to ages in Group 1.

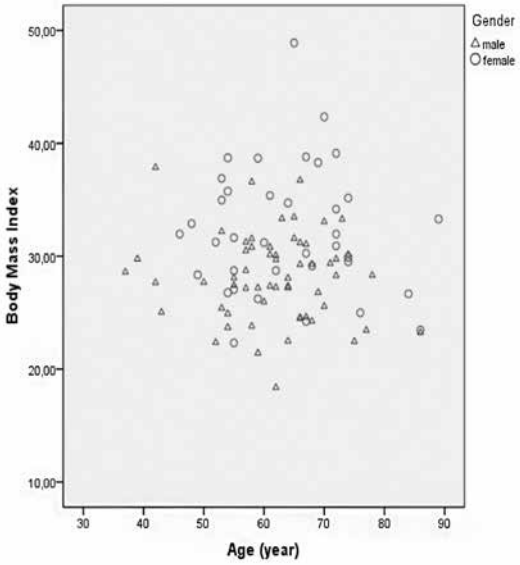

Figure 2. Distribution of BMI according to ages in Group 2.

undergoing dialysis patients, were excluded from this study to create a homogeneous group. Data were collected retrospectively. The stage approach was applied in patients with carotid artery disease over 70% and under 100%, and carotid artery surgery was delayed until one month after CABG.

Study Groups

Patients who underwent CABG were grouped according to two different surgical techniques. The first group (Group 1) included those that underwent CABG by using CPB and the cross-clamp (on-pump) technique. The second group (Group 2) consisted of patients who underwent CABG by the beating heart (off-pump) technique. A side clamp was used for proximal anastomosis in all cases.

In a study about CPB duration, it was found that the prolonged CPB duration independently increased mortality and morbidity after CABG[7]. Mean duration was 115 min in CABG patients participating in the study. To make a more balanced comparison between groups, the patients who underwent CABG by cross-clamp technique and CPB with cross-clamping times and CPB times not exceeding 90 and 120 min, respectively, were included.

Beating heart operation indications in our clinic: the proper diameter of the coronary artery, the epicardial view of the coronary arteries, and the cardiac performance are good enough to allow for cardiac manipulation. Otherwise, on-pump surgery is preferred. This choice obviously increases the number of anastomoses in on-pump surgery.

To create homogeneous groups, dialysis patients (or patients with creatinine level higher than 2 g/dL), patients whose surgery procedure has been changed because aortic pathology was seen during surgery, patients who underwent surgery under emergency conditions, patients who underwent redo-CABG, and patients who underwent surgery without touching the ascending aorta or underwent left internal mammarian artery (LIMA)-LAD CABG were not included in the study.

Surgical Procedure

Isolated CABG was performed in all patients who participated in this study. Fentanyl, midazolam, and pancuronium bromide were administered for the induction of anesthesia. Standard median sternotomy was applied. Vascular conduits (LIMA, saphenous vein and radial artery) were prepared. Heparin sodium (Nevparin® 5000 IU/mL Mustafa Nevzat, TURKEY) was administered (at a dose of 300 IU/kg). CPB, cross-clamp, standard aortic cannula, and two-stage venous cannula were applied. Jostra-Cobe (Model 043213 105, VLC 865, SWEDEN) heart-lung machine was used. Crystalloid cardioplegia during surgery and hot shot cardioplegia at the end of the surgery were used in all patients. LIMA was used in all cases, but the right internal artery was not. Great saphenous vein and radial artery have been the preferences for conduit. Meticulous aseptic technique was used in all operations. Unnecessary electrocautery and luxury perfusion (unnecessary CPB that enhances postoperative complications) were avoided. Heparinization was performed by administering 150 IU/kg heparin in patients who underwent the beating heart technique. Octopus and Starfish were applied in distal anastomoses.

In on-pump and off-pump techniques, a side clamp was used for proximal anastomoses. Several data about surgery are demonstrated in Table 1.

Postoperative Care

Cefazolin sodium (Cefamezin®-IM/IV, Zentiva, TURKEY), which is being used as standard prophylactic antibiotic in our clinic, was administered at a dose of 1 g/30 min before surgery and continued at 8 h intervals for 72 h after surgery. Acetylsalicylic acid (Coraspin® 300, Bayer Turk, TURKEY) was commenced at a dose of 300 mg/d together with enteral nutrition in all study participants. Blood glucose levels in diabetic patients were strictly regulated after surgery by using insulin glargine at a dose of 100 IU/ml (Lantus® flacon, Sanofi Aventis, FRANCE) and human soluble regular insulin at a dose of 100 IU/ml (Humulin-R® flacon, Lilly, TURKEY). Insulin infusion was not avoided. Blood glucose concentration was kept below 200 mg/dL in all diabetic patients.

Patients stayed at the cardiovascular surgery (CVS) intensive care unit for 48 h. They were admitted to the CVS clinic within 72 h after their drains and arterial catheters were removed. The patients were discharged from the hospital 6-12 d after surgery and were followed up until the 30th postoperative day for mortality and cerebral accident.

Statistical Analysis

Statistical analyses were made by SPSS (SPSS Inc., Chicago, IL, USA). Pearson's chi-squared analysis was used in the analysis of the statistical significance of nonparametric data between the groups, and Fisher's exact test was used for nonparametric data

Table 1. Data according to group

	Group 1 (n= 164) (On-pump CABG)	Group 2 (n= 96) (Off-pump CABG)	p
Age (± SD) (year)	63 ± 9.5	62.5 ± 10	0.687[T]
Gender (Male)	107 (65.2%)	59 (61.5%)	0.540[P]
Smoking	72 (43.9%)	37 (38.5%)	0.398[P]
COPD	37 (22.6%)	32 (33.3%)	0.058[P]
Hypertension	136 (82.9%)	74 (77.1%)	0.249[P]
PAD	9 (5.9%)	3 (3.1%)	0.544[F]
Preoperative leuykocyt count	8.14 ± 5.2	8.36 ± 2.15	0.682[T]
Preoperative thrombocyst count	258.6 ± 90.4	253.7 ± 68.7	0.647[T]
Preoperative stroke story	11 (6.7%)	7 (7.3%)	0.858[P]
Diabet oral a/d	49 (29.9%)	30 (31.3%)	0.907[P]
Parenteral a/d	29 (17.7%)	15 (5.6%)	
Right carotid artery			
No stenosis	*101 (61.5%)	*61 (63.5%)	*0.753[P]
Stenosis < %50	55 (33.5%)	28 (% 29.2%)	
%50 < stenosis ≤ %70	6 (3.7%)	7 (% 7.3%)	
% 70 ≤ stenosis < %100	1 (0.6%)	0	
Stenosis= %100	1 (0.6%)	0	
Left carotid artery			
No stenosis	*96 (38.5%)	63 (36.5%)	*0.258[P]
Stenosis < %50	54 (32.9%)	29 (% 30.2)	
%50 < stenosis ≤ %70	10 (6.1%)	4 (% 4.2)	
% 70 ≤ stenosis < %100	2 (1.2%)	0	
Stenosis= %100	2 (1.2%)	0	
Weight (kg)	78.3 ± 13.4	77.3 ± 13.1	0.548[T]
BMI	29.5 ± 5.1	29.7 ± 5	0.768[T]
Ejection Fraction	53.7 ± 9.7	54.5 ± 8.8	0.536[T]
Numbers of grafting	3.6 ± 0.8	2.6 ± 0.9	< 0.001[T]
Preoperative leukocyte count	8.1 ± 5.2	8.3 ± 2.1	0.682[T]
Preoperative thrombocyte count	258.6 ± 90.4	253.7 ± 68.7	0.647[T]
Postoperative stroke	4 (2.4%)	2 (2.1%)	1[F]
Postoperative mortality	3 (1.8%)	1 (1%)	1[F]

[T]: p value as Student's t-test result,
[P]: p value as Pearson's chi-squared test result,
[*]: Student's t-test was made according to these values,
[F]: Fisher's exact test was used because the observed values were below the expected values.
BMI: Body mass index, SD: Standard deviation, PAD: Peripheral artery disease, COPD: Chronic obstructive pulmonary disease, CABG: Coronary artery bypass grafting.

in case the observed between-group values were lower than expected. Although parametric data were shown as minimum, maximum, and mean ± standard deviation, independent Student's t-test was used in the statistical significance of parametric data between the groups. If two-tailed p value was lower than 0.05 (p< 0.05), it was considered statistically significant (Table 1).

RESULTS

Subject Characteristics

The minimum and maximum ages of all participants were 29 and 89 years (mean ± standard deviation: 62.8 ± 9.7 y), respectively. Among the patients in our study, 166 (63.8%) were male and 94 (36.2%) were female. The number of patients receiving an antidiabetic agent was 123 (47.3%), and the number of patients with hypertension (HT) was 210 (80.8%). There were 69 (26.5%) patients with chronic obstructive pulmonary disease (COPD) and 109 smokers (41.9%). A total of 18 (6.9%) patients have histories of stroke, 1 patient (0.4%) with right carotid artery stenosis (70% ≤ lesion < 100%), 2 patients (0.8%) with left carotid artery stenosis (70% ≤ lesion < 100%). In our study, the number of patients who underwent CABG with CPB was 164 (63.1%), and the number

of patients who underwent beating heart technique was 96 (36.9%). Mortality was observed in four patients (1.5%) in the postoperative period.

Groups Characteristics

Males in Group 1: Two (1.9%) dead cases were shown, and the mean ± standard deviation preoperative EF was 52.5 ± 9.4. The mean ± standard deviation age was 62.4 ± 10.3 y, the mean ± standard deviation body mass index (BMI) was 28.2 ± 4.6 kg/m^2, and the mean ± standard deviation number of bypass grafting performed in CABG was 3.5 ± 0.8. The number of patients with history of cerebrovascular accident (CVA) before surgery, right carotid artery stenosis (70% ≤ lesion < 100%), and left carotid artery stenosis (70% ≤ lesion < 100%) was nine (8.4%), zero (0%), and two (1.9%), respectively. There were 67 (62.6%) smokers, 82 (76.6%) hypertensive patients, 29 (27.1%) patients with COPD, 7 (6.5%) patients with PAD, 28 (26.2%) patients receiving oral antidiabetic agent, and 12 (11.2%) patients receiving parenteral antidiabetic agents. The mean ± standard deviation preoperative leukocyte count was 8.27 ± 6.1, and the mean ± standard deviation preoperative thrombocyte count was 247.9 ± 74.9.

Females in Group 1: One (1.8%) dead case was shown. The mean ± standard deviation age was 64.1 ± 7.9 y, the mean ± standard deviation BMI was 31.8 ± 5.1 kg/m^2, the mean ± standard deviation preoperative EF was 56 ± 9.8, and the mean ± standard deviation number of bypass grafting performed in CABG was 3.7 ± 0.8. Two patients (3.5%) have CVA histories before surgery, one patient (1.8%) has right carotid artery stenosis (70% ≤ lesion < 100%), and no patient (0%) has left carotid artery stenosis (70% ≤ lesion < 100%). It was observed that there were 54 (94.7%) hypertensive patients, 5 (8.8%) smokers, 8 (14%) patients with COPD, 2 (3.5%) patients with PAD, 21 (36.8%) patients receiving oral antidiabetic agent, and 17 (29.8%) patients receiving parenteral antidiabetic agent. The mean ± standard deviation preoperative leukocyte count was 7.89 ± 2.5 and the mean ± standard deviation preoperative thrombocyte count was 278.9 ± 112.

Males in Group 2: No (0%) death cases were encountered after surgery. The mean ± standard deviation age was 61.5 ± 9.5 y, the mean ± standard deviation BMI was 28.1 ± 3.8, the mean ± standard deviation preoperative EF was 56.3 ± 7.5, and the mean ± standard deviation number of bypass grafting performed in CABG was 2.7 ± 1. Five patients (8.5%) have CVA histories, zero patients (0%) have right carotid artery stenosis (70% ≤ lesion < 100%), and no patient (0%) has left carotid artery stenosis (70% ≤ lesion < 100%). There were 33 smokers (55.9%), 42 hypertensive patients (71.2%), 18 patients (30.5%) with COPD, 2 patients (3.4%) with PAD, 19 patients (32.2%) receiving oral antidiabetic agent, and 3 patients (5.1%) receiving parenteral antidiabetic agent. The mean ± standard deviation preoperative leukocyte count was 8.51 ± 2.1, and the mean ± standard deviation preoperative thrombocyte count was 256.7 ± 71.8.

Females in Group 2: One (2.7%) dead case was shown after surgery. The mean ± standard deviation) age was 63.9 ± 10.8 y, the mean ± standard deviation BMI was 32.2 ± 5.6, the mean ± standard deviation preoperative EF was 51.5 ± 10, the mean ± standard deviation number of bypass grafting performed in CABG was 2.5 ± 0.8. Two patients (5.4%) have CVA histories before surgery, no patient (0%) has right carotid artery stenosis (70% ≤ lesion < 100%), and no patient (0%) has left carotid artery stenosis (70% ≤ lesion < 100%). There were 4 smokers (10.8%), 32 hypertensive patients (86.5%), 14 patients (37.8%) with COPD, 1 patient (2.7%) with PAD, 11 patients (29.7%) receiving oral antidiabetic agent, and 12 patients (32.4%) receiving parenteral antidiabetic agent. The mean ± standard deviation preoperative leukocyte count was 8.1 ± 2, and the mean ± standard deviation preoperative thrombocyte count was 249 ± 64.1.

The patients were followed up until the 30th postoperative day for mortality and cerebral accident. We encountered four dead cases and six cerebrovascular accidents. The distribution of mortality in all participants is presented in Figure 3.

DISCUSSION

Conventional CABG is performed using a CPB device and is called on-pump CABG, whereas the CABG performed without CPB is called off-pump CABG. On-pump CABG is described as the gold standard; however, this method has some physiological outcomes, including thrombocytopenia, complement system activation, immune suppression, and inflammatory response, which lead to organ dysfunction. The manipulation of the ascending aorta during cannulation has risk for embolization and stroke.

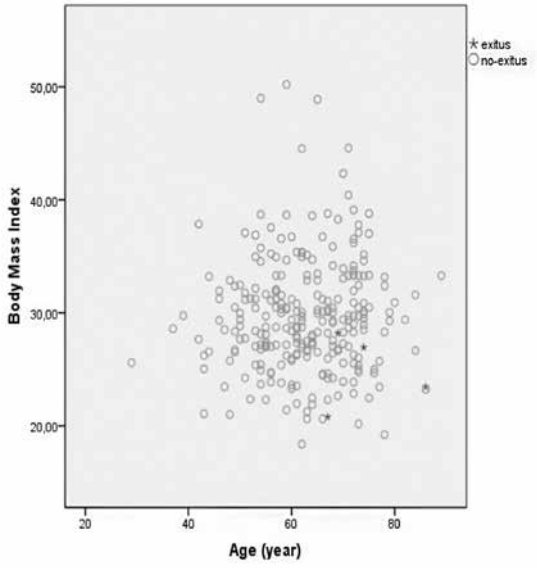

Figure 3. Distribution of mortality in all participants.

Puskas et al. reported that beating heart CABG (off-pump) has become the preferred technique because of similar number of revascularization, improved time until hospital discharge, and decreased number of patients with low cardiac output compared with conventional CABG (on-pump CABG)[8]. Supporting these data, some authors reported that off-pump CABG might reduce perioperative morbidity compared with on-pump CABG[9].

Conventional CABG is characterized by precise coronary anastomoses performed by using CPB. However, providing blood-free surgical area and performing precise anastomosis using CPB brings along unfavorable effects for the patient including blood trauma, inflammatory response, negative nonpulsatile flow, potential air embolus, and debris embolization arising from the aorta[10]. Off-pump CABG was considered a technique for removing the unfavorable effects of CPB.

Dalen et al. retrospectively reviewed patients who underwent CABG surgery in Sweden in a mean period of 7.1 years [11]. They emphasized that patients who underwent off-pump or on-pump surgery had similar outcomes in terms of long-term survival, mortality, re-hospitalization due to myocardial infarction (MI), heart failure, and stroke. Hueb et al. prospectively followed 155 patients who underwent off-pump CABG and 153 patients who underwent on-pump CABG surgery for five years and found no difference between off-pump CABG and on-pump CABG in terms of mortality, MI, revascularization, recurrence of angina, and stroke [12].

Recently, CABG is increasingly being performed in many high-risk patients. The benefits of off-pump CABG are obvious in terms of complications due to CPB and aorta. Recent studies have demonstrated improvements in high-risk patients who underwent off-pump CABG [13-16].

Off-pump CABG and the gold standard on-pump CABG have been compared both in large retrospective observational studies and in randomized controlled studies. The results of studies on both techniques revealed comparable outcomes. However, small, prospective, randomized, controlled studies are lacking. One study has reported that these other studies are incapable of demonstrating early- and late-term results concerning incomplete revascularization, decreased long-term graft patency, increased recurrent revascularization, and survival. This has encouraged researchers who are against off-pump CABG to promote the discontinuation of this technique. There are studies stating that those who have doubt about the applicability and benefit of off-pump CABG ignore statistically significant studies that demonstrate similar long-term outcomes and more comfortable hospital care periods than on-pump CABG [17-22].

Selnes et al. followed 75 patients who underwent off-pump CABG and 152 patients who underwent on-pump CABG for 6 years and reported that long-term cardiac and cognitive outcomes are generally similar [23]. Van Dijk et al. performed 282 off-pump CABG surgeries by using the octopus stabilizer device and emphasized that it is not different from CPB in terms of five-year survival rate, MI, angina recurrence, stroke, revascularization, and cognitive functions[24].

Van Dijk et al., Roy et al., Legare et al. and Parolari et al. compared the short-term outcomes of on-pump and off-pump CABG and found no comparable differences [25]. Beckermann et al. stated that off-pump CABG is superior to on-pump CABG owing to mildly better hospital discharge rates and lower incidence of some postoperative complications particularly atrial fibrillation, psychotic syndromes, and renal dysfunction [1].

In their large-series studies, Plomondon et al. reported that off-pump CABG is superior to on-pump CABG in terms of early morbidity and mortality rates [26].

In this study, it was observed that the rate of death and cerebral accident in hospitals or within 30 postoperative days was the same (i.e., statistically insignificant) in the on-pump CABG group (Group 1) compared with the off-pump group (Group 2). The preoperative evaluation of EF by transthoracic ECHO was not different between the groups. It was observed that EF was over 50% in two of three cases that died and below 50% in the other case in Group 1. EF was below 50% in one patient who died in Group 2. Although the mortality in Group 1 was due to low cardiac output syndrome in two cases and due to multiple organ failure in one case, mortality was due to catastrophic CVA in Group 2. Even though postoperative stroke was not the cause of any postoperative death in the on-pump CABG group, stroke was considered the cause of mortality in the off-pump CABG group. Two of the cases that died in Group 1 were under the age of 70, and one was over the age of 70. By contrast, the case that died in Group 2 was over the age of 80. The mean number of bypass grafting was found to be statistically significantly higher in the on-pump group versus the off-pump group. However, it was determined that three grafts were used in two of the three patients who died in the postoperative period in Group 1, and four grafts were used in the other case. By contrast, three grafts were used in the case that died in the postoperative period in Group 2.

CONCLUSION

In this study, no statistically significant difference was determined between on-pump CABG and off-pump CABG in terms of early postoperative mortality rate and cerebral accident rate during 30 postoperative days. The results can be summarized under two topics: the number of bypass grafting performed in on-pump CABG surgeries is statistically significantly higher than the number of bypass grafting performed in off-pump CABG surgeries; the rates of cerebral accident (2.4% vs. 2.1%) and death (1.8% vs. 1%) have the same ratios and are not statistically significant in on-pump CABG compared with off-pump CABG[1,2]. In recent years, developments

in CPB have improved the surgical experience and patient management. Additionally, we have observed improvements in the cooperation of specialists, such as cardiac surgeons, clinical perfusionists, anesthetists, and other technicians. These improvements help surgical teams achieve better results. We believe that current on-pump CABG surgery is as safe as off-pump CABG for patients who meet the criteria mentioned in our study.

Study Limitations

All study participants are Caucasians and do not represent other ethnic groups. The present study does not comprise patients with renal insufficiency, dialysis patients, or redo-CABG cases.

CONFLICT of INTEREST

The authors reported no conflict of interest related to this article.

AUTHORSHIP CONTRIBUTIONS

Concept/Design: FA

Analysis/Interpretation: MÖ

Data Acquisition: FA

Writting: MÖ

Critical Revision: FA

Final Approval: All of authors

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Üçüncü Basamak Bir Merkezden Kardiyak Arrest Serisi

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ÖZET

Giriş: Kardiyak arrest etkili kardiyopulmoner resüsitasyon (KPR) yapılmazsa ölümle sonuçlanan kardiyak fonksiyonların beklenmedik şekilde kaybolmasıdır. Ani kardiyak arrest olayın meydana geldiği yere bağlı olarak hastane içi ve dışı olarak sınıflandırılır.

Hastalar ve Yöntem: Çalışmaya 2013-2016 yılları arasında kardiyak arrest tanısıyla hastane içi ve hastane dışı olmak üzere Koşuyolu Kalp Hastanesi Acil Servisine başvuran veya hasta yakını ya da ambulans yardımı ile tıbbi ekipmanla getirilen 18 yaş üstü 134 hasta dahil edilmiştir. Hastaların demografik özellikleri hastane veri tabanından sağlanmıştır.

Bulgular: Çalışmaya 95 (%71) erkek, 39 (%29) kadın hasta olmak üzere toplam 134 hasta dahil edilmiştir. Yaş ortalaması 61.7 ± 14.6 olarak saptandı. Total 134 kardiyak arrestin 58'i hastane içi, 76'sı hastane dışı olarak saptanmıştır. KPR sonrası nabızlı elektriksel aktivite saptanan hastaların 35 (%64.8)'i hastane içi arrest, 19 (%35.2)'u hastane dışı arrest; nabızlı elektriksel aktivite sağlanamayan hastaların 23 (%28.7)'ü hastane içi arrest, 57 (%71.2)'si hastane dışı arrest olarak saptanmıştır ($p< 0.001$).

Sonuç: Çalışmamızda kardiyak arrest nedeni olarak en sık nedenler; ST yükselmeli miyokart infarktüsü, konjestif kalp yetersizliği ve nedeni belirlenemeyen grup olarak belirlenmiştir. Geliş ritmi olarak en fazla asistol ritmi saptanmıştır. KPR sonrası nabızlı elektriksel aktivite sağlanan grupta saptanan ventriküler fibrasyon oranı nabızlı elektriksel aktivite sağlanamayan gruptakine göre daha yüksek oranda tespit edilmiş ve istatistiksel olarak anlamlı saptanmıştır. Çalışmamızda literatüre benzer olarak şoklanabilir ritim olanlarda nabızlı elektriksel aktivite sağlanma oranı daha fazla saptanmıştır.

Anahtar Kelimeler: Kardiyak; arrest

Cardiac Arrest Registry at a Tertiary Center

ABSTRACT

Introduction: Cardiac arrest, which may result in death without an effective cardiopulmonary resuscitation (CPR), is the unexpected loss of cardiac functions. Sudden cardiac arrest is classified as in-hospital and out-of-hospital depending on the place where the event occurs.

Patients and Methods: In this study, 134 patients (age, >18 years) who were admitted or were brought with the help of their relatives or in an ambulance and medical equipment to the Emergency Department of Kosuyolu Cardiac Hospital with the diagnosis of in-hospital or out-of-hospital cardiac arrest between 2013 and 2016 were enrolled. Demographic characteristics of the patients were obtained from the hospital database.

Results: In total, 134 patients were included in this study. Of these, 95 (71%) were males and 39 (29%) were females. The mean patient age was 61.7 ± 14.6 years. In a total of 134 cardiac arrests, 58 were in-hospital and 76 were out-of-hospital. Among the patients who exhibited electrical activity with pulse after CPR, 35 (64.8%) experienced in-hospital cardiac arrest and 19 (35.2%) experienced out-of-hospital cardiac arrest, whereas among the patients who exhibited pulseless electrical activity after CPR, 23 (28.7%) experienced in-hospital cardiac arrest and 57 (71.2%) experienced out-of-hospital cardiac arrest ($p< 0.001$).

Conclusion: The most common cause of cardiac arrest in our study cohort was myocardial infarction with ST segment elevation, followed by congestive heart failure and indefinite causes. Asystole was the most common rhythm at admission. The rate of ventricular fibrillation detected in the returning group was found to be higher than the non-returning group and the difference was statistically significant ($p< 0.001$). Similary to literature in our study, pulsatile electrical rhythm was found to be more prominent in pulsatile rhythms.

Key Words: Cardiac; arrest

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GİRİŞ

Kardiyak arrest etkili kardiyopulmoner resüsitasyon (KPR) yapılmazsa ölümle sonuçlanan kardiyak fonksiyonların beklenmedik şekilde kaybolmasıdır. Ani kardiyak arrest olayın meydana geldiği yere bağlı olarak hastane içi ve dışı olarak sınıflandırılır. Hastane dışı arrestin en sık nedeni iskemik kalp hastalığı olmasına rağmen, diğer reversible nedenler olan hipoksi, hipovolemi, hipo ya da hiperkalemi, metabolik bozukluklar, hipotermi, tromboemboli, perikardiyal tamponad, toksik nedenler ve tansiyon pnömotoraks gibi durumlar da kardiyak arreste neden olabilir. Her türlü tanı ve tedavi uygulamalarına rağmen hastane dışı arrestlerin mortalite oranları çok yüksektir[1]. Hastane dışı kardiyak arrest dünya çapında ölüme neden olan başlıca nedenlerden olup, gelişmekte olan ülkelerde total mortalitenin yaklaşık %10 kadarını oluşturmaktadır[2].

Hastane dışı arrestte sonucu etkileyen faktörler arasında tanıklı arrest, acil servise ulaşma zamanı, başlangıç ritmi ve defibrilasyon uygulanma zamanı bulunmaktadır[3,4]. Hastane içi arrest, Amerika Birleşik Devletleri (ABD)'nde yıllık ortalama 200.000 olgu olarak rapor edilmiş olup, hastaneden taburculuk sonrası sağkalım oranı %7-26 civarındadır[5,6]. Hastane içi arrest olan hastalar daha düşkün hastalar olup, daha fazla komorbid durum eşlik etmekte, asistol ya da nabızsız elektriksel aktivite gibi şoklanamayan ritimler daha fazla bulunmaktadır[6].

Çalışmamızda 3 yıllık zaman periyodu içinde, acil servis başvuru sonrası acil servis izlemde olmak üzere, hastane içi ya da hastane dışı arrest olarak tersiyer bir merkez olan Kartal Koşuyolu Yüksek İhtisas Sağlık Uygulama ve Araştırma Merkezi Acil Servisine başvuran hastaları etyoloji, demografik özellikleri, geliş ritimleri ve geliş ritimlerinin KPR sonrası elektriksel aktivite sağlanma oranları açısından yayınlamayı amaçladık.

HASTALAR ve YÖNTEM

Çalışmamıza Yerel Etik Kuruldan 2017.6/18-62 dosya numarası ile etik kurul onayı alınmıştır.

Çalışmaya 2013-2016 yılları arasında kardiyak arrest tanısıyla hastane içi ve hastane dışı olmak üzere Kartal Koşuyolu Yüksek İhtisas Sağlık Uygulama ve Araştırma Merkezi Acil Servisine başvuran veya hasta yakını ya da ambulans yardımı ile tıbbi ekipmanla getirilen 18 yaş üstü 134 hasta dahil edilmiştir. Hastaların demografik özellikleri hastane veri tabanından sağlanmıştır.

Hipertansiyon ve diabetes mellitus tanıları hastaların geçmiş kayıtları ve hasta yakınlarının ifadeleri doğrultusunda alınmıştır. Önceden koroner stent işlemi ya da koroner baypas operasyonu varlığı önceden koroner arter hastalığı olarak tanımlanmıştır. Kronik böbrek yetersizliği, konjestif kalp yetersizliği, perifer arter hastalığı ve kronik obstrüktif akciğer hastalığı geçmiş kayıtlardan elde edilmiştir.

İlk tıbbi başvuru anında çekilen elektrokardiyografi (EKG) sonucu ST segment yükselmeli miyokart infarktüsü ve ST segment yükselmesiz miyokard infarktüsü tanıları ilgili kılavuzlara göre konulmuştur. Önceden kalp yetersizliği nedeniyle takipte olan ve acil servise arrest olarak gelen ve kalp yetersizliği kliniği ile acilde izlemde hemodinamisi bozulan ve arrest olan hastalar konjestif kalp yetersizliği nedenli olarak tanımlanmıştır. Önceden akciğer nedenli problemlerle takipte olan ve acil serviste kardiyak nedenler dışlandıktan sonra arrest olan hastalar akciğer hastalıkları ve kronik obstrüktif akciğer hastalıkları olarak tanımlanmıştır. Önceden renal yetersizlik olsun olmasın acil servise geliş sonrası takipte idrar çıkışı olmayan, asidozu olan ve nefroloji konsültasyon sonrası acil diyaliz planlanan hastalar akut böbrek yetersizliği olarak kabul edilmiştir. Hiperosmolar nonketotik koma, hipoglisemi ve diabetik ketoasidoz tanısı konulan hastalar metabolik nedenler olarak saptanmıştır. Önceden yapısal kalp hastalığı olmayan, Brugada sendromu, Wolf Parksinson White sendromu ve long QT tanılı hastalar malign aritmiler olarak tanımlanmıştır. Pulmoner emboli tanısı kontrastlı pulmoner bilgisayarlı tomografi anjiyografi sonrası trombüs ve sağ kalp boşluklarında genişleme olması olarak tanımlanmıştır. Yakınlarından alınan bilgiler doğrultusunda aktif göğüs ağrısı sonrası arrest olan ancak ritim sağlanamayan hastalar aktif göğüs ağrısı sonrası arrest olarak tanımlanmıştır.

Geliş ritimleri; nabızsız geniş QRS'li ritim; ventriküler taşikardi (VT), tanımlanabilen P, QRS ve T dalgasının olmadığı değişik yükseklikte karmaşık düzensiz dalgalar; ventriküler fibrilasyon (VF), ritim olup nabızın olmadığı durum; elektromekanik disosiasyon ve hiçbir elektriksel aktivitenin olmadığı, düz çizgilenmenin olduğu ritim; asistol olarak tanımlanmıştır. Başarılı KPR sonrası sağlanan klinik durum nabızlı elektriksel aktivite olarak tanımlanmıştır.

İstatistiksel Analiz

Sürekli değişkenler ortalama ± standart sapma şeklinde verildi. Kategorik değişkenler ise yüzde olarak verildi. Kategorik değişkenleri karşılaştırmada ise Ki-kare (x^2) veya Fisher x^2 testleri kullanıldı. Tüm istatistiksel analizlerde $p< 0.05$ olan değerler anlamlı olarak kabul edildi. Tüm istatistiksel analizler SPSS 17.0 (SPSS Inc, Chicago, IL, USA) kullanılarak yapıldı.

BULGULAR

Çalışmaya 95 (%71) erkek , 39 (%29) kadın hasta olmak üzere toplam 134 hasta dahil edilmiştir. Yaş ortalaması 61.7 ± 14.6 olarak saptandı. Hastaların demografik özellikleri Tablo 1'de verilmiştir. Etyolojik olarak saptanan kardiyak arrest nedenleri Tablo 2'de verilmiştir. En sık 3 kardiyak arrest nedeni; ST segment yükselmeli miyokart infarktüsü, konjestif kalp yetersizliği ve nedeni belirlenemeyen grup olarak saptanmıştır. Kardiyak arrest ile acile ilk gelişte tespit edilen geliş ritimleri Tablo 3'te verilmiştir. En sık geliş ritmi olarak asistol saptan-

Tablo 1. Hastaların demografik özellikleri

	Hasta sayısı (n= 134)
Yaş, yıl	61.7 ± 14.6
Cinsiyet, n (erkek %)	95 (%70.9)
Hipertansiyon, n (%)	110 (%82.1)
Diabetes mellitus, n (%)	90 (%67.2)
Sigara kullanımı, n (%)	109 (%81.3)
Önceden koroner arter hastalığı varlığı, n (%)	45 (%33.6)
Kronik böbrek yetersizliği, n (%)	51 (%38.1)
Konjestif kalp yetersizliği	47 (%35.1)
Perifer arter hastalığı	12 (%9)
Kronik obstrüktif akciğer hastalığı	29 (%21.6)

Tablo 2. Kardiyak arrest etyolojisi

	Hasta sayısı (n= 134)
ST segment yükselmeli miyokart infarktüsü, n (%)	38 (%28.4)
Konjestif kalp yetersizliği n (%)	23 (%17.2)
Nedeni belirlenemeyen grup n (%)	18 (%13.4)
ST segment yükselmesiz miyokart infarktüsü, n (%)	15 (%11.2)
Akciğer hastalıkları ve kronik obstrüktif akciğer Hst n (%)	11 (%8.2)
Akut böbrek yetersizliği n (%)	6 (%4.5)
Metabolik nedenler n (%)	5 (%3.7)
Malign aritmiler n (%)	4 (%3)
Pulmoner emboli n (%)	3 (%2.2)
Aktif göğüs ağrısı sonrası arrest n (%)	3 (%2.2)
İntrakranial kanama n (%)	2 (%1.5)
Abdominal aort anevrizma rüptürü n (%)	1 (%0.7)
İskemik serebrovasküler olay n (%)	1 (%0.7)
Atrioventriküler tam blok n (%)	1 (%0.7)
Torasik aort anevrizma rüptürü n (%)	1 (%0.7)
Pnömotoraks n (%)	1 (%0.7)

Tablo 3. Hastaların hastaneye geliş ritimleri

	Hasta sayısı (n= 134)
Ventiküler taşikardi n (%)	14 (%10.4)
Ventiküler fibrilasyon n (%)	23 (%17.2)
Elektromekanik disosiasyon n (%)	2 (%1.5)
Asistol n (%)	94 (%70.1)
Geliş ritim belirlenemeyen n (%)	1 (%0.7)

Tablo 4. KPR sonrası nabızlı elektriksel aktivite sağlanma oranları

	Total hasta sayısı (n= 134)
KPR sonrası nabızlı elektriksel aktivite sağlanan hasta sayısı n (%)	54 (%40.3)
KPR sonrası nabızlı elektriksel aktivite sağlanamayan hasta sayısı n (%)	80 (%59.7)

KPR: Kardiyopulmoner resüsitasyon.

Tablo 5. Geliş ritimlerine göre nabızlı elektriksel aktivite sağlanabilme ilişkisi

	NEA sağlanan grup	NEA sağlanamayan grup	
Ventiküler taşikardi n (%)	12 (%22.2)	2 (%2.5)	
Ventiküler fibrilasyon n (%)	18 (%33.3)	5 (%6.3)	p< 0.001
Elektromekanik Disosiasyon n (%)	0 (%0)	2 (%2.5)	
Asistol n (%)	24 (%44.4)	70 (%88.6)	

NEA: Nabızlı elektriksel aktivite.

mıştır. Sadece 1 hasta ex-duhul olarak kabul edilmiş ve monitörize edilmediğinden ritim tespiti saptanamamıştır. Tablo 4'te gösterildiği üzere 134 arrest hastasından 54 hastada KPR sonrası nabızlı elektriksel aktivite saptanmıştır. Total 134 kardiyak arrestin 58'i hastane içi, 76'sı hastane dışı olarak saptanmıştır. KPR sonrası nabızlı elektriksel aktivite saptanan hastaların 35 (%64.8)'i hastane içi arrest, 19 (%35.2)'u hastane dışı arrest; nabızlı elektriksel aktivite sağlanamayan hastaların 23 (%28.7)'ü hastane içi arrest, 57 (%71.2)'si hastane dışı arrest olarak saptanmıştır (p< 0.001). Geliş ritimlerine göre nabızlı elektriksel aktivite sağlanabilme ilişkisi Tablo 5'te verilmiştir. Buna göre nabızlı elektriksel aktivite sağlanan grupta %33.3 oranda saptanan ventriküler fibrilasyon, nabızlı elektriksel aktivite sağlanamayan grupta %6.3 oranında saptanmıştır (p< 0.001).

TARTIŞMA

Çalışmamızda, kardiyak arrest nedeni olarak en sık nedenler, ST yükselmeli miyokart infarktüsü, konjestif kalp yetersizliği ve nedeni belirlenemeyen grup olarak belirlenmiştir. Geliş ritmi olarak en fazla asistol ritmi saptanmıştır. KPR sonrası nabızlı elektriksel aktivite sağlanan grupta %33.3 oranda saptanan VF, nabızlı elektriksel aktivite sağlanamayan grupta %6.3 oranında tespit edilmiş ve istatistiksel olarak anlamlı saptanmıştır.

Kardiyak arrest etkili KPR yapılmazsa ölümle sonuçlanan kardiyak fonksiyonların beklenmedik şekilde kaybolmasıdır. Ani kardiyak arrest olayın meydana geldiği yere bağlı olarak

hastane içi ve hastane dışı olarak sınıflandırılır. Hastane dışı arrestin en sık nedeni iskemik kalp hastalığı olmasına rağmen, diğer reversible nedenler olan hipoksi, hipovolemi, hipo ya da hiperkalemi, metabolik bozukluklar, hipotermi, tromboemboli, perikardiyal tamponad, toksik nedenler ve tansiyon pnömotoraks gibi durumlar da kardiyak arreste neden olabilir. Her türlü tanı ve tedavi uygulamalarına rağmen hastane dışı arrestlerin mortalite oranları çok yüksektir[1]. Hastane dışı kardiyak arrest dünya çapında ölüme neden olan başlıca nedenlerden olup, gelişmekte olan ülkelerde total mortalitenin yaklaşık %10 kadarını oluşturmaktadır[1,2].

ABD ve diğer endüstrileşmiş ülkelerde, ani kardiyak ölüm, toplam yıllık mortalitenin yaklaşık %15`ini kapsamaktadır[7]. İnsidansı ilerleyen yaş, erkek cinsiyet ve altta yatan kalp hastalığına göre artmaktadır[7-9]. Ani kardiyak ölümle sonuçlanan hastaların yaklaşık %60'ında daha önceden bilinen koroner kalp hastalığı bulunmaktadır ancak yaklaşık %15'inde koroner kalp hastalığının ilk başvuru şekli ani kardiyak arrest olarak saptanmaktadır[7,10-12].

Kardiyak arrest erkeklerde daha sık görülmektedir[13,14]. Çalışmamızda literatürle uyumlu olarak erkeklerde daha fazla oranda kardiyak arrest oranlarını saptadık. Erkeklerde tanıklı arrest oranı ve VF, VT görülme sıklığı daha fazladır ve 1 aylık sağkalım erkeklerde daha fazladır[14-16]. Ancak başvuru anında VF, VT saptanan bayanlarda da sağ kalım oranları iyidir. İlerleyen yaş ile prognoz kötüleşmektedir, 5882 adet hastane dışı kardiyak arresti içeren bir çalışmada 80 yaş ve üzerinde olan grupta, 80 yaşın altındaki gruba göre taburcu oranları düşüktür ve taburcu olan grupta VF ve nabızsız VT daha sık saptanmıştır[17]. ST segment yükselmeli miyokart infarktüsü sonrası ölümlerin çoğu ilk birkaç saat içinde VF'ye bağlı olmaktadır. Bu ölümlerin çoğu erken evrede olması nedeniyle sıklıkla hastane dışında olmaktadır. Bu nedenle tüm medikal ve paramedikal ekibin kardiyak yaşam desteğinde eğitimli olması, defibrilasyonu kullanabilmesi ve EKG monitörizasyonu esansiyeldir[18]. Çalışmamızda en sık arrest nedeni olarak ST segment yükselmeli miyokart infarktüsü saptanmıştır. Merkezimizin primer bir merkez olması özelliğiyle ST elevasyonu ile gelen hastalar ritim sağlandıktan sonra hemen koroner anjiyografi laboratuvarına alınmış ve revaskülarizasyon işlemi ivedilikle planlanmıştır. Çalışmamızda aktif göğüs ağrısı sonrası arrest olan hastalar ve nedeni belirlenemeyen arrest hastalarında da ST elevasyonlu hastaların olabileceğini düşünmekteyiz. O nedenle belirlenemeyen bu hastalar nedeniyle belki de saptadığımız oran, gerçek oranların daha da altında kalmış olabilir.

Kalp yetersizliğinde ani kardiyak ölümden sorumlu birçok faktör bulunmaktadır. Bunlardan bazıları koroner arter hastalığı, semptomatik olsun ya da olmasın kardiyomiyopati, ritim bozuklukları ve hipertansif kalp hastalığıdır[19]. New York Kalp Cemiyeti fonksiyonel sınıflaması, sol ventrikül ejeksiyon fraksiyonu, sistolik kan basıncı, kullanmış olduğu ilaçlar, hemoglobin, serum ürik asid seviyesi, serum kolesterolü, B tipi natriüretik peptid, ambulatuar EKG monitörizasyonu, T dalga alternansı, kalp hızı değişkenliği ve sinyal ortalamalı EKG kalp yetersizliğinde ani ölümü değerlendirmek için kullanılmaktadır[20].

Hastane dışı ani kardiyak arrestlerin yaklaşık %25-35'inde temel ritim VF ve nabızsız VT olarak saptanırken yaklaşık %25'inde nabızsız elektriksel aktivite saptanmıştır. Bradiaritmi ve asistol ise daha az sıklıkla rastlanmaktadır[21]. Bradiaritmiler, özellikle non iskemik kardiyomiyopatilerde daha sıktır[22]. Asistol ve nabızsız elektriksel aktivite ise pulmoner embolide sıklıkla izlenen ritimlerdir[23]. Kalp yetmezliği olan hastalarda görülen ani kardiyak ölümde en sık neden VF olup bradiaritmi ve nabızsız elektriksel aktivite ise %5-33 oranında saptanmaktadır[24]. Hastaneye başvuru anında temel ritim asistol ise kardiyak arrest ile başvuru arasında geçen süre uzundur ve başarılı KPR oranı düşüktür. Asistol şeklinde başvuran hastaların yaklaşık %10'unda KPR sonrasında nabızlı elektriksel aktivite sağlanmakta ve hastaların %0-2'si taburcu olabilmektedir[25-27]. Nabızsız elektriksel aktivitede prognoz kötüdür, yapılan bir çalışmada nabızsız elektriksel aktivite saptanan 150 hastanın yaklaşık %23'ünün hayatta kaldığı ve yalnızca %11'inin taburcu olduğu gösterilmiştir[28]. Başvuru anında temel ritim VF ise prognoz diğer ritimlere göre daha iyidir, yapılan çalışmalarda VF saptanan grupta %25-40 hastanın taburcu olduğu saptanmıştır[13,29,30]. Çalışmamızda literatüre benzer olarak şoklanabilir ritim olanlarda nabızlı elektriksel aktivite sağlanma oranı daha fazla saptanmıştır. Bu nedenle özellikle kardiyak arrestin ilk dakikasından itibaren hastane içi ya da hastane dışı monitörizasyon ve şoklama imkanlarının önemini vurgulamaktayız. Özellikle şoklanabilen ritmin geliş süresinin uzaması ile şoklanamayan ritime dönmesi başarısız KPR'ye neden olmaktadır. Özellikle hastane içi arrest hastalarında tüm hastanelerde uygulanmakta olan mavi kod uygulaması başarı oranını artırarak hastanın nabızlı elektriksel aktivite sağlanma oranını artırmaktadır. Bu noktada tüm personelin KPR konusunda eğitiminin önemini özellikle vurgulamaktayız.

Limitasyonlar

Çalışmamızın ana limitasyonlarından ilki prospektif olmaması ve tek merkezli olmasıdır. Ayrıca alınan hasta sayısının azlığı da diğer kısıtlayıcı parametrelerden biridir. Retrospektif olması nedeniyle bazı hasta verilerine ulaşılamaması diğer bir sınırlayı parametredir.

SONUÇ

Çalışmamızda, kardiyak arrest nedeni olarak en sık nedenler, ST yükselmeli miyokart infarktüsü, konjestif kalp yetersizliği ve nedeni belirlenemeyen grup olarak belirlenmiştir. Geliş ritmi olarak en fazla asistol ritmi saptanmıştır. KPR sonrası nabızlı elektriksel aktivite sağlanan grupta %33.3 oranda saptanan VF, nabızlı elektriksel aktivite sağlanamayan grupta %6.3 oranında tespit edilmiş ve istatistiksel olarak anlamlı saptanmıştır.

ÇIKAR ÇATIŞMASI

Yazarlar bu makale ile ilgili olarak herhangi bir çıkar çatışması bildirmemişlerdir.

YAZAR KATKISI

Anafikir/Planlama: ÇG, MK
Analiz/Yorum: ÖC, ÇG
Veri sağlama: AN, ÖA
Yazım: ÇG, AK
Gözden Geçirme ve Düzeltme: Aİ, CK
Onaylama: Tüm yazarlar

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İki Boyutlu Ekokardiyografik Speckle Tracking ile Değerlendirilen Sol Atriyal Strain Parametresinin Koroner Yavaş Akım Fenomeni ile İlişkisi

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ÖZET

Giriş: Koroner yavaş akım (KYA) fenomeni anjiyografik olarak koroner arterleri normal olan veya tıkayıcı kritik darlığı olmayan hastalarda koroner anjiyografi sırasında distal koroner arterlere opak madde ulaşmasının yavaş olmasıdır. Gerilim (strain) görüntülemesi tekniği hem global hem de bölgesel kalp fonksiyonları değerlendirmesinde oldukça güvenilir bir yöntemdir. Bu çalışmada sol ventrikül diyastolik disfonksiyonunun en iyi girişimsel olmayan göstericisi olan sol atriyal strain değeri ile koroner yavaş akım arasındaki ilişkiyi araştırmayı planladık.

Hastalar ve Yöntem: Hastanemizde Ocak 2016 ve Aralık 2016 tarihleri arasında koroner anjiyografi yapılmış ve KYA saptanan ardışık 38 hasta çalışmaya alınmıştır. Yaş ve cinsiyet açısından çalışma grubu ile benzerlik gösteren ve normal koroner arterler saptanan 37 hasta ise kontrol grubu olarak çalışmamıza dahil edilmiştir.

Bulgular: Hastaların yaş ortalaması 52 ± 10.4 ve erkek cinsiyet oranı %54.1'dir. Kontrol grubu ile kıyaslandığında global pik atriyal longitidunal strain (PALS) ve pik atriyal kontraksiyon strain (PACS) değerlerinin KYA grubunda azaldığını bulduk (32.84 ± 8.06'ya karşı 38.49 ± 6.42, p= 0.001 ve < 0.001, sırasıyla). Bununla birlikte pik longitidunal straine ulaşma süresi (TPLS)'nin koroner yavaş akım tespit edilen hastalarda daha uzun olduğunu tespit ettik (445 ± 58'e karşı 407 ± 36, p= 0.001).

Sonuç: Koroner yavaş akım ile sol ventrikül diyastolik disfonksiyonun ilişkili olduğu ve speckle trecking yöntemi ile ölçülen sol atriyal strain değerinin invaziv ölçümler kadar sol ventrikül doluş basıncını gösterdiği bilinmektedir. Biz çalışmamızda kolaylıkla uygulanabilen, ucuz ve girişimsel olmayan bir yöntem olan sol atrial strain parametresi ile koroner yavaş akım arasında pozitif bir ilişki saptadık.

Anahtar Kelimeler: Speckle tracking; sol atriyal strain; koroner yavaş akım

Relation Between Left Atrial Strain Function and Coronary Slow Flow Phenomenon Using Two-Dimensional Speckle-Tracking Echocardiography

ABSTRACT

Introduction: Coronary slow flow (CSF) phenomenon is a clinical entity characterized by a slow, opaque material reaching distal coronary arteries in patients with normal or noncritical coronary artery diseases. Strain imaging techniques are reliable methods for evaluating both global and regional cardiac functions. In this study, we planned to investigate the relationship between left atrial strain (LAS), which is the best noninvasive demonstrator of left ventricle diastolic dysfunction, and CSF.

Patients and Methods: Thirty-eight consecutive patients whose coronary angiography was performed and CSF was detected at our hospital between January and December 2016 were included in the study. Thirty-seven age and sex matched patients with normal coronary arteries were enrolled as a control group.

Results: The median age was 52 ± 10.4 years, and 54.1% patients were male. Peak atrial longitudinal strain and peak atrial contraction strain were lower in the CSF group than in the control group (32.84 ± 8.06 vs. 38.49 ± 6.42, p= 0.001 and p< 0.001, respectively). In addition, time to peak longitudinal strain was higher in CSF group when compared with control group (445 ± 58 vs. 407 ± 36, p= 0.001, respectively).

Conclusion: It is known that there is a relationship between CSF and diastolic dysfunction and it is also known that LAS, which can be measured using the speckle-tracking method, shows left ventricle filling pressure like invasive measurements. In this study, we found an association between LAS, which is an easily available, cheap, and noninvasive method, and CSF.

Key Words: Speckle tracking; left atrial strain; coronary slow flow

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GİRİŞ

Koroner yavaş akım (KYA) fenomeni anjiyografik olarak koroner arterleri normal olan veya tıkayıcı kritik darlığı olmayan hastalarda koroner anjiyografi (KAG) sırasında distal koroner arterlere opak madde ulaşmasının yavaş olmasıdır[1]. Etyolojisinde vasküler, inflamatuvar, endotelyal, genetik ve vazomotor bozukluklar gibi birçok faktör suçlanmıştır[2,3]. KYA fenomeni etyolojisinde endotel hasarı, mikrovasküler hasar, vazomotor bozukluk ve küçük damar hastalığının rol oynadığı ileri sürülmektedir[3].

Daha önce yapılan çalışmalarda sol ventrikül sistolik ve diyastolik disfonksiyonu ile koroner yavaş akım arasında ilişki gösterilmiştir[4]. Bu çalışmalarda sol ventrikül diyastolik disfonksiyonu için sol ventrikül strain değerleri kullanılmıştır. Sol ventrikül doluş basıncı en doğru şekilde girişimsel yöntemlerle gösterilmektedir. Speckle trecking yöntemi ile ölçülen sol atriyal strain değerinin ise invaziv ölçümler kadar sol ventrikül doluş basıncını gösterdiği çalışmalarda ortaya konulmuştur [5]. Bu çalışma ile sol ventrikül doluş basıncını noninvaziv olarak en iyi değerlendiren yöntem olan sol atriyal strain ile KYA arasındaki ilişki varlığını araştırmayı planlanladık.

HASTALAR ve YÖNTEM

Çalışmaya T.C. Trakya Üniversitesi Tıp Fakültesi Dekanlığı Bilimsel Araştırmalar Etik Kurulu tarafından etik kurul onayı verilmiştir.

Hastanemizde Ocak 2016 ve Aralık 2016 tarihleri arasında stabil angina pektoris nedeniyle koroner anjiyografi yapılan ve koroner yavaş akım saptanan 40 hasta ile koroner arterleri normal saptanan 40 hasta çalışmada değerlendirilmiştir. Koroner arter ektazisi olan, proksimal damar lümen çapı 3 mm altında olan, orta-ciddi kapak hastalığı, atrial fibrilasyon, kalp yetersizliği, elektrokardiyografi (EKG)'de ventriküler preeksitasyon veya dal bloğu, hipertrofik veya dilate kardiyomiyopati, konjenital kalp hastalığı, kontrolsüz hipertansiyon, hipertiroidizm, hipotiroidizm, malignite, otoimmün hastalık, aktif infeksiyon, pulmoner, hepatik, renal veya hematolojik hastalık, kötü ekokardiyografik pencere, hemodinamik instabilite, gebelik varlığı ve araştırmayı reddeden hastalar ise çalışma dışı bırakılmıştır.

Koroner Anjiyografi

Tüm hastalara standart pozlarda Artis zee anjiografi sistemi (Siemens AG, Forchheim, Germany) ile koroner anjiyografi yapıldı. Hastalara sağ veya sol femoral arter yaklaşımla Judkins tekniği ile 6 veya 7 French (F) kateterler kullanılarak selektif KAG yapıldı. Opak madde olarak Iopromide (Ultravist-370®) veya Iohexol (Omnipaque® 350 mg/mL) kullanıldı. Her bir poz için ortalama 6-8 mL opak madde enjekte edilerek koroner arterler sağ ve sol oblik pozisyonlarda kraniyal ve kaudal açılandırmalar kullanılarak, 25 kare/saniye hızında görüntülendi.

TİMİ Kare Sayısı

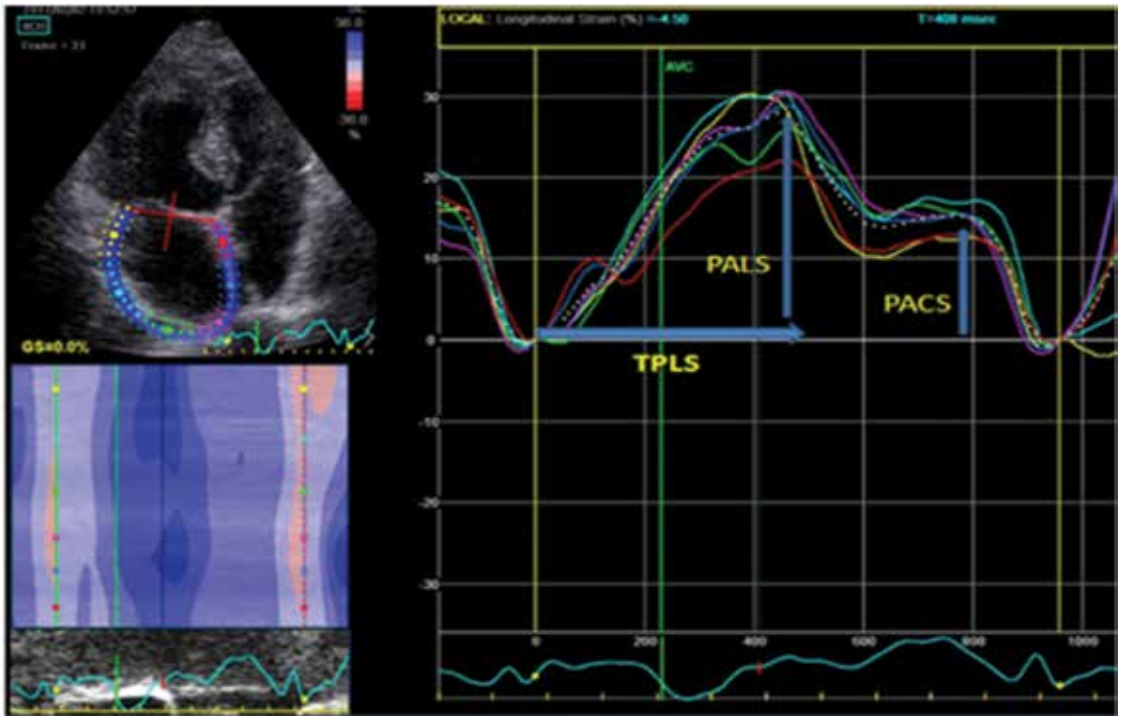
Koroner yavaş akım varlığının saptanması ve derecelendirilmesi için düzeltilmiş TİMİ Kare Sayısı (TKS) yöntemi kullanıldı[6]. İlk kare olarak arter lümeninin anterograt akımla ilk kolunun tamama yakın dolduğu an, son kare olarak da arter distal sonlanım noktasına opak maddenin vardığı an kabul edildi. Ön inen arter (LAD) için apekste distal çatallanma noktası, sirkumfleks koroner arter (Cx) için geniş olduğu gövde veya büyük obtus marjinalin distal ayrım noktası, sağ koroner arter (RCA) için de kraksın ilk majör dalın başlangıcı veya posterolateral uzanımı değerlendirme için kullanıldı. LAD'ın TKS sayısı 1.7 katsayısına bölünerek düzeltilmiş TKS (cLAD) bulundu. Koroner arterlerin normal TKS'leri LAD için 36 ± 2.5, Cx için 22 ± 4.1 ve RCA için 20.4 ± 3.1 kabul edildi. Ortalama TKS; LAD, Cx ve RCA için hesaplanan TKS toplanıp üçe bölünmesiyle belirlendi. En az bir koroner arterde bu değerlerin iki standart sapmadan fazla olması durumunda koroner yavaş akım olarak kabul edildi[6].

Standart Ekokardiyografik Değerlendirme

Tüm hastalarda standart ekokardiyografik değerlendirme Vivid S70 (GE Healthcare) ultrasonografi cihazı kullanılarak yapılmıştır ve tüm ölçümler iki ayrı tecrübeli kardiyolog tarafından yapıldı. Hastalar beş dakikalık istirahat sonrası sol yan dekübitis pozisyonu verilerek değerlendirildi. Amerikan Ekokardiyografi Derneği'nin önerdiği şekilde standart pencerelerden; M-mode, ekokardiyografi ile sol ventrikül diyastol ve sistol sonu çapları, septum ve posteriyor duvar kalınlıkları ölçüldü. EF ölçümü modifiye simpson yöntemi ile yapıldı[7]. Pulse dalga Doppler hız kayıtları apikal dört boşluk görüntüde örneklem volüm mitral kapakçık uçlarına konularak ve ardışık üç siklusun görüntüsü incelenerek yapıldı. Mitral erken zirve hızı (E), mitral geç zirve hızı (A), izovolümetrik gevşeme zamanı (IVRT) ve E dalga deselerasyon zamanı (DT) değerlendirildi. Doku Doppler incelemede apikal dört boşluk penceresinde anülüs ve duvar bileşkesine örneklem volümü konularak sol ventrikül, lateral duvar anülüse ait kayıtlar alındı. Doku Doppler değerlendirme ile mitral yan duvarı üzerinden sistolik miyokart hızı (Sm), erken diyastolik hızı (Em) ve geç diyastolik hız (Am) hesaplandı. Hastalarda E/A ve E/Em oranı hesaplandı. Her parametre için arka arkaya alınan üç ölçümün ortalaması alındı. Sol atrium (SA) çapları sistol sonunda parasternal uzun aks görüntülerden ölçülmüştür. SA volümler ise apikal dört ve iki boşluk görüntülemeden Simpson kuralı uygulanarak yapıldı. Bütün SA volümleri vücut kitle endeksine göre düzeltildi.

İki Boyutlu Strain Değerlendirmesi

Apikal 4 boşluk ve 2 boşluk gri skala görüntüleri dijital olarak depolandı. Daha sonra kayıtlar akustik tracking software (EchoPAC, GE Vingmed) ile işlendi. Global strain 15 atriyal segmentten ölçülen değerlerin ortalaması alınarak hesaplandı. Frame hızı 60-80 frame/saniye idi. Analiz off-line olarak ya-



Resim 1. Global PALS, PACS ve TPLS.

pıldı. Litetratürde daha önce tanımlandığı gibi, apikal 4 boşluk incelemesinde sol atriyumun endokart hattı elle belirlendi ve atriyum duvar kalınlığına göre region of interest (ROI) ayarlaması yapıldı. Toplam 6 atriyum segmentinin QRS noktasının referans kabul edildiği strain eğrisindeki rezervuar fazı sonundaki pik longitudinal strain (PALS) ve geç diyastolik kontraktil strain (PACS) değerleri % (yüzde) cinsinden elde edildi. Pik longitidunal straine ulaşma süresi (TPLS) ise milisaniye cinsinden ifade edildi (Resim 1).

İstatistiksel Analiz

İstatistiksel çalışma SPSS 17 (SPSS Inc., Chicago, IL, United States) paket bilgisayar programı kullanılarak yapıldı. Normal dağılım gösteren değişkenler ortalama ± standart sapma, normal dağılım göstermeyen değişkenler ise medyan (interquartile range: IQR) olarak ifade edildi. Kategorik değişkenler ise sıklık ve yüzde (%) olarak verildi. Normal dağılan sayısal değişkenlerin iki farklı grupta karşılaştırılmasında Student's t testi kullanılırken, normal dağılmayan sayısal değişkenler için Mann-Whitney U testi kullanıldı. Nominal verilerin karşılaştırılması için ki-kare ya da Fisher's exact testleri kullanıldı. p değeri < 0.05 anlamlı olarak kabul edildi.

BULGULAR

Çalışmaya yaş ortalaması 52 ± 10.4 yıl olan 38 KYA fenomenli hasta (26 erkek, 12 kadın) ve kontrol grubu olarak yaş ortalaması 53 ± 10.6 yıl olan normal koroner arterlere sahip 37 gönüllü (20 erkek, 17 kadın) alındı. Çalışma grubunun te-

Tablo 1. Hastaların bazal demografik, klinik ve laboratuvar parametrelerinin karşılaştırılması

	KYA grup (n= 38)	Kontrol grup (n= 37)	p
Erkek cinsiyet (%, n)	%68 (26)	%74 (20)	0.24
Yaş	52 ± 10.4	53 ± 10.6	0.87
Diyabet (%, n)	%23 (9)	%18 (7)	0.77
Hipertansiyon (%, n)	%42 (16)	%56 (21)	0.25
Hiperlipidemi (%, n)	%13 (5)	%13 (5)	0.98
Sigara (%, n)	%7 (3)	%13 (5)	0.43
Beden kitle indeksi (kg/m^2)	27.4 ± 2.9	27.2 ± 3.4	0.82
Sistolik kan basıncı (mmHg)	123 ± 9	122 ± 6	0.75
Diyastolik kan basıncı (mmHg)	74 ± 8	71 ± 7	0.07
Kalp hızı	77 ± 13	77 ± 11	0.92
Glukoz (mg/dL)	108 ± 34.9	112 ± 34.8	0.61
Kreatinin (mg/dL)	0.76 ± 0.12	0.74 ± 0.15	0.68
LDL (mg/dL)	98 (31-172)	102 (41-151)	0.58
HDL (mg/dL)	49 (23-197)	47 (27-90)	0.78

KYA: Koroner yavaş akım, LDL: Düşük dansite lipoprotein, HDL: Yüksek dansite lipoprotein.

mel özellikleri Tablo 1'de sunulmuştur. Grupların demografik, klinik ve laboratuvar parametreleri arasında anlamlı bir fark saptanmadı.

Çalışma grubunun konvansiyonel ve doku doppler ekokardiyografik karşılaştırma sonuçları Tablo 2'de gösterilmiştir. Grupların sistolik ve diyastolik fonksiyon parametreleri arasında istatistiksel olarak anlamlı fark tespit edilmedi.

İki boyutlu global strain değerlendirmesinde PALS ve PACS değerlerinin KYA olan hastalarla kıyaslandığında azaldığını bulduk (32.84 ± 8.06'ya karşı 38.49 ± 6.42, p= 0.001 ve < 0.001, sırasıyla). Bununla birlikte pik TPLS de koroner yavaş akım tespit edilen hastalarda daha uzun olduğunu tespit ettik 445 ± 58'e karşı 407 ± 36, p= 0.001) (Tablo 3).

Tablo 2. Hastaların ekokardiyografik parametrelerinin karşılaştırılması

	KYA grup (n= 38)	Kontrol grup (n= 37)	p
SVDÇ (mm)	45.5 ± 4.9	46.7 ± 2.8	0.19
SVSÇ (mm)	29.7 ± 3.5	30.6 ± 3.5	0.26
SVEF (%)	59.6 ± 4.4	60.7 ± 5.1	0.29
IVSÇ (mm)	0.99 (0.8-1.1)	1.02 (0.9-1.1)	0.08
PDÇ (mm)	1.00 (0.9-1.1)	1.02 (0.9-1.1)	0.07
SAÇ (mm)	32.1 ± 2.5	31.6 ± 2.5	0.38
SOa (cm^2)	14.8 ± 3.3	15.0 ± 2.6	0.79
SOv (cm^3)	39 ± 13.8	35 ± 8.8	0.08
SAVİ (mL/m^2)	25 ± 8.7	23 ± 6.6	0.28
Mitral E (cm/s)	0.84 ± 0.07	0.84 ± 0.09	0.87
Mitral A (cm/s)	0.76 (0.5-0.9)	0.78 (0.6-0.9)	0.24
EDT (ms)	203 ± 20.3	200 ± 13.5	0.55
Mitral E/A oranı	1.13 ± 0.20	1.08 ± 0.16	0.28
Ortalama E' (cm/s)	1.07 ± 0.01	1.11 ± 0.01	0.31
Ortalamal A' (cm/s)	0.10 ± 0.02	0.09 ± 0.02	0.46
E/E' oranı	8.05 ± 1.53	7.7 ± 1.51	0.40

KYA: Koroner yavaş akım, SVDÇ: Sol ventrikül diyastolik çap, SVSÇ: Sol ventrikül sistolik çap, SVEF: Sol ventrikül ejeksiyon fraksiyonu, IVSÇ: Interventriküler septum çap, PDÇ: Posterior duvar çap, SAÇ: Sol atriyum çap, SOa: Sol atriyum alanı, SOv: Sol atriyal volume, SAVİ: Sol atriyal volüm indeks, EDT: Mitral E yavaşlama zamanı.

Tablo 3. Hastaların sol atriyal global strain parametrelerinin karşılaştırılması

	KYA grup (n= 38)	Kontrol grup (n= 37)	p
PALS (%)	32.84 ± 8.06	38.49 ± 6.42	0.001
PACS (%)	16.37 ± 4.44	19.60 ± 2.90	< 0.001
TPLS (ms)	445 ± 58	407 ± 36	0.001

KYA: Koroner yavaş akım, PALS: Pik atriyal longitidunal strain, PACS: Pik atriyal kontraksiyon strain, TPLS: Pik longitudinal strain ulaşma süresi.

TARTIŞMA

Standart ekokardiyografik yöntemler ile değerlendirilen diyastolik disfonksiyon parametrelerinin gruplar arasında farklı olmadığını saptadığımız çalışmamızda KYA saptanan hastalarda pik sol atrial strain ve geç diyastolik kontraktil strain değerlerinin koroner arterleri normal olan hastalarla kıyaslandığında arttığını bulduk. Bununla birlikte pik longitidunal straine ulaşma süresinin de koroner yavaş akım tespit edilen hastalarda daha uzun olduğunu tespit ettik.

KYA, rutin KAG sırasında koroner arterlerde anlamlı tıkanıklığa yol açan stenoz, trombüs, spazm ve diseksiyon olmadan opak maddenin geç yıkanmasıdır. KAG uygulanan hastaların yaklaşık %1'inde görülmektedir[8]. Bu klinik durum birçok çalışmada çok iyi bir şekilde tanımlanmış ve kardiyak sendrom X'in bir alt grubu olabileceği öne sürülmüştür[3]. Birçok patofizyolojik mekanizmanın KYA'nın nedeni mi, sonucu mu olduğuna dair tartışmalar halen sürmektedir. Ancak, tüm bu olaylar sonucunda kalp fonksiyonlarının etkilendiği, normal akımı olan insanlara göre miyokart iskemisi ve infarktüs sıklığının arttığı gösterilmiştir[9-11]. KYA tespit edilen hastalarda sağlıklı grupla kıyaslandığında sistolik ve diyastolik fonksiyon bozukluğu geliştiği nabız dalgalı Doppler ve doku Doppler yöntemleri ile gösterilmiştir[4]. Baykan ve arkadaşları tarafından yapılan çalışmada geleneksel ekokardiyografi parametrelerinde (E, A, E/A, DT ve IVRT) KYA fenomeni ile kontrol grubu arasında anlamlı fark saptanmamıştır[12]. Zencir ve arkadaşları tarafından yapılan başka bir çalışmada ise ekokardiyografik olarak bakılan sol ventrikül sistolik ve diyastolik fonksiyonların kontrol grubundan farklı bulunmadığı saptanmıştır[13] . Çalışmamızda da benzer şekilde standart ekokardiyografik yöntemler ile ölçülen diastolik fonksiyon parametrelerinin gruplar arasında benzer olduğunu saptadık. Bilindiği gibi doku Doppler görüntülemesi açı bağımlıdır ve kalbin "tethering" hareketlerinden etkilenmektedir. Bu nedenlerle standart ekokardiyografik yöntemler ile değerlendirilen diastolik fonksiyonların yetersiz kaldığını düşünmekteyiz.

Son yıllarda birçok çalışmada, strain ve strain rate parametrelerinin miyokart deformasyonunu göstererek iskemi değerlendirilmesinde kullanılabilecek duyarlı parametreler olduğu gösterilmiştir[14-17]. Nurkalem ve arkadaşları doku Doppler, gerilim ve gerilim hızı (strain rate) tekniğini kullanarak yaptıkları çalışmada ejeksiyon fraksiyonu korunmuş olan KYA grubunda bölgesel ve global longitudinal sol ventrikül sistolik fonksiyonlarının bozulduğunu ve bunun da KYA bulunan koroner arter sayısı ile ilişkili olduğunu göstermişlerdir [18].

Sol atriyum, kalp siklusundaki dört temel fonksiyonu ile tüm kalp fonksiyonların düzenlenmesinde önemli bir role sahiptir. Geleneksel parametreler kalp siklusunda bir noktadaki anlık ölçümle atriyal fonksiyonları göstermektedir[19]. Bununla birlikte, atrial fazdaki boş hacim ve boş fraksiyon da atriyal fonksiyonu değerlendirmek için hesaplanabilir. Ancak, bu öl-

çümler atriyal yüke duyarlıdır ve dolaylı olarak atriyal miyokart özelliklerini yansıtırlar. Atrial miyokardiyal mekaniklerinin strain ve strain rate görüntüleme ile analiz edilmesi atrial miyokardiyal bozulmanın direk ölçülebilmesine izin vermesi açısından oldukça önemlidir. Bununla birlikte strain ve strain rate atriyal dolumdan ve açıdan bağımsızdır. Daha önce yapılan çalışmalarda sol atriyal deformasyon parametrelerinin atriyum hacmi değişmeden daha önce bozulduğu gösterilmiş ve strain ölçümlerenin atriyal dolum parametrelerine kıyasla daha duyarlı oldukları ortaya konulmuştur[20,21]. Wakami ve arkadaşları tarafından yapılan bir çalışmada sol atriyum pozitif global pik strain değeri ile invaziv olarak ölçülen sol ventrikül diyastol sonu basıncı arasında ters bir ilişki olduğu gösterilmiştir[22]. Ölçülen sol atriyal strain değerinin invaziv ölçümler kadar sol ventrikül doluş basıncını gösterdiği ortaya konulmuştur[5].

Çalışmamızda en önemli sınırlama gerilim tekniğinin açıdan etkilenmesidir; bu sorun, görüntü penceresi daraltılarak, kayıtların 20 dereceden düşük açılarda alınmasıyla giderilmeye çalışıldı. Ayrıca, TKS'nin kalp hızı, kullanılan opak madde ve kateter boyutundan etkilendiği bilinmektedir. Çalışmamızda iki grup arasında kalp hızı açısından fark yoktu. Koroner anjiyografi işlemi sırasında tüm olgularda aynı opak madde ve aynı boyutta kateter kullanıldı.

SONUÇ

Çalışmamızda kolaylıkla uygulanabilen, ucuz ve girişimsel olmayan bir yöntem olan sol atriyal strain parametresi ile koroner yavaş akım arasında bir ilişki saptadık. Koroner anjiyografi ile KYA saptanan ve standart ekokardiyografik yöntemler ile diyastolik disfonksiyon gösterilmeyen hastalarda sol atriyal strain ile diyastolik fonksiyonların değerlendirilmesini önermekteyiz.

ÇIKAR ÇATIŞMASI

Yazarlar bu makale ile ilgili olarak herhangi bir çıkar çatışması bildirmemişlerdir.

YAZAR KATKISI

Anafikir/Planlama: FMU
Analiz/Yorum: FMU
Veri sağlama: FMU, MAY
Yazım: FMU, MAY
Gözden Geçirme ve Düzeltme: MAY
Onaylama: Tüm yazarlar

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ST Yükselmeli Miyokart İnfarktüsü Hastalarında Yaşam Kalitesi ile 5 Yıllık Mortalite Arasındaki İlişki

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ÖZET

Amaç: Sağlık ile ilgili yaşam kalitesi ile mortalite ilişkisi ile ilgili sınırlı sayıda çalışma mevcuttur. Çalışmamızda perkütan koroner girişim (PKG) ile tedavi edilen ST yükselmeli miyokart infarktüsü (STYMİ) hastalarının yaşam kalitelerinin mortalite ile ilişkisini değerlendirmeyi amaçladık.

Hastalar ve Yöntem: Çalışmaya akut STYMİ tanısı alıp primer PKG uygulanan ve 6. ay takipleri yapılan 92 hasta dahil edildi. Altıncı ayda yapılan klinik vizitte demografik ve klinik verileri toplandıktan sonra uluslararası geçerliliği olan ve Türkiye'de de akut koroner sendromlarda geçerlilik çalışması yapılmış olan EQ5D yaşam kalite ölçeği hastalar tarafından doldurduldu. Hastaların 5 yıl takiplerinin tamamlanmasını takiben veriler analiz edildi. Klinik vizit yapılamayan hastalar ya da bu hastaların yakınları mortaliteyi değerlendirmek için telefonla arandı.

Bulgular: Bizim çalışmamız, STYMİ hastalarında yaşam kalitesi ile uzun dönem sağkalımın ilişkisini inceleyen ilk çalışmadır. Beş yıl takibi edilen 92 hastanın yaş ortalaması 56.96 ± 12.61 ve 81 (%88)'i erkek idi. Beş yıl sonunda 12 hastada mortalite görüldü. İndeks skor ortalaması 0.903 ± 0.145 ve vizüel analog ölçek (VAS) skor ortalaması 80.58 ± 16.03'dü. İndeks skor ve VAS skor ortalamaları mortalite olan hastalarda daha düşük bulundu (sırasıyla, p= 0.008, p= 0.011). Hem indeks skor hem de VAS skor anlamlı olacak şekilde mortalite ile ilişkiliydi (sırasıyla, p= 0.002, ki-kare= 9.918; p= 0.008, ki-kare= 7.112). Geriye doğru kademeli Cox regresyon analizi kullanılarak indeks skor ≤ 0.9 olmasının mortalite ile ilişkili olduğu ortaya çıkarıldı [p= 0.005; HR= 5.546 (1.668-18.443)].

Sonuç: Bizim analizlerimize göre, düşük sağlık ile ilgili yaşam kalitesi skorları mortalite ile ilişkilidir. EQ5D indeks skoru PKG ile tedavi edilen STYMİ hastalarında uzun dönem mortalitenin bağımsız bir ön gördürücüsüdür.

Anahtar Kelimeler: Sağlıkla ilişkili yaşam kalitesi; EQ5D; miyokart infarktüsü; mortalite

The Association Between Health Related Quality of Life and Five Year Mortality in Patients with ST-Elevated Myocardial Infarction

ABSTRACT

Introduction: There is a lack of studies focusing on the association between health related quality of life (HRQoL) and mortality. In our study, we aimed to evaluate the association between HRQoL and mortality of patients with ST-elevated myocardial infarction (STEMI) treated by percutaneous coronary intervention (PCI).

Patients and Methods: Ninety-two patients with STEMI undergoing primary PCI with committed 6-month follow-up were included to the study. In the 6-month follow-up visit, EQ5D questionnaire, which is valid internationally and is also valid for studies performed in Turkey for acute coronary syndromes, was filled by patients after obtaining their demographical and clinical findings. Data analyzes were performed after 5-year follow-up. Mortality of the patients whose clinical visits could not be performed evaluated by contacting with their relatives.

Results: Our study is the first study which evaluates the association between HRQoL and long-term survival in patients with STEMI. The mean age was 56.96 ± 12.61 and 81 (88%) of the population were males. Mortality was observed in 12 patients after 5 years. The mean Index score was 0.903 ± 0.145 and the mean Visual Analog Scale (VAS) score was 80.58 ± 16.03. The means of the Index score and VAS score were lower in patients with mortality (p= 0.008 and p= 0.011, respectively). Both Index and VAS Scale scores were significantly associated with mortality (p= 0.002, ki-kare: 9.918; p= 0.008, ki-kare= 7.112, respectively). It was revealed by backward stepwise Cox regression analysis that the presence of an Index score ≤ 0.9 is associated with mortality [p= 0.005; HR= 5.546 (1.668-18.443)].

Conclusion: According to our analysis, lower HRQoL scores are associated with mortality. EQ5D index score is an independent predictor of the long-term mortality in patients with STEMI treated by PCI.

Key Words: Health related quality of life; EQ5D; myocardial infarction; mortality

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GİRİŞ

Koroner arter hastalıkları (KAH) tüm dünyada ölümün en sık nedenidir. Avrupa'da her altı erkekten ve her yedi kadından biri miyokart infarktüsü (Mİ) nedeniyle ölmektedir[1]. Perkütan koroner girişimlerin (PKG), modern antitrombotik tedavilerin ve ikincil korunma tedavilerinin kullanımına girmesiyle ST yükselmeli miyokart infarktüsü (STYMİ) sonrası mortalitede azalma olduğu pek çok güncel çalışma ile gösterilmiştir[2-5]. STYMİ hastalarında yaşam süresindeki uzama ve tedavideki gelişmeler sonucu, sadece hastalık ve tedavi üzerinde durmak yerine sağlığı bütüncül bir şekilde ele alan stratejiler geliştirilmelidir. Bu perspektifte hastalıkla ilgili yaşam kalitesi değerlendirilmesine yönelik çalışmalar artmaktadır.

"EuroQol five dimensions questionnaire (EQ5D)" yaşam kalite ölçeği, Batı Avrupa Araştırma Topluluğu olan EuroQol grubu tarafından 1987 yılında geliştirilmiş ve 60'ı aşkın dile çevrilmiştir[6-9]. Bunlardan birisi de Türkçedir. Hastalar tarafından anlaşılabilir ve tamamlanabilir olması nedeniyle ve kolay uygulanabilirliği, skorlaması ve değerlendirilmesi sayesinde sağlık ile ilgili yaşam kalitesi değerlendirilmesinde EQ5D yaygın kullanım alanı bulmuştur.

Akut STYMİ hastalarının yaşam kalitelerinin değerlendirilmesi ve mortaliteye etkisini değerlendirmek üzere çalışma yapılması planlandı. Çalışmamızda uluslararası geçerliliği olan ve Türkiye'de de akut koroner sendromlarda geçerlilik çalışması yapılmış olan EQ5D yaşam kalite ölçeği kullanıldı[6].

HASTALAR ve YÖNTEM

Eskişehir Osmangazi Üniversitesi Klinik Araştırmalar Etik Kurulundan 2011/151 sayılı etik kurul onayı alınarak tek merkezli olarak prospektif çalışma başlatıldı. Daha önce de belirtildiği gibi bu çalışmaya akut STYMİ tanısı alıp primer PKG uygulanan ve 6. ay takipleri tamamlanan 92 hasta dahil edildi [10]. STYMİ "Consensus Document of The Joint European Society of Cardiology/American College of Cardiology Committee For The Redefinition of Myocardial Infarction"a göre tanımlandı[11]. Tüm primer PKG prosedürleri konvansiyonel teknikler kullanılarak uygulandı. Stent tipi, trombektomi cihazı kullanımı, predilatasyon ve poststent dilatasyon uygulamaları, intraaortik balon pompası kullanımı ile tirofiban tedavisi kararı operatörün takdirine bırakıldı. Hastalar en az 48 saat olacak şekilde koroner yoğun bakım ünitesinde izlendi. Çalışmaya alınan tüm hastalarda başvuru anında serum elektrolitleri, kan şekeri, kan üre azotu (BUN), kreatinin, aspartat aminotransferaz (AST), aspartat aminotransferaz (ALT), tam kan sayımı çalışıldı. Tam kan sayımı Beckman Coulter cihazında, biyokimyasal parametreler ise Cobas 6000 cihazında çalışıldı. Tam kan sayımında hemoglobin (Hgb), hematokrit (Htc), beyaz küre (WBC), nötrofil yüzdesi, absolü nötrofil sayısı, lenfosit yüzdesi, absolü lenfosit sayısı ve trombosit değerleri elde edildi.

Hastalar takiplerinde 6. ayda ise klinik vizit yapıldı. Altıncı ayda yapılan klinik vizitte 2 boyutlu transtorasik ekokardiyografi ile apikal iki ve dört boşluk görüntülemeden ortalamaları alınarak "modifiye Simpson" yöntemiyle sol ventrikül ejeksiyon fraksiyonu (LVEF) ölçüldü. LVEF ≤ %40 olması kalp yetmezliği olarak değerlendirildi. Buna ek olarak da olgulara demografik verileri toplandıktan sonra uluslararası geçerliliği olan ve Türkiye'de de akut koroner sendromlarda geçerlilik çalışması yapılmış olan EQ5D yaşam kalite ölçeği uygulandı[6,9]. Ölçeğin Türkçe versiyonu EuroQol grubundan temin edilmiştir. Ölçek iki parçadan oluşmaktadır. Birincisi EQ5D indeks ölçek; ikincisi ise vizüel analog ölçektir (VAS). İndeks ölçekte hastalar beş konuda beş seviyeli sorulara cevap verirken; VAS ölçekte ise o günkü sağlık düzeylerine 0 (hayal edebileceği en kötü sağlık düzeyi)-100 (hayal edebileceği en iyi sağlık düzeyi) arasında olmak üzere puanlama sistemi dahilinde puan verdiler. Hastalar beş konuda beş seviyeli sorulara cevap verdiler ve o günkü sağlık durumlarına 0 (hayal edebileceği en kötü sağlık düzeyi)-100 (hayal edebileceği en iyi sağlık düzeyi) arasında olmak üzere VAS ölçek adı verilen puanlama sistemi dahilinde puan verdiler. Cevapladıkları beş seviyeli sorulara göre ise 0-1 (1'e yaklaştıkça iyileşen yaşam kalitesi) arasında EuroQor grubunun belirlemiş olduğu indeks ölçek adı verilen puanları saptandı[9]. Hastaların 5. yılda klinik vizit yapıldı. Klinik vizit yapılamayan hastalara ya da bu hastaların yakınlarına telefonla ulaşılarak mortalite değerlendirildi. Hasta yaşam kalitesi ve mortalite ilişkisi değerlendirildi.

İstatistiksel Değerlendirme

Verilerin istatistiksel analizinde sürekli veriler ortalama ± standart sapma, median (Q1-Q3); kategorik değişkenler ise yüzde (%) olarak verilmiştir. Grupların karşılaştırılmasında; normal dağılım gösteren gruplar ve grup sayısı iki olanlar için Student's t-testi, normal dağılım göstermeyen gruplar için ise Mann-Whitney U testi kullanılmıştır. Kategorik verilerin karşılaştırılmasında Ki-kare analizi kullanılırken; verilerin normal dağılıma uygunluğu Kolmogorov-Smirnov testi ile test edilmiştir. Analizlerin uygulamasında IBM statistics 21.0 paket programları kullanılmıştır. İstatistiksel anlamlılık için $p< 0.005$ değeri kriter olarak kabul edilmiştir. Sensitivite/spesifisite "Receiver Operating Characteristic (ROC)" eğrisi ve eğri altında kalan alanla değerlendirilerek kesme noktaları tespit edildi (cut-off). Sağkalım analizi Kaplan-Meier eğrileri ile değerlendirildi. Sağkalım analizi ROC eğrisine göre değerlendirilen kesme değerine göre gruplandırılarak karşılaştırıldı. Sağkalımı etkileyen faktörler geriye doğru kademeli Cox regresyon analizi ile değerlendirildi.

BULGULAR

Bu çalışma ile STYMİ tanısı ile PKG uygulanan ve 6 aylık takibi tamamlanan toplam 92 hasta değerlendirildi. Takibe alınan 92 hastanın 81 (%88)'i erkek, 11 (%12)'i kadındı. Yaş ortalaması 56.96 ± 12.61 olarak saptandı. On iki hastada 5 yıl

sonunda mortalite izlendi. Hastaların 32 (%34.8)'si anterior miyokart infarktüsü (Mİ), 13 (%14.1)'ü anteroseptal Mİ, 28 (%30.4)'i inferior Mİ, 17 (%18.5)'si inferior ve sağ Mİ, 2 (%2.2)'si lateral Mİ tanısı ile primer PKG'ye alındı. Bir (%1.0)'inde LMCA, 47 (%51.1)'sinde LAD, 11 (%12.0)'inde Cx, 33 (%35.9)'ünde RCA külprit damar olarak saptandı ve PKG uygulandı. Olguların 21 (%22.8)'inde diabetes mellitus (DM), 37 (%40.2)'sinde hipertansiyon (HT), 34 (%37.0)'ünde hiperlipidemi, 17 (%18.5)'sinde aile öyküsü, 57 (%62.0)'sinde sigara kullanımı, 24 (%26.1)'ünde obezite ve kadınların 2 (%18.2)'sinde erken menopoz öyküsü mevcuttu.

Takibe alınan hastaların 90 (%97.8)'ı asetilsalisilik asit, 91 (%98.9)'i klopidogrel, 81 (%88.0)'i beta-bloker, 20 (%21.7)'si nitrat, 81 (%88)'i statin, 83 (%90.2)'ü anjiyotensin converting enzim inhibitörü/anjiyotensin reseptör blokeri (ACEİ/ARB), 10 (%10.9)'u spirinolakton, 4 (%4.3)'ü varfarin tedavilerini 6 aylık takip boyunca kullanmaktaydılar. Demografik bulguların 5 yıllık mortalite gelişimi ile ilişkisi Tablo 1'de gösterilmiştir.

Doksan iki hastanın 6 aylık takibi sonunda transtorasik 2 boyutlu ekokardiyografi ile yapılan LVEF ölçümlerine göre 15 (%16.3)'inde kalp yetmezliği tespit edildi. EQ5D anket verilerinin istatistiksel olarak yapılan değerlendirmesinde Cronbach alfa katsayısı hesaplandı. Cronbach alfa katsayısı 0.83 saptandı ve yüksek derecede güvenilir olduğu görüldü[6,8,9].

Olguların cevapladıkları 5 seviyeli sorulara göre ise 0-1 (1'e yaklaştıkça iyileşen yaşam kalitesi) arasında EuroQor Grubunun belirlemiş olduğu indeks ölçek adı verilen puanları saptandı[7-9]. İndeks ölçeklerin ortalaması 0.903 ± 0.145 olarak saptandı. VAS puanlama sisteminde VAS ortalaması 80.58 ± 16.03 olarak saptandı. İndeks skor ve VAS skor ortalamaları mortalite olanlarda daha düşük bulundu (sırasıyla, p= 0.008, p= 0.011). Laboratuvar, klinik bulguların ve EQ5D skorlarının mortalite ile ilişkisi Tablo 2'de gösterilmiştir.

Bununla birlikte 5 yılllık mortalite değerlendirildiğinde indeks skorun ≤ 0.9 olması %66.67 sensitivite ve %76.25 spesifite ile mortaliteyi göstermiştir (AUC: 0.733 ± 0.073, p= 0.001); VAS skorun ≤ 82 %75.0 sensitivite ve %65 spesifite ile mortaliteyi göstermiştir (AUC: 0.729 ± 0.072, p= 0.002). ROC eğrisi ile tespit edilen kesme değerleri göz önüne alınarak Kaplan-Meier eğrileri değerlendirildi. Hem indeks skor hem de VAS skor istatistiksel olarak anlamlı olacak şekilde mortalite ile ilişkili bulundu (sırasıyla, p= 0.002, Ki-kare: 9.918; p= 0.008, Ki-kare= 7.112) (Şekil 1,2).

DM, HT, yaş, cinsiyet ve EQ5D skorlarının dahil edildiği geriye doğru kademeli Cox regresyon analizi ile indeks skor ≤ 0.9 olması ile mortalite ilişkisi gösterildi [p= 0.005; HR= 5.546 (1.668-18.443)] (Tablo 3).

Tablo 1. Demografik bulguların 5 yıllık mortalite gelişimi ile ilişkisi

	Mortalite yok (n= 80)	Mortalite var (n= 12)	p
Erkek	73 (%91.3)	8 (%66.7)	0.014
Yaş	55.08 ± 1.34	69.50 ± 2.78	< 0.001
Anterior Mİ	26 (%32.5)	6 (%50.0)	0.671
Inferior Mİ	24 (%30.0)	4 (%33.3)	0.671
Anteroseptal Mİ	12 (%15.0)	1 (%8.3)	0.671
Lateral	2 (%2.5)	0 (%0)	0.671
İnferior-sağ	16 (%20)	1 (%8.3)	0.671
LAD	40 (%50)	7 (%58.3)	0.801
Cx	9 (%11.3)	2 (%16.7)	0.801
RCA	30 (%37.5)	3 (%25.0)	0.801
DM	17 (%21.3)	4 (%33.3)	0.352
HT	30 (%37.5)	7 (%58.3)	0.170
HL	31 (%38.8)	3 (%25.0)	0.357
Heredite	17 (%21.3)	0 (%0)	0.077
Sigara	53 (%66.3)	4 (%33.3)	0.029
Obezite	21 (%26.3)	3 (%25.0)	0.927
ASA	78 (%97.5)	12 (%100)	0.580
Klopidogel	80 (%100)	11 (%91.7)	0.009
B-Bloker	78 (%97.5)	12 (%100)	0.580
Nitrat	17 (%21.3)	3 (%25.0)	0.769
Statin	72 (%90.0)	9 (%75.0)	0.135
ACEi/ARB	74 %92.5)	9 (%75.0)	0.057
Spironolakton	8 (%10.0)	2 (%16.7)	0.489
Varfarin	4 (%5.0)	0 (%0)	0.428

ME: Miyokart infarktüsü, LAD: Left anterior descending arter, Cx: Sirkumleks arter, RCA: Sağ coroner arter, DM: Diabetes mellitus, HT: Hipertansiyon, HL: Hiperlipidemi, ASA: Asetilsalisilik asit, ACEi: Anjiotensin konverting enzim inhibiyörleri, ARB: Anjiyotensin reseptör blokerleri.

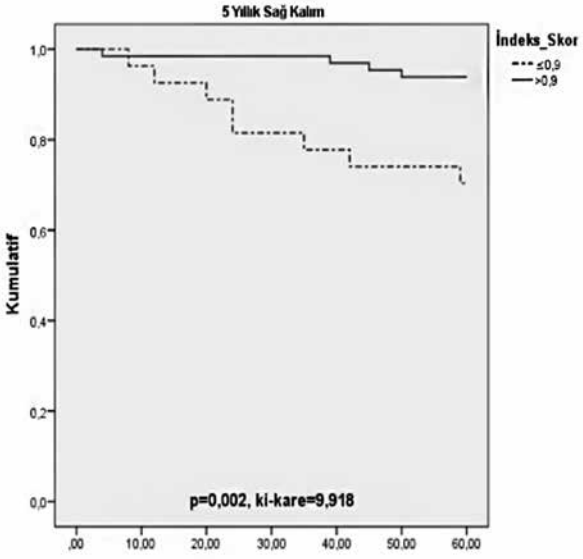
TARTIŞMA

Bizim çalışmamız STYMİ hastalarında yaşam kalitesi ile uzun dönem sağkalımın ilişkisini inceleyen ilk çalışmadır. EQ5D anketi ile 5 yıllık mortalite değerlendirildiğinde yaşam kalitesi skoru ile mortalite arasında anlamlı ilişki bulunmuştur. Hem VAS skor hem de indeks skordaki düşüklük mortalite ile anlamlı ilişkisi açıkça gösterilmiştir. Ayrıca, çalışmamızda sağlık ile ilgili yaşam kalitesinin düşüklüğü ile mortalite ilişkisi açıkça gösterilmiştir. Yaşam kalitesi ile mortalite ilişkisinin incelendiği sınırlı sayıda çalışma mevcuttur. Hastalığa özgü değerlendirme yapıldığında sağlık ile ilgili yaşam kalitesinin sağkalımın bağımsız bir göstergesi olduğu bu sınırlı çalışmalarda gösterilmiştir. Sağlık ile ilgili yaşam kalitesinin mortalitenin göstergesi olabileceği en çok SF-36 anketi ile değerlendirilmiştir[12]. SF-36 skorları ile mortalite arasındaki

Tablo 2. Laboratuvar, klinik bulguların ve EQ5D skorlarının mortalite ile ilişkisi

	Mortalite yok (n= 80)	Mortalite var (n= 12)	p
Na	137.75 ± 0.30	136.67 ± 0.98	0.458
K	4.21 ± 0.05	4.23 ± 0.15	0.897
Cre	0.93 ± 0.02	1.04 ± 0.19	0.593
Glu	167.75 ± 9.82	161.92 ± 7.55	0.345
Hgb	14.76 ± 0.19	13.03 ± 0.49	0.001
Htc	42.65 ± 0.58	38.1 ± 1.45	0.005
BK	11.71 ± 0.48	12.29 ± 1.33	0.785
Plt	250.78 ± 7.80	249.33 ± 24.81	0.949
LVEF (%)	54.05 ± 1.17	47.75 ± 3.29	0.056
Kalp yetmezliği (+)	12 (%15)	5 (%41.7)	0.026
VAS skor	82.08 ± 1.74	70.58 ± 4.69	0.011
İndeks skor	0.913 ± 0.16	0.836 ± 0.04	0.008

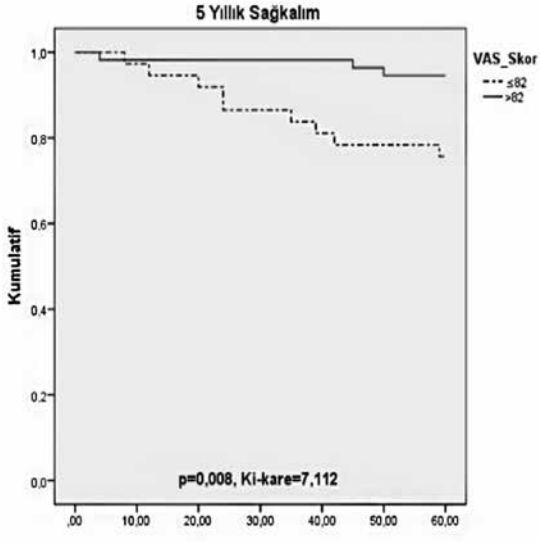
Na: Sodium, K: Potasyum, Cre: Kreatinin, Hgb: Hemoglobin, Htc: Hemotokrit, BK: Beyaz küre, Plt: Platelet, LVEF: Sol ventrikül ejekiyon fraksiyonu, VAS: Vizüel analog ölçek.



Şekil 1. İndeks skorun sağkalıma etkisi.

ilişki koroner arter baypas greft ameliyatı olan hastalarda, kalp yetmezlikli hastalarda, yaşlı popülasyonda, hayatı tehdit edici ventriküler aritmisi olan hastalarda gösterilmiştir [13-17]. Ancak mortalitenin en sık nedenlerinden olan STYMİ ile ilişkisi inceleyen daha önce bir çalışma yoktur.

Biz çalışmamızda standart, kolay uygulanabilir ve hastaların fonksiyonel ve global sağlık durumunun derecelendirildiği EQ5D anketini kullandık[18-20]. EQ5D anketi daha önceki birçok epidemiyolojik çalışmada ve özellikle akut koroner sendromlar için validasyonu sağlanmış basit ve kolay uygulanabilirliği nedeniyle tercih edildi[19,20]. Daha önceki yayınlarda EQ5D skorlarının insan immünyetmezlik virüsü (HIV) hastalarında mortalite ve hospitalizasyonun göstergesi olduğu gösterilmiştir[21]. Aynı zamanda yaşlı popülasyonda da EQ5D ile mortalite ve hastaneye yatış öngörülebildiği gösterilmiştir. Tamamlanmış EQ5D anketi olan 5.256 yaşlının değerlendirildiği bu çalışmada Cavrini ve arkadaşları hem indeks hem de VAS skorun mortalite ve hasteneye yatış ile ilişkisini göstermişlerdir[22]. Kardiyak nedenli ölümler ve özellikle Mİ tüm yaş gruplarında olduğu gibi yaşlıları daha çok etkilemekte ve daha ölümcül seyretmektedir. Mortalite ve morbiditeyi değerlendirmek için basit, maliyeti az ve klinik olarak uygulanması kolay enstrümanların geliştirilmesine yönelik önem gittikçe artmaktadır. Biz de özellikle mortalitenin yüksek olduğu STYMİ olan hastalarda EQ5D ile 5 yıllık mortalite ilişkisini değerlendirdik. Cavrini ve arkadaşları benzer şekilde düşük EQ5D indeks ve VAS skorlarını artmış mortalite ile ilişkili bulduk[22]. Ancak kardiyak ve kardiyak olmayan nedenlerle hastaneye yatışın incelenmemesi bizim çalışmamızın kısıtlılığı olarak değerlendirilebilir.



Şekil 2. VAS skorun sağkalıma etkisi.

Genel yaşam kalitesi ölçekleri belli bir hastalığa özgü olarak değil de bireylerin genelinin sağlık durumunu ölçmek için geliştirilmiş ölçeklerdir. Geçerli oldukları ispatlanırsa hastalıklarda da kullanılabilirler. Çalışmada kullanılan EQ5D ölçeği bu kategoriye girmektedir. Ayrıca SF-36, Sintonen 15-D, Nottingham Sağlık Profili, Sağlık Yarar İndeksi (Health Utility Index) gibi ölçekler de bu kategoriye girmektedir[23]. Hastalığa özgü yaşam kalitesi ölçekleri ise belli hastalıklara özgü olarak geliştirilen ve sadece bu hastalarda yaşam kalitesini ölçmede kullanılan ölçeklerdir. MacNew kalp hastalığına özgü yaşam kalitesi ölçeği bu kategoriye girmektedir[9,24-28]. Çalışmada

Tablo 3. Geriye doğru kademeli Cox regresyon analizi

						95.0% güven aralığı	
		B	SE	p	Hazard oranı	alt	üst
Adım 1	Kalp yetmezlik	0.611	0.667	0.360	1.843	0.498	6.817
	İndeks skor ≤ 0.9	1.102	1.078	0.307	3.012	0.364	24.923
	VAS skor ≤ 82	0.255	1.206	0.832	1.291	0.122	13.715
	DM	0.268	0.721	0.710	1.307	0.318	5.369
	HT	0.209	0.649	0.747	1.233	0.345	4.401
	Cinsiyet	-0.467	0.763	0.541	0.627	0.140	2.798
Adım 6	İndeks skor ≤ 0.9	1.713	0.613	0.005	5.546	1.668	18.443

VAS: Vizüel analog ölçek, DM: Diabetes mellitus, HT: Hipertansiyon.

kullanılan genel yaşam kalite ölçeği olan EQ5D ölçeğinin Türkiye'deki geçerlilik çalışması MacNew yaşam kalite ölçeği ile karşılaştırmalı olarak yapılmıştır[6].

Cinsiyet değerlendirildiğinde Mİ sonrası kısa ve uzun dönem mortalite kadınlarda erkeklere göre daha fazla tespit edilmiş ancak bu fark yaş ilerledikçe azalmaktadır[29-31]. Benzer şekilde bizim çalışmamızda da mortalite ile cinsiyet ilişkisini görüldü. Bununla birlikte yaş, serum kreatinin düzeyi ve düşük LVEF Mİ sonrası ölümün bağımsız öngördürücüsü olarak tespit edilmiştir[32]. Yine benzer bir çalışmada LVEF düşüklüğü Mİ sonrası ölümün göstergesi olduğu açıkça gösterilmiştir[33]. Altı aylık takip sonunda transtorasik 2 boyutlu ekokardiyografi ile yapılan LVEF ölçümlerinde hastaların 15 (%16.3)'inde kalp yetmezliği tespit edildi. Daha önceki yayınımızda EQ5D skoru ile LVEF düşüklüğü arasındaki ilişki açıkça gösterilmiştir[10]. Bu çalışmamızda da EQ5D skoru ile mortalite ilişkili bulundu. Ancak böbrek fonksiyonları ile mortalite arasında ilişki tespit edilmedi.

Yaşlılarda Mİ daha fazla gözlendiği gibi Mİ sonrası komplikasyonlar ve kardiyovasküler nedenli ölümler de daha sık gözlenmektedir. Yaş ve DM'nin STYMİ sonrası mortalitenin göstergesi olduğu görülmüş ve bu veriler TIMI, PAMI, GRACE, CADILLAC gibi STYMİ de kullanılan birçok risk skoru içerisinde değerlendirilmektedir[34-38]. Bununla birlikte HT'nin, yine Mİ sonrası hastaların mortalitesini gösterdiği iyi bilinmektedir[39,40]. Yaş, DM, HT ve cinsiyet gibi STYMİ hastalarında mortaliteyi arttırdığı gösterilmiş faktörlerle birlikte EQ5D skorlarının çoklu Cox regresyon analizi ile değerlendirildiğinde indeks skorun mortalite artışını 5.5 kat daha fazla ön gördürdüğü çalışmamızda tespit edilmiştir [41]. EQ5D indeks skoru STYMİ hastalarında uzun dönemli mortalitenin bağımsız bir ön gördürücüsü olarak değerlendirilmiştir.

Yaşam kalitesi anketlerinin sağkalıma etkisini inceleyen çalışmalar sınırlıdır. Çalışmamızın kısıtlılığı olarak görünen az sayıda hasta değerlendirilmiş olmasına rağmen mortalite ile EQ5D skorlarının ilişkisi gösterilmiştir. Özellikle STYMİ gibi mortalitenin hala en sık sebebi olan bir hastalıkta bu gibi kolay uygulanabilir, yatakbaşı ya da kontrole gelen hastalarda poliklinik koşullarında hızla değerlendirilebilecek, mortalite hakkında fikir verecek bir değerlendirme testinin bulunmasının klinik faydası yadsınamaz. Yaşam kalitesi ile mortalitenin değerlendirildiği daha iyi dizayn edilmiş, randomize kontrollü klinik çalışmalar ile bizim bulgularımızın teyidi gerekmektedir. Aynı zamanda bu bulgular sağlık ile ilgili yaşam kalitesinde düzelme ve yaşam kalitesini etkileyen sosyoekonomik, psikolojik faktörlerin düzeltilmesinin mortaliteyi olumlu yönde etkileyip etkilemeyeceği sorusunu akıllara getirmektedir.

SONUÇ

EQ5D anketi ve 5 yıllık mortalitenin değerlendirildiği çalışmamızda sağlık ile ilişkili yaşam kalitesi skoru düşüklüğü ile mortalite ilişkisi gösterilmiştir. EQ5D indeks skoru PKG ile tedavi edilen STYMİ hastalarında uzun dönemli mortalitenin bağımsız bir ön gördürücüsüdür.

ÇIKAR ÇATIŞMASI

Yazarlar bu makale ile ilgili herhangi bir çıkar çatışması bildirmemişlerdir.

YAZAR KATKISI

Anafikir/Planlama: GM
Analiz/Yorum: KM
Veri sağlama: GM, KM
Yazım: KM
Gözden Geçirme ve Düzeltme: GM, MD
Onaylama: Tüm yazarlar

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Repair of Complex Mitral Valve Pathologies: Is It Worth to Cope With?

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ABSTRACT

Introduction: Mitral valve (MV) repair is preferred over replacement for its benefits of preservation of ventricular function, lower operative mortality, superior long-term survival, and avoidance of anticoagulation. In this study, we aimed to review the repair techniques of complex MV pathologies and their outcomes.

Patients and Methods: We retrospectively analyzed 56 patients (mean age 41.8 ± 16.5 years; 33 males) who underwent repair of complex MV pathologies. 44 patients had pure mitral regurgitation (MR), and 12 (21.4%) had mixed mitral disease (mitral stenosis (MS) + MR). Preoperative and operative characteristics, postoperative MR severity, operative mortality, and midterm survival were examined for each patient.

Results: There was only one early death (30-day mortality: 1.8%) due to postoperative low cardiac output syndrome. The procedures were successful in all patients who underwent MV repair. Transthoracic echocardiography examinations revealed no/trivial MR in 74.6% and mild MR in 21.8% of patients at discharge. Late follow-up was obtained in 55 patients. The mean follow-up period of patients was 47.9 ± 23.1 months. Mortality developed in one (1.8%) patient with Marfan syndrome who had acute aortic dissection three years after MV surgery. During follow-up visits, mitral repair procedures were successful in 49 (90.7%) patients. Four (7.4%) patients presented with moderate MR. Only one (1.9%) patient needed reoperation because of severe MR.

Conclusion: This study showed that repair of complex MV pathologies provides excellent surgical outcomes. Repair of complex MV pathologies is safe and highly effective, but operations require considerable surgical experience.

Key Words: Mitral valve repair; mitral regurgitation; mitral stenosis

Kompleks Mitral Kapak Patolojilerin Onarımı; Uğraşmaya Değer mi?

ÖZET

Giriş: Ventrikül fonksiyonun korunması, daha az cerrahi mortaliteye sahip olması, üstün uzun dönem survey ve antikoagülan kullanımının önlenmesi gibi üstünlükleri nedeniyle mitral kapak onarımı replasmana daha çok tercih edilmektedir. Bu çalışmanın amacı, kompleks mitral kapak patolojilerin onarım teknikleri ve sonuçları sunmaktır.

Hastalar ve Yöntem: Retrospektif olarak kompleks mitral kapak patolojilerin onarımı geçiren 56 hasta incelendi (ortalama yaş 41.8 ± 16.5 yıl; 33 erkek). Kırk dört hastada saf mitral yetmezliği varken, 12 (%21.4) hastada miks mitral kapak hastalığı (mitral darlığı + mitral yetmezliği) vardı. Preoperatif ve operatif özellikleri, postoperatif mitral yetmezliği derecesi, cerrahi mortalite ve orta dönem sonuçları her hasta için araştırıldı.

Bulgular: Postoperatif düşük kardiyak debi sendromuna bağlı bir hastada erken mortalite (30 gün mortalite: %1.8) görüldü. Mitral kapak onarımı ameliyatı olan bütün hastalarda mitral onarım prosedürleri başarılı olmuştur. Hastalar taburcu olduğunda yapılan ekokardiyografik değerlendirmede %74.6'sında hiç/eser yetersizlik ve %21.8'inde hafif yetersizlik saptandı. 55 hastada geç dönem takibi yapıldı. Hastalarımızın ortalama takip süresi 47.9 ± 23.1 aydı. Geç mortalite mitral kapak onarımından 3 yıl sonra akut aort diseksiyonu nedeniyle ameliyata alınan marfan sendromlu bir hastada gözlendi. Takipler sırasında yapılan ekokardiyografik değerlendirmede hastaların %90.7 (49 hasta)'sinde hiç ya da hafif yetersizlik gözlendi. Orta yetersizlik gözlenen 4 (%7.4) hastada tıbbi tedavi uygulandı. İleri yetersizlik gözlenen 1 (%1.9) hastada reoperasyon uygulandı.

Sonuç: Çalışmamız kompleks mitral kapak patolojilerin onarımının sonuçları mükemmel olduğunu gösterdi. Kompleks mitral kapak patolojilerin onarım teknikleri güvenli ve sonuçları son derece etkindir, fakat ameliyatlarda yeterli cerrahi tecrübe gereklidir.

Anahtar Kelimeler: Mitral kapak onarımı; mitral yetmezliği; mitral darlığı

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INTRODUCTION

Mitral valve (MV) repair is preferred over replacement for its advantages of preservation of ventricular function, lower operative mortality, better long-term survival, and avoidance of anticoagulation[1-3]. MV repair has been shown to have excellent durability in patients with mitral regurgitation (MR) caused by degenerative diseaseand is indeed the method of choice in the correction of MR whenever feasible[4-7]. In contrast, valve reconstruction for rheumatic MR remains controversial as it is not only less feasible to repair but also the repaired rheumatic valve has poorer durability when compared with a degenerative MV repair[8,9].

Most of the MV pathology involves the posterior leaflet or annulus and usually can be repaired using standard valve repair techniques. These procedures are feasible in almost 95% of patients with degenerative MR despite the presence of complex lesions[10]. Difficulties may arise when trying to repair the less common anterior leaflet prolapse or calcified mitral annulus. Although the repair for the prolapse of the posterior leaflet with valvular resection or artificial chordae is usually possible, correction of anterior or bileaflet prolapse may demand more complex repair procedures. MV repair in a complex setting such as redo repair procedure, congenital anomalies, and hypertrophic obstructive cardiomyopathy (HOCM) is often challenging because of a lack of leaflet mobility or adequate surface of coaptation. In this study, we aimed to review repair techniques of complex MV pathologies and their outcomes.

PATIENTS and METHODS

For this study, our hospital has been approved by the Scientific Ethics Committee.

Study Group and Definitions

This is a retrospective study of 56 patients who underwent repair of complex mitral pathologies using multiple procedures for MR or mitral stenosis (MS) at our hospital. Complex repair was defined as using multiple mitral valve repair techniques (three techniques or more) in the same patient. These more complex and challenging patients were selected as study group in order to assess more convincingly the efficacy of these techniques. All preoperative, intraoperative, and postoperative demographic, echocardiographic, and clinical data were collected. Additionally, all surgical notes and discharge summaries were reviewed to collect supplementary information. The data collected were focused on preoperative ejection fraction, grade of MR or MS, valve pathology, repair techniques, and intraoperative, postoperative early (< 30 days), and late (> 30 days) complications.

Surgical Techniques

Operative data were retrospectively extracted from medical records, surgery notes, and the computer-based databank from the Department of Cardiac Surgery. Surgical approach was via a mid-sternotomy in 52 patients and a right anterolateral thoracotomy in four patients for cosmetic reasons. Aorto-bicaval cannulation was used in all. Operations were performed under cardiopulmonary bypass (CPB) at moderate hypothermia. Concomitant cardiac procedures were performed. After a right atriotomy was performed with an oblique incision, the mitral repair was completed through transseptal approach. In 14 patients, we used left atriotomy. Leaflet repair techniques were performed with principles originally reported by Carpentier et al. and Duran et al. but several modifications based on these principles were used[11,12]. Our techniques of MV repair evolved over the years. In complex mitral pathologies, chordal replacement with Gore-tex cords, leaflet resection with sliding or folding annuloplasty, or commissurotomy was performed considering the status of the mitral pathology. In rheumatic MV disease, leaflet augmentation with pericardium, commissurotomy, resection of primary or/and secondary chordae, and chordal replacement were preferred. In MR due to HOCM, we performed shortening of posterior leaflet, neochordae, and ring annuloplasty in addition to septal myectomy to prevent systolic anterior motion (SAM). The left atrial appendage was routinely ligated in patients with atrial fibrillation (AF). Upon completion of repair, MV was tested by injecting cold saline into the left ventricular cavity to observe coaptation of leaflets. Intraoperative transesophageal echocardiography (TEE) was used routinely for intraoperative assessment of MV repair after CPB. When an unsatisfactory finding was observed during TEE examination, a second cross-clamp was placed for satisfactory repair, if possible.

Follow-Up

Follow-up data were analyzed using cardiology and cardiac surgery outpatient follow-up notes, primary care and institutional computer-based databanks, and telephone interviews. All patients had a TTE before hospital discharge. Echocardiographic findings were recorded in the computer database of the hospital. The clinical parameters recorded during the follow-up period included early (< 30 days) and late mortality after surgery. All patients were anticoagulated with warfarin sodium for 3 months after surgery and permanently if they had AF or other mechanical valves.

Statistical Analysis

Data were presented as frequencies and percentages for categorical variables, and medians or means with standard deviations for continuous variables.

RESULTS

Patient Characteristics

The demographic data and preoperative characteristics for all patients are presented in Table 1. Patients' age ranged from 5 to 77 years (mean age was 41.8 ± 16.5 years), and female sex was less frequent than male sex (23 patients; 41.1%). Twenty-five patients (44.7%) were in New York Heart Association (NYHA)

functional class III-IV. The mean preoperative LV ejection fraction was 62 ± 5%. Concomitant cardiovascular pathologies included ischemic heart disease in 4 and tricuspid regurgitation in 18 cases (Figure 1). Most patients had preoperative Grade 4 MR and underwent mitral repair according to our definition. Degenerative MV disease as the cause of MR was diagnosed in 38 patients. The distribution of MV pathologies during surgical exploration is presented in Table 2. Five patients presented with the prolapse of the posterior leaflet, whereas 25 patients had an involvement of both mitral leaflets. Commissural fusion was diagnosed in 11 patients.

Table 1. Patient demographics and preoperative characteristics

Variables	
Sex (male)	33 (58.9%)
Age (years)	41.8 ± 16.5
BMI (kg/cm^2)	26 ± 3
Hypertension	15 (26.7%)
Diabetes mellitus	3 (5.4%)
NYHA functional status, n	
Class II	31 (55.3%)
Class III	23 (41.1%)
Class IV	2 (3.6%)
Euroscore	1 (0-5)
LVEF, %	62 ± 5
Mitral valve pathology, n	
Mitral regurgitation (MR)	44 (78.6%)
Mixed lesion (MR + MS)	12 (21.4%)
Mitral valve disease, n	
Degenerative	38 (67.8%)
Rheumatic	13 (23.2%)
Congenital	3 (5.4%)
HOCM	2 (3.6%)

Data are presented as mean value ± standard deviation, median value, or number of patients. BMI: Body mass index, NYHA: New York Heart Association, LVEF: Left ventricle ejection fraction, MR: Mitral regurgitation, MS: Mitral stenosis, HOCM: Hypertrophic obstructive cardiomyopathy.

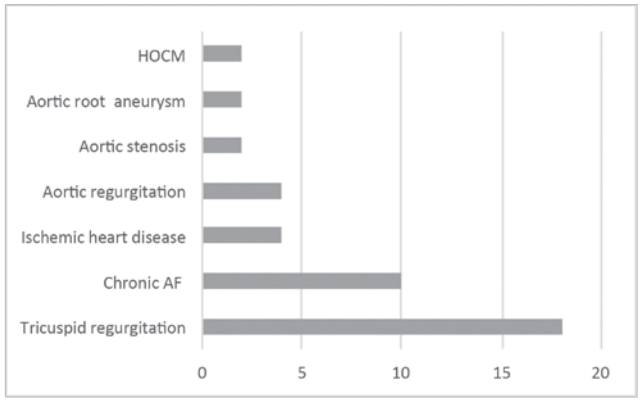

Figure 1. Concomitant cardiovascular pathologies.

Operative Data

Operative data are presented in Table 3. Most of the procedures were performed through a median sternotomy. A minimally invasive approach through a right anterior mini-thoracotomy and transthoracic aortic clamping was used in four patients for cosmetic reasons.

Surgical procedures involving different techniques are listed in Table 4. Ring annuloplasty was performed in 54 patients. Technically, for example, quadrangular resection of the posterior leaflet, sliding annuloplasty, ring annuloplasty, Reed annuloplasty, and chordal replacement were performed. All patients undergoing chordal replacement and posterior leaflet resection had an annuloplasty procedure.

The concomitant procedures are listed in Table 5. Four coronary artery bypass grafting, 18 tricuspid repair, left atrial radiofrequency ablation in 12 patients with preoperative AF, and left atrial appendix ligation in all patients with preoperative AF were performed. In patients presenting with MR, aortic aneurysm, and aortic regurgitation, we preferred making valve sparing aortic repair (reimplantation procedure) if patients were below 70 years of age and had a favorable physical status.

Clinical Outcomes

The early and late complications after mitral repair are presented in Table 6. There was only one early death (30-day

Table 2. Distribution of mitral valve pathologies

Variables	N
Annular dilatation	34
Leaflet prolapse	
Anterior leaflet	2
Posterior leaflet	5
Both leaflets	25
Commissural	9
Chordal rupture	
Anterior leaflet	2
Posterior leaflet	3
Mitral cleft	
Anterior leaflet	4
Posterior leaflet	6
Commissural fusion	11
Leaflet retraction	
Anterior leaflet	1
Posterior leaflet	14
Chordal retraction	
Primary chordae	10
Secondary chordae	20
HOCM	2

Data are presented as number of patients. HOCM: Hypertrophic obstructive cardiomyopathy.

Table 3. Operative data

Variables	
Incision, n (%)	
Sternotomy	52 (92.8%)
Right mini-thoracotomy (port access)	4 (7.2%)
Surgical approach, n (%)	
Left atrium	14 (25%)
Right atrium	42 (75%)
Operation duration	
Cardiopulmonary bypass duration, min	144 ± 35
Aortic cross-clamp duration, min	101 ± 30
ICU stay, days	1.83 ± 0.4
Hospital stay, days	7.12 ± 1.86

Data are presented as mean ± SD or number of patients. ICU: Intensitive care.

mortality: 1.8%) due to postoperative low cardiac output syndrome in patient with significant left ventricle dysfunction. The mean intensive care unit and hospital stays of patients were 1.83 ± 0.4 and 7.12 ± 1.86 days, respectively. New-onset AF developed in four patients and medically resolved in all. Inotropic support for more than 24 hours was needed in four cases, and two of them needed an intra-aortic balloon pump.

Late follow-up was obtained in 55 patients at an average of 47.9 ± 23.1 months postoperatively. Mortality developed in one (1.8%) patient with Marfan syndrome who had acute aortic dissection three years after MV surgery. Only one (1.9%) patient needed reoperation because of severe MR. This patient was treated with mechanical valve replacement after four years of initial repair.

Echocardiographic Results

Echocardiographic data are given in Table 7. In all patients who underwent MV repair, the procedures were successful at discharge; transthoracic echocardiography examinations revealed no/trivial MR in 74.6% and mild MR in 21.8% of patients. During follow-up visits, mitral repair procedures were successful in 49 (90.7%). Only four (7.4%) patients presented with moderate MR, and they were asymptomatic under medical treatment. Unfortunately, severe MR developed in one patient. This patient was treated with mechanical valve replacement after four years of initial repair.

DISCUSSION

Current consensus guidelines on MR recommend repair over replacement whenever possible and earlier surgical intervention if there is a high likelihood of repair[13,14]. Accordingly, repair feasibility is a key factor in the decision to operate and is highly dependent on lesion complexity and surgeon experience[15]. Repair of the MV is well known for its efficacy, durability, and avoidance of many complications[16]. As demonstrated in many studies, MV replacement is associated with (a) gradual decline in left ventricular function, (b) hazards of anticoagulation, (c)

Table 4. Surgical repair techniques

Technique	Patient (n)
Resection of P2, Sliding Artificial chordae Commissuroplasty Ring annuloplasty	10
Resection of P2, Sliding Cleft repair Ring annuloplasty	1
Commissurotomy Resection of secondary chordae Resection of primary chordae Artificial chordae Ring annuloplasty	3
Commissurotomy Resection of secondary chordae Posterior leaflet augmentation Ring annuloplasty	6
Commissurotomy Posterior leaflet augmentation Ring annuloplasty	1
Commissurotomy Resection of secondary chordae Reed annuloplasty	1
Artificial chordae Posterior leaflet augmentation Ring annuloplasty	4
Artificial chordae Cleft repair Commissuroplasty Ring annuloplasty	6
Artificial chordae Shortening posterior leaflet Ring annuloplasty	12
Artificial chordae Cleft repair Shortening posterior leaflet Ring annuloplasty	1
Artificial chordae Resection of secondary chordae Resection of primary chordae Posterior leaflet augmentation Ring annuloplasty	6
Artificial chordae Resection of secondary chordae Ring annuloplasty	1
Artificial chordae Resection of secondary chordae Resection of primary chordae Cleft repair Reed annuloplasty	1
Anterior leaflet augmentation Shortening posterior leaflet Ring annuloplasty	1
Cleft repair Resection of secondary chordae Ring annuloplasty	2

Table 5. Concomitant surgical procedures

Concomitant surgical procedures	n (%)
CABG	4 (7.1%)
TR	18 (32.1%)
Kay annuloplasty	12 (21.4%)
Ring annuloplasty	6 (10.7%)
AVR	3 (5.4%)
Aortic valve reconstruction	3 (5.4%)
Valve-sparing aortic root replacement	2 (3.6%)
Septal myectomy for HOCM	2 (3.6%)
RF ablation	12 (21.4%)

CABG: Coronary artery bypass grafting, TR: Tricuspid repair, AVR: Aortic valve replacement, HOCM: Hypertrophic obstructive cardiomyopathy, RF: Radiofrequency ablation.

Table 6. Early and late morbidity and mortality

Variables	n (%)
Early (< 30 days)	
Mortality	1 (1.8%)
New-onset atrial fibrillation	4 (7.1%)
Pleural effusion requiring drainage	1 (1.8%)
Low cardiac output syndrome	1 (1.8%)
Inotropic support > 24 hours	4 (7.1%)
Intra-aortic balloon pump	2 (3.6%)
Acute renal failure	1 (1.8%)
Cerebrovascular accident	1 (1.8%)
Late (47.9 ± 23.1 months)	
Mortality	1 (1.8%)
Reoperation	1 (1.8%)

Data are presented as number of patients (percentage).

thromboembolism, and (d) higher incidence of endocarditis [3,12,17]. Results from a recent series show a poor survival after valve replacement[18]. Growth, marriage, and pregnancy are important issues which are adversely affected by anticoagulation. During the last two decades, the number of MV repair procedures has increased across the world. As experience grows in this field, surgeons try to repair more valves in complex MV disease patients. In our series consisting of 56 complex mitral valve cases that underwent MV repair, there was one early mortality after 5 days of surgery due to postoperative low cardiac output syndrome in a patient with significant left ventricle dysfunction. In the late follow-ups, there was one mortality due to acute aortic dissection after three years of surgery. This patient had Marfan syndrome, and we repaired his MV. At the time of operation, there was mild aortic regurgitation, and the diameter of the aortic root was 36 mm. Echocardiographic assessment of patients at discharge revealed no/trivial regurgitation in 74.6% and mild MR in 21.8% of all patients. Echocardiographic examination during follow-up revealed that mitral insufficiency was none or mild in 90.7% of patients. Four (7.4%) patients had moderate MR and were treated medically. Mitral insufficiency recurrence with severe regurgitation occurred in one (1.9%) patient. This patient was treated with mechanical valve replacement after four years of initial repair. We prefer surgical repair of the MV in young patients (mean age 41.8 ± 16.5), and we think that it is not a good strategy for elderly patients.

The mitral apparatus includes the leaflets, annulus, chordae tendineae, papillary muscles, and left ventricle. The goals of mitral repair are to maintain leaflet mobility, remodel the annulus, and allow normal coaptation of the anterior and posterior leaflets. In MV prolapse or Barlow's syndrome, the leaflets and chordae become thickened and redundant, which results in leaflet prolapse beyond the plane of the annulus and MR. In our study, 38 patients had degenerative MV. Up to 2011, we repaired degenerative MVs with leaflet resection; after that, we switched to artificial chordae implantation as a routine technique. The most simple and common MV lesion, the prolapse of the posterior leaflet, can be treated with leaflet resection with excellent short-term and long-term results[19]. However, the correction of anterior, bileaflet prolapse, or even large areas of posterior prolapse is more complex[20,21]. Particularly in patients with complex degenerative MV disease, we used three or more techniques together. For example, we used a combination of artificial chordae, resection of secondary chordae, resection of primary chordae, posterior leaflet augmentation, and ring annuloplasty in six patients. Our degenerative MV repair was successful in all patients.

Table 7. Echocardiographic follow-up data of patients

Variables	Preoperative	Operative TEE	At discharge	At follow-up
MR grade, n (%)	56	56	55	54
None/Trivial	0	46 (82.1%)	41 (74.6%)	25 (46.3%)
Mild	0	10 (17.9%)	12 (21.8%)	24 (44.4%)
Moderate	4 (7.1%)	0	2 (3.6%)	4 (7.4%)
Severe	52 (92.9%)	0	0	1 (1.9%)
	25 (43%)	89 (63%)	0.024	

Data are presented as number of patients (percentage). MR: Mitral regurgitation.

Echocardiographic examination during follow-up revealed that mitral insufficiency was none or mild in 37 patients. One patient had moderate MR and was treated medically.

MV repair has been shown to have excellent durability in patients with MR caused by degenerative disease[4,5]. In contrast, valve reconstruction for rheumatic MR remains controversial as it not only suffers from an inferior feasibility of repair, but also the repaired rheumatic valve is less stable, with inferior durability when compared with a degenerative MV repair[8,9]. The utilization of leaflet mobilization and extension with the pericardium to increase the leaflet area and the surface of coaptation may provide satisfactory results[22-24]. Chauvaud et al. on the other hand, had demonstrated good long-term results in repairing diseased rheumatic MVs using Carpentier's reconstruction techniques[22,23]. Dillon and colleagues reported that, after leaflet extension in rheumatic MV reconstruction, MR grade was none/trivial in 64.5% of patients, mild in 22.6%, moderate in 6.5%, moderately severe in 4.8%, and severe in 1.6%. Two patients had redo mitral surgery. At 5 years postoperatively, the estimated rates of freedom from reoperation was 96.8%[25].

13 of our patients had diseased rheumatic MV. We repaired their valves using commissurotomy, resection of primary or/and secondary chordae, artificial chordae, ring annuloplasty, or posterior leaflet augmentation. Echocardiographic examination during follow-up revealed that mitral insufficiency was none or mild in 10 patients. Two patients had moderate MR and were treated medically. One patient had redo mitral surgery after four years of surgery. In the follow-up, regurgitation was seen once often in rheumatic valves. Retraction of the pericardial patch and the on-going process of rheumatic disease were considered to be the undergoing pathologies in these cases.

In contrast, in children with congenital MR, conventional repair of the valve is not always successful. In part, this reflects the complicated abnormalities of the valvular structures and the associated cardiac malformations. When planning the optimal surgical repair of the MV, attention must be directed at the annular attachment, the valvar leaflets, and the tension apparatus of the valve. In patients with congenital MR, the annular attachment is commonly dilated, and the papillary muscles, as well as their attachments to the ventricular wall, are frequently abnormal[26,27]. In some patients with prolapse of the leaflets of the MV, use of artificial chords has been suggested to provide efficient short-term results[28].

In our study, three patients underwent mitral reconstructive operations for congenital mitral diseases. The pathologic findings of the first patient's MV were short and thickened chordae and annular dilatation. Her MV was repaired using artificial chordae, resection of secondary chordae, resection of primary chordae, posterior leaflet augmentation, and ring annuloplasty. The second's echocardiography showed severe mitral stenosis related to a hammock MV, and his valve was repaired using commissurotomy, resection of secondary chordae, and Reed annuloplasty. The third's MV was repaired using artificial chordae, resection of secondary chordae, resection of primary chordae, cleft repair, and Reed annuloplasty.

Kawahira et al. used artificial cords in 11 children with congenital MR, and they reported that, in two patients, regurgitation recurred within 1 year of the operation[29]. Early and late results of reconstructive operation for congenital MR in 66 pediatric age group patients were reported by Okita et al. Valvuloplasty failed in 19 of the long-term survivors, and one of these patients underwent MV replacement 11 years after initial operation[30]. During follow-up, there was no reoperation, and one of the patients had moderate MR during echocardiographic examination. Valve repair was particularly preferred in this patient because he had mental retardation and warfarin use and regular INR follow-up were not feasible. The recurrence of MR in this patient may be explained by the fact that mitral ring was not used in the repair surgery to avoid development of functional stenosis in the following years.

The MV in HOCM usually has an increased length of the anterior and posterior mitral leaflets. The MV, specifically the SAM of the MV leaflets, is an important component of the obstruction[31]. In HOCM, abnormal anatomy and valve displacement induce drag forces that cause SAM. This condition can be corrected by an autologous pericardial patch in the anterior mitral leaflet[32].

We routinely excise sufficient septal muscles to leave a residual septal thickness within the normal range. Patients with more severe forms of hypertrophic obstructive cardiomyopathy with MV involvement may require a more complex reconstructive operation. The anterior leaflet is reconstructed using an ovoid patch of glutaraldehyde-treated autologous pericardium sutured to the edges of the leaflet incision. Whenever the posterior leaflet was higher than 20 mm, we reduced it to less than 20 mm by an ovoid resection. Finally, in severe forms with an excessively small annulus and a hyperkinetic ventricle, a rigid annuloplasty ring is implanted. There were two HOCM patients at this study. In the first case, we repaired the MV using artificial chordae, shortening posterior leaflet, commissuroplasty, and ring annuloplasty. The other's MV was repaired using shortening posterior leaflet, anterior leaflet augmentation, and ring annuloplasty. There is no MR in echocardiographic examination during follow-up.

CONCLUSION

MV repair for complex pathologies is a feasible and safe procedure with excellent surgical outcomes in experienced hands. We demonstrated that MV repair can be performed for mixed MV disease patients with results similar to those in pure MR patients. Autologous pericardium is a useful leaflet substitute that facilitates MV repair. Combining multiple techniques of MV repair may extend valve repair into a wider spectrum of complex valve pathologies.

Limitations of the Study

The major limitations of this study are the retrospective design, the small number of patients, and the short follow-up period in some patients.

CONFLICT of INTEREST

The authors reported no conflict of interest related to this article.

AUTHORSHIP CONTRIBUTIONS

Concept/Design: SS, TK, AK

Analysis/Interpretation: SS, AK

Data Acquisition: SS, MG

Writting: SS, TK

Critical Revision: SS, MG

Final Approval: All of authors

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İzole CABG Operasyonlarında Aralıklı Antegrad ile Tek Doz Antegrad Sonrası Devamlı Retrograd İzotermik Kan Kardiyopleji Uygulamalarının Karşılaştırılması

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ÖZET

Giriş: Koroner arter baypas greftleme operasyonları (CABG) günümüzde miyokardiyal koruma yöntemlerinin geliştirilmesi sayesinde güvenle uygulanabilmektedir.

Hastalar ve Yöntem: Çalışmamızda 1 Haziran-31 Temmuz 2014 tarihleri arasında kliniğimizde opere edilen izole CABG'li 109 hastanın tamamı, uygulanan miyokardiyal koruma yöntemlerinin üstünlüklerini değerlendirmek amaçlı iki grup halinde retrospektif olarak incelendi. Grup A'da bulunan 26 hastada, 29-32°C'de aralıklı antegrad izotermik kan kardiyoplejisi kullanıldı. Grup R'de bulunan 83 hastada, 29-32°C'de tek doz antegrad kan kardiyoplejisi kullanımı sonrası devamlı retrograd izotermik kan kardiyoplejisi uygulandı.

Bulgular: Tüm hastalarda erken dönem mortalitenin 1 (%0.91) adet olduğu görüldü. Euroskor, yaş, cinsiyet, diyabet, ameliyat öncesi kan kreatin düzeyi, hipertansiyon ve ejeksiyon fraksiyonu değerleri, gruplar arası ameliyat öncesi hasta karakteristikleri olarak karşılaştırıldı. Bu parameterlerde istatistiksel olarak anlamlı farklılık bulunmadı. Ameliyat sırası ve sonrasında ise gruplar arası, total perfüzyon zamanı, aortik kros klemp süresi, inotrop ihtiyacı, iskemik elektrokardiyografi (EKG) değişikliği, uzamış entübasyon ihtiyacı, diyaliz gerektiren renal yetmezlik ve ameliyat sonrası birinci gün troponin değerleri karşılaştırıldı. Total perfüzyon zamanı (p= 0.016) ve aortik kros klemp süresi (p= 0.006) parametrelerinde gruplar arası istatistiksel olarak anlamlı farklılık görüldü. Diğer parametreler arasında ise istatistiksel olarak anlamlı farklılık bulunmadı.

Sonuç: İzole CABG'li hastalarda kullanılan miyokardiyal koruma yöntemlerinden antegrad ve retrograd kardiyopleji uygulamalarının iki grupta karşılaştırıldığı çalışmamızda, ameliyat öncesi ve sonrası parametrelerde gruplar arası çok yakın sonuçlar elde ettik. Her iki yöntemle de miyokardiyal koruma güvenle sağlanabilmektedir.

Anahtar Kelimeler: Antegrad kardiyopleji; retrograd kardiyopleji; izotermik kan kardiyoplejisi; izole CABG operasyonları

Comparison of Isothermic Continuous Retrograde Blood Cardioplegia vs. Intermittent Antegrade Blood Cardioplegia in Isolated CABG Surgery Patients

ABSTRACT

Introduction: CABG surgeries are performed without complications owing to the improvements in various myocardial protection methods.

Patients and Methods: In the present study, 109 patients who had undergone CABG surgeries between June 1, 2014 and July 31, 2014 were analyzed to investigate the superiority of two different myocardial protection methods utilized in two groups. Group A comprised 26 patients and intermittent isothermic antegrade blood cardioplegia was used at 29°C-32°C. Group R comprised 83 patients and continuous retrograde isothermic blood cardioplegia was used after single dose antegrade blood cardioplegia at 29°C-32°C.

Results: For all 109 patients, early mortality rate was 1 (0.91%). Euroscore, age, sex, diabetes mellitus, hypertension, ejection fraction, and preoperative creatinine levels were comprehensively compared between the groups as the patient's characteristics. No statistical differences were found in these parameters of the groups. Intraoperative and postoperative parameters such as total perfusion time, aortic cross clamping time, prolonged mechanical ventilation needs, postoperative first day troponin levels, usage of inotropic drugs, renal insufficiency requiring hemodialysis, and ischemic ECG changes were comprehensively compared between the groups. Total perfusion time (p= 0.016) and aortic cross clamping time (p= 0.006) parameters were found statistically different between the groups. No significant differences were found for the other postoperative parameters of the groups.

Conclusion: The findings of this study revealed that all methods compared and analyzed in this study for myocardial protection can be used safely with similar early outcomes.

Key Words: Antegrade cardioplegia; retrograde cardioplegia; isothermic blood cardioplegia; isolated CABG surgery

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GİRİŞ

Koroner arter baypas greftleme operasyonlarının (CABG), ortalama yaşam süresinin uzamasıyla beraber obesite, hipertansiyon, perifer arter hastalıkları, diyabet ve redo vakalar gibi riskli gruplarda da uygulanma sıklığı artmaktadır[1]. Sıklıkları artan bu tür kalp cerrahilerinin güvenle uygulanabilirliğinde, miyokardiyal koruma yöntemlerinin önemi büyüktür. Miyokardiyal korumanın temeli olan kardiyopleji uygulamaları ile elektromekanik kardiyak arrest sağlanarak miyokardın oksijen ihtiyacı azaltılır. Bu sayede, kalp cerrahisinde konfor sağlanırken, mükemmele yakın klinik sonuçlar da beraberinde gelmektedir[2].

Aort kökünden antegrad kardiyopleji uygulaması sırasında aort yetmezliği olan hastalarda, verilen kardiyoplejinin ventriküle kaçması nedeniyle, koroner ostiyumlar vasıtasıyla yeterli miktarda kardiyopleji miyokardiyumu besleyememektedir. Ayrıca ciddi proksimal koroner arter darlığı olan hastalarda, kardiyoplejinin antegrad olarak homojen dağılmasındaki problemler nedeniyle retrograd kardiyopleji kullanılması gündeme gelmiştir. Retrograd kardiyopleji uygulamasının miyokardiyal korumada efektif olabileceği bildirilmiştir ancak tek başına kullanılmasının, kardiyoplejinin sağ ventriküle ve arka septuma dağılımında yetersizlik sonucu, yetersiz sağ ventrikül korunmasına yol açabileceği belirtilmiştir[3,4].

Kardiyopleji solüsyonlarının, uygulama yöntemlerinin ve hasta gruplarının çeşitliliği nedeniyle, miyokart hasarını önlemede en uygun kardiyopleji metodunu tespit etmek her zaman kolay olmayabilir. Kan kardiyoplejisi kullanımının özellikle komplike kalp cerrahisi vakalarında ameliyat mortalitesini düşürdüğü görülmüştür[5,6]. Kan kardiyoplejisinin soğuk ya da ılık, antegrad ya da retrograd yolla verilmesi yöntemleri, koroner arter bypass greftleme operasyonlarında ayrıntılı olarak çalışılmıştır[7,8].

Biz de çalışmamızda, iki aylık süre içerisinde merkezimizde antegrad veya retrograd kardiyopleji uygulanan izole CABG olgularını, erken dönem sonuçları ile ayrıntılı karşılaştırdık.

HASTALAR ve YÖNTEM

Çalışma hastanemiz bilimsel değerlendirme kurulu tarafından onaylandı.

Çalışmamızda 1 Haziran-31 Temmuz 2014 tarihleri arasında kliniğimizde opere edilen izole CABG'li 109 hastanın tamamı, uygulanan miyokardiyal koruma yöntemlerinin üstünlüklerini değerlendirmek amaçlı, A (antegrad) ve R (retrograd) olmak üzere iki grup halinde retrospektif olarak incelendi.

Grup A; 26 (%23.9) hasta içermekteydi ve 29-32°C'de aralıklı antegrad izotermik kan kardiyoplejisi kullanıldı.

Grup R; 83 (%76.1) hasta içermekteydi ve 29-32°C'de tek doz antegrad kan kardiyoplejisi kullanımı sonrası devamlı retrograd izotermik kan kardiyoplejisi uygulandı.

Gruplardaki izole CABG uygulanan 109 hastanın ortalama yaşı 60.95 (35-81) idi. Tüm hastalardan ameliyat öncesi yazılı onam formu alındı.

Gruplar, ameliyat öncesi hasta karakteristikleri (Euroskor, yaş, cinsiyet, diyabet, hipertansiyon, ejeksiyon fraksiyonu ve ameliyat öncesi kan kreatin düzeyi) açısından ayrıntılı olarak karşılaştırıldı (Tablo 1).

İstatistiksel Analiz

Çalışmada elde edilen bulgular değerlendirilirken, istatistiksel analizler için IBM SPSS Statistics 22.0 programı kulla-

Tablo 1. Ameliyat öncesi hasta karakteristiklerinin gruplara göre değerlendirilmesi

		Antegrad Grup A	Retrograd Grup R	Total	p
Euroskor[1] Ort ± SS (Medyan)		3.19 ± 1.47 (3)	3.46 ± 1.92 (3)	3.39 ± 1.82 (3)	0.825
Yaş[2] n (%)	< 65	14 (%53.8)	57 (%68.7)	71 (%65.1)	0.251
	≥ 65	12 (%46.2)	26 (%31.3)	38 (%34.9)	
Cinsiyet[2] n (%)	Erkek	21 (%80.8)	65 (%78.3)	86 (%78.9)	1.000
	Kadın	5 (%19.2)	18 (%21.7)	23 (%21.1)	
DM[2] n (%)	Yok	14 (%53.8)	57 (%68.7)	71 (%65.1)	0.251
	Var	12 (%46.2)	26 (%31.3)	38 (%34.9)	
HT[2] n (%)	Yok	11 (%42.3)	35 (%42.2)	46 (%42.2)	1.000
	Var	15 (%57.7)	48 (%57.8)	63 (%57.8)	
EF[2]	30-50%	9 (%34.6)	28 (%33.7)	37 (%33.9)	1.000
	> 50%	17 (%65.4)	55 (%66.3)	72 (%66.1)	
Preop[3] Kreatin	< 1.5	25 (%96.2)	79 (%95.2)	104 (%95.4)	1.000
	> 1.5	1 (%3.8)	4 (%4.8)	5 (%4.6)	

[1] Mann-Whitney U test, [2] Continuity Correction (Yates) test, [3] Fisher's Exact test, DM: Diabetes mellitus, HT: Hipertansiyon, EF: Ejeksiyon fraksiyonu.

Tablo 2. Ameliyat sırası ve sonrası erken dönem parametrelerin gruplara göre değerlendirilmesi

		Antegrad Grup A	Retrograd Grup R	Total	p[1]
TPZ[1] (dakika) Ort ± SS (Medyan)		82.58 ± 44.67 (78)	99.33 ± 31.64 (95)	95.33 ± 35.68 (94)	0.016*
AKKS[1] (dakika) Ort ± SS (medyan)		51.04 ± 34.57 (46)	62.46 ± 23.43 (61)	59.73 ± 26.78 (56)	0.006**
İnotrop ihtiyacı[3]	Yok	18 (%69.2)	45 (%54.2)	63 (%57.8)	0.353
	< 12 saat	7 (%26.9)	28 (%33.7)	35 (%32.1)	
	> 12 saat	1 (%3.8)	10 (%12)	11 (%10.1)	
İskemik EKG değişikliği[3]	< 12 saat	4 (%15.4)	7 (%8.4)	11 (%10.1)	0.290
	> 12 saat	22 (%84.6)	76 (%91.6)	98 (%89.9)	
Uzamış entübasyon[2]	< 12 saat	21 (%80.8)	64 (%77.1)	85 (%78)	0.903
	> 12 saat	5 (%19.2)	19 (%22.9)	24 (%22)	
Diyaliz gerektiren renal yetmezlik[2]	Yok	25 (%96.2)	79 (%95.2)	104 (%95.4)	1.000
	Var	1 (%3.8)	4 (%4.8)	5 (%4.6)	
PO1 troponin[2]	< 20	22 (%84.6)	71 (%85.5)	93 (%85.3)	1.000
	> 20	4 (%15.4)	12 (%14.5)	16 (%14.7)	

* $p < 0.05$,
** $p < 0.0$
[1] Mann-Whitney U test, [2] Continuity Correction (Yates) test, [3] Fisher's Exact test.
TPZ: Total perfüzyon zamanı, AKKS: Aortik kros klemp süresi.

nıldı. Çalışma verileri değerlendirilirken tanımlayıcı istatistiksel metodların (ortalama, standart sapma) yanı sıra niceliksel verilerin karşılaştırılmasında normal dağılım göstermeyen parametrelerin iki grup arası karşılaştırmalarında Mann-Whitney U test kullanıldı. Niteliksel verilerin karşılaştırılmasında ise Fisher's Exact test ve Continuity Correction (Yates) test kullanıldı. Anlamlılık $p< 0.05$ düzeyinde değerlendirildi.

Cerrahi Yaklaşım

Standart cerrahi teknikler uygulandı. Orta hat sternotomisi sonrası arteryal kanülasyon çıkan aortadan, venöz kanülasyon ise sağ atriyumdan iki aşamalı tek venöz olarak yapıldı. Sol mamaryan arter grefti iki olgu dışında tüm olgularda kullanıldı.

29-32°C'de sistemik hipotermi kullanıldı. Grup A'da ilk doz antegrad izotermik kan kardiyoplejisi aort kökünden verilerek, 20 dakika aralıklarla tekrarlandı. Grup R'de tek doz antegrad kardiyopleji sonrası devamlı retrograd izotermik kan kardiyoplejisi uygulandı. İzotermik terimi, kardiyopleji solüsyonunun sıcaklığının hasta sıcaklığı ile aynı olduğunu gösterir.

Proksimal anastomozlar cerrahın tercihine göre kros ya da side klempte yapıldı.

BULGULAR

Çalışmamızdaki 3 hastada (Grup R) intraaortic balon pompası kullanım ihtiyacı oldu. Erken dönem mortalitenin 1(%0.91) adet (Grup R) olduğu görülerek sebebinin düşük kalp debisi olduğu tespit edildi.

Tablo 2'de ayrıntılı olarak değerlendirilen parametrelerde, ameliyat sırası ve sonrası erken dönem veriler (total perfüzyon zamanı, aortik kros klemp süresi, inotrop ihtiyacı, iskemik elektrokardiyografi (EKG) değişikliği, uzamış entübasyon ihtiyacı, diyaliz gerektiren renal yetmezlik ve ameliyat sonrası birinci gün troponin değerleri) karşılaştırıldı.

Gruplara göre ameliyat öncesi hasta karakteristikleri arasında istatistiksel olarak anlamlı farklılık bulunmadı. Gruplara göre ameliyat sırası ve sonrası erken dönem parametreler arasında, total perfüzyon zamanı ($p= 0.016$) ve aortik kros klemp süresi ($p= 0.006$) değerlerinde istatistiksel olarak anlamlı farklılık görüldü. Ameliyat sonrası erken dönem diğer parametreler arasında istatistiksel olarak anlamlı farklılık bulunmadı.

TARTIŞMA

Çalışmamızda erken dönem mortalite yönünden gruplar arasında anlamlı farklılık görülmedi. Ancak total perfüzyon zamanı ve aortik kros klemp süresi değerlerinin Grup R'de daha uzun olduğunu tespit ettik. Farklı ekipler tarafından gerçekleştirilen olgulardaki gruplar arası bu farkın, uzun aortik kros klemp süresi olacağı düşünülen olgularda retrograd kardiyoplejinin daha sık tercih edilmesinden ileri geldiği kanısındayız. Fakat ameliyat öncesi hasta karakteristikleri arasında ve ameliyat sonrası ilk gün troponin düzeyi, inotrop ihtiyacı, iskemik EKG değişikliği, diyaliz gerektiren renal yetmezlik ve uzamış entübasyon ihtiyacı değerlerinde, gruplar arası anlamlı farkılılık görülmedi.

Kardiyoplejinin antegrad ya da retrograd verilmesindeki dezavantajlar, cerrahın ameliyat sırasındaki kardiyopleji kullanım tercihinde önemli rol oynamaktadır. Aort yetmezliği, ciddi proksimal koroner arter lezyonları ve redo olgulardaki önceki greftler, antegrad kardiyopleji kullanımını kısıtlayabilir [9]. Antegrad aralıklı 20 şer dakikalık kardiyopleji uygulamaları, total perfüzyon zamanını ve aortik kros klemp süresini de uzatmaktadır. Ancak kardiyak korumanın sağlanamadığı 20 dakikalık süre içerisinde kalıcı iskemik hasarlanma başlayabilmektedir[10,11]. Çalışmamızda da gruplar arası miyokardiyal korumada, 20 dakikadan daha uzun kardiyoplejisiz periyoda izin verilmedi.

Sadece retrograd kardiyopleji uygulaması ile, sağ atriyum ve ventriküldeki venovenöz şantlar ve thebesian kanallarının varlığı nedeniyle kardiyoplejinin miyokardiyal homojen dağılımı sağlanamayabilir. Bu durum da retrograd kullanımını kısıtlar[12,13]. Grup R'de de devamlı retrograd kan kardiyoplejisi kullanımı öncesi, tek doz antegrad kan kardiyoplejisi uygulandı.

Kardiyoplejinin sıcaklığı da bir başka tartışma konusudur. Literatürde, 29-32°C kardiyoplejinin, 37°C veya 15°C'ye göre daha iyi koruma sağladığını savunan kaynaklar bulunmaktadır [14,15]. Kan kardiyoplejisi kullanımının da özellikle komplike kalp cerrahisi olgularında, ameliyat mortalitesini düşürdüğü savunulmuştur[5,6]. Biz de çalışmamızda her iki grupta da 29-32°C'de kan kardiyoplejisi kullanıldığını tespit ettik.

Sonuç olarak, izole CABG operasyonlarında gerek aralıklı antegrad, gerekse tek doz antegrad sonrası devamlı retrograd kardiyopleji uygulamaları ile miyokardiyal koruma güvenle sağlanabilmektedir. Her iki grupta da erken dönem mortalite oranları düşük bulunmuştur. Ancak ejeksiyon fraksiyonu değerleri düşük olan fazla sayıda hasta grupları arasında, greft sayıları ve greftable damar durumlarını da içine alan, daha geniş kapsamlı bir çalışma önerilmektedir.

ÇIKAR ÇATIŞMASI

Yazarlar bu makale ile ilgili herhangi bir çıkar çatışması bildirmemişlerdir.

YAZAR KATKISI

Anafikir/Planlama: BÖ, MT
Analiz/Yorum: BÖ, MT
Veri sağlama: BÖ
Yazım: BÖ
Gözden Geçirme ve Düzeltme: MT
Onaylama: Tüm yazarlar

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Relation of Troponin I Levels with Postoperative Mortality and Morbidity Rates in Patients Followed in Intensive Care Unit After Congenital Cardiac Surgery Whose Ages Between 7 Days and 16 Years Old

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ABSTRACT

Introduction: Troponin I levels are the most important predictive marker of myocardial injury. Myocardial injury has been reported as the most significant cause of morbidity and mortality in pediatric cardiac surgery. In this study, we aimed to evaluate the effect of troponin I on postoperative mortality and morbidity in the child population.

Patients and Methods: Ninety-nine patients to whom congenital cardiac surgery were included in this study. Perioperative and postoperative troponin I values at 24th and 48th hours were recorded. Patients were divided into two groups according to troponin I values at 24th hour (lower and higher than 15 ng/mL, respectively). Aortic cross-clamp time, cardiopulmonary bypass (CPB) time, intubation time, and the duration of intensive care unit stay and medication of inotropic agents were recorded.

Results: Postoperative troponin I levels at 24th hour were higher than 15 ng/mL in patients who underwent congenital cardiac surgery and were related with significantly higher CPB, aortic cross-clamp, intubation time, and longer stay in intensive care unit.

Conclusion: Higher troponin I levels at 24th hour are associated with increased morbidity in patients who undergo congenital cardiac surgery.

Key Words: Congenital cardiac surgery; troponin I; mortality; morbidity

Konjenital Kardiyak Cerrahi Sonrası Yoğun Bakım Ünitesinde Takip Edilen 7 Gün ile 16 Yaş Aralığındaki Hastalarda Troponin I Seviyelerinin Postoperatif Mortalite ve Morbidite ile İlişkisi

ÖZET

Giriş: Troponin I miyokardiyal hasarın tahmininde önemli bir belirteçtir. Pediyatrik kardiyak cerrahide miyokardiyal hasarın en önemli mortalite ve morbidite nedeni olduğu anlaşılmıştır. Bu çalışma ile konjenital kalp ameliyatı olan çocuklarda troponin I değerlerinin postoperatif mortalite ve morbidite üzerine etkisini değerlendirmek amaçlanmıştır.

Hastalar ve Yöntem: Konjenital kardiyak cerrahi uygulanan 99 hastanın perioperatif, postoperatif 24. ve 48. saatteki troponin I değerleri kaydedildi. Hastalar hesaplanan cut off değerine göre 24. saat troponin I seviyelerine göre iki gruba ayrıldı (15 ng/mL'den yüksek olanlar ve olmayanlar). Hastaların aortik kros klemp süreleri, kardiyopulmoner baypas süresi, entübasyon süresi, yoğun bakımda kalış süresi ve inotropik ajan düzeyleri kaydedildi.

Bulgular: Konjenital kalp ameliyatı olan hastalarda postoperatif 24. saatte ölçülen troponin I seviyelerinin 15 ng/mL'nin üzerinde olmasının: kardiyopulmoner baypas süresi, aortik kross klamp süresi, entübasyon süresi ve yoğun bakım kalış süresini anlamlı olarak arttırdığı gösterildi.

Sonuç: Konjenital kalp ameliyatı olan hastalarda postoperatif 24. saat yüksek troponin I düzeyleri yüksek morbidite riski ile uyumludur.

Anahtar Kelimeler: Konjenital kalp ameliyatı; mortalite; morbidite; troponin I

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INTRODUCTION

With technological improvement in anesthesia of cardiac surgery, cardiopulmonary bypass (CPB), and continuation of extracorporeal circulation, there has been significant development in pediatric and adult cardiac surgery. It is well known that myocardial injury secondary to surgery or CPB affects cardiac functions, therefore increase morbidity and mortality[1].

Pediatric open heart surgery is a special operation that has different success rates depending on the quality of technique. Intraoperative myocardial tissue injury affects postoperative cardiac functions which is directly related with morbidity and mortality[2].

Cardiac troponins are sensitive and specific markers for myocardial injury. High specificity of troponin is derived from specific isoforms of cardiac troponin T and I. Therefore, creatine kinase (CK) and creatine kinase MB (CK-MB) associated with skeletal muscle but are not relevant with cardiac troponins[3,4]. Several studies have shown that cardiac troponin I levels are safe can be used as an indicator of myocardial damage both in pediatric and adult cardiac surgery. Increased troponin I levels have been associated with postoperative complications like delayed extubation time, necessity of higher inotropic support, and mortality[5-7].

In this study, we aimed to evaluate the effects of troponin I on postoperative mortality and morbidity in patients between 7 days and 16 years old who underwent congenital cardiac surgery.

PATIENTS and METHODS

This study has been approved by Institutional Review Board.

Study Subjects

Ninety-nine patients between 7 days and 16 years old, who were operated in Siyami Ersek Thoracic and Cardiovascular Surgery Center due to congenital cardiac disease, were included in this study. Patients who had liver and kidney failure were excluded. The indications for operation were as follows: transposition of the great arteries (TGA) (n= 14), atrioventricular canal defect (AVCD) (n= 6), Glenn shunt (n= 2), ventricular septal defect (n= 34), atrial septal defect (n= 7), tetralogy of Fallot (TOF) (n= 18), cor atrium (n= 1), anomalous origin of the left coronary artery from the pulmonary artery (ALCAPA) (n= 2), double outlet right ventricle (DORV) (n= 4), supravalvular aort stenosis (n= 2), truncus arteriosus (n= 1), total anomalous pulmonary venous connection (TAPVD) (n= 3), VSD and aortic coarctation (n= 1), AVCD and DORV (n= 1), VSD and ASD (n= 1), supraaortic ridge (n= 3).

All subjects gave their consent for inclusion in the study. The investigation conforms with the principles outlined in the Declaration of Helsinki. The study was approved by the local ethics committee.

Anesthesia and Surgical Protocol

All patients included in the study underwent the same anesthesia protocol. For sedation 3-5 mg/kg intramuscular (IM) ketamine was performed; afterward arterial line and venous angiocatheter was inserted. We administered 0.1 mg/kg intravenous (IV) midazolam, 5-10 μg/kg Fentanyl (IV), 0.1 μg/kg Vecuronium (IV) for induction of anesthesia. To maintain anesthesia during the operation, before and after CPB 0.1 mcg/kg/m Fentanyl and Sevoflurane, during CPB in every 30 minutes 0.5-1 mg Vecuronium, 5-10 μg/kg Fentanyl and 0.5-1 mg midazolam were performed.

Following sternotomy, standard aortic and bicaval cannulation was administered. Activated clotting time was held over 400 seconds by 300 U/kg heparin IV infusion. CPB membrane oxygenator (Minimax Plus, Medtronic Inc., Minneapolis, MN USA) and roller pump (Sarns Inc. USA) were used. Primary solution was prepared with lactate, whole blood (to hold hematocrit over 20%), albumin 20%, mannitol, and heparin. After cross-clamping aorta, to save myocardial tissue, blood cardioplegia at 4°C with an initial dose of 20 mL/kg and maintenance in every 20 minutes 10 mL/kg were performed. Ultrafiltration was applied starting from warming period of CPB.

Design of the Study

Blood samples for troponin I levels were taken from all patients on preoperative, postoperative 1st, 24th, and 48th hours. The following data below were recorded.

- Duration of aortic cross-clamp and operation time.
- Lactate levels of pre-operative, 1st, 24th, and 48th hours.
- Levels of inotropic agents performed after CPB was determined by Vasoactive-Inotropic Score.
- Inotropic score= [dopamine (μg/kg/min) + dobutamine (μg/kg/min) + adrenalin (μg/kg/min) x 100]
- Duration of mechanical ventilation and stay in intensive care unit.

Statistical Analysis

Number Cruncher Statistical System 2007 (NCSS), Power Analysis & Sample Size 2008 (PASS), Statistical Software 2008 (Utah, USA) programs were used in this study. Descriptive statistical methods (mean, standard deviation, median, frequency, ratio, minimum, and maximum) were used in statistical evaluation. Student's t-test was performed for comparison of normally distributed variables and Mann-Whitney U test was used for the parameters that were not normally distributed. The repeated Measures repeated measures analysis of variance (ANOVA) for normally distributed in-group comparison and corrected Bonferroni test for binary comparisons were used. Freidman test was used to compare groups that were not normally distributed, and Wilcoxon Signed Ranks were applied for binary comparisons. ROC analysis and diagnostic screening tests were used to detect cut-off points according to the presence of morbidity and/or mortality. Significance was assessed at $p< 0.01$ and $p< 0.05$.

RESULTS

The study was composed of 99 patients, and 49.5% (n= 49) of the participants were female. The median age of the patients was 38 ± 41.9 months (range; 26-192). The distributions of descriptive properties of the cases are shown in Table 1. Mortality was observed in 3% (n= 3) of the patients.

Preoperative and postoperative 1st, 24th, and 48th hours troponin I levels are demonstrated in Table 2 and Figure 1.

Table 1. Distribution of descriptive features

	Min-Max	Mean ± SD
Age (month)	0.26-192.0	38.07 ± 41.95
Cross time (minute)	16.0-223.0	74.89 ± 44.42
Bypass time (minute)	31.0-323.0	105.05 ± 58.62
Intubation time in ICU (hour)	2.0-504.0	48.13 ± 79.35
ICU stay (day)	1.0-31.0	4.68 ± 5.46
	n	**%**
Gender		
Female (1)	49	49
Male (2)	50	50
Mortality		
Survival	96	96
Exitus	3	3
Inotropic agents		
0	5	5.1
1	19	19.2
2	38	38.4
3	27	27.3
4	10	10.1

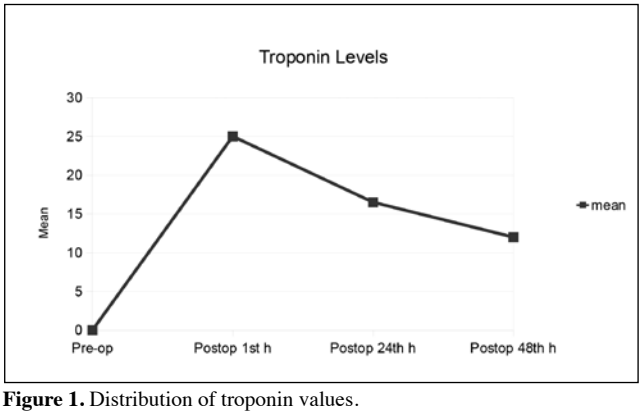

Figure 1. Distribution of troponin values.

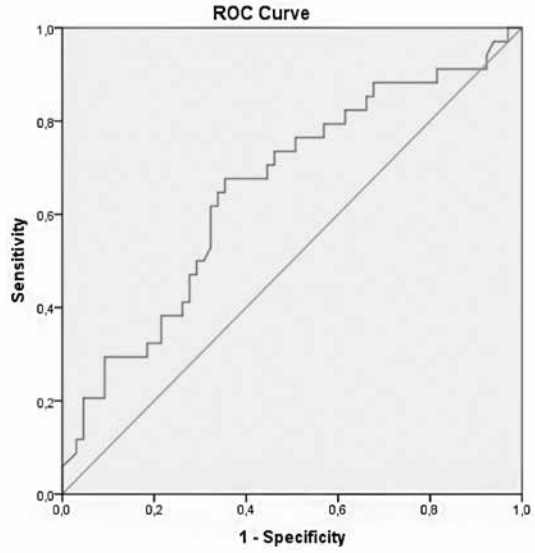

Figure 2. ROC curve of 24th hour troponin levels in morbidity and/or mortality.

The changes of preoperative, postoperative 1st, 24th, and 48th hours Troponin I levels were statistically significant (p= 0.001; p< 0.01). The increase in postoperative 1st, 24th, and 48th hours troponin levels were significantly higher than the preoperative levels (p= 0.001; p= 0.001; p= 0.001; p< 0.01, respectively). Postoperative 24th and 48th hours troponin I levels were in decreasing trend when compared to preoperative levels (p= 0.001; p= 0.001; p< 0.01, respectively). Postoperative 48th hour levels were siginificantly lower than 24th hour levels (p= 0.001; p< 0.01).

The 24th hour troponin levels were significantly different (p= 0.012; p< 0.05) and troponin levels in 24th hour were notably higher (Table 3). Based on this data, ROC analysis for 24th hour Troponin levels and cut-off values for diagnostic screening tests were calculated.

The cut-off point of 24th hour troponin level for prediction of morbidity and mortality was 15 with a sensitivity of 58.82%; specificity of 67.69%; positive predictive value of 48.78%; and negative predictive value of 75.86% (Table 3). Area under ROC curve was 65.5% with 5.9% standard deviation (Figure 2). Postoperative 24th hour troponin I levels are demonstrated in Table 4. The cross-clamping, bypass, intubation, and intensive care stay time were significantly shorter in the group with troponin levels < 15 in the postoperative 24th hour compared with those with troponin levels ≥ 15 (p< 0.05).

The patients who had intensive care unit staying time shorter than 5 days had significantly lower postoperative 24th hour troponin levels than those with longer stays (p= 0.029; p< 0.05) (Table 5).

Table 2. Troponin values

Troponin (ng/mL)	Min-Max	Mean ± SD (median)	[a]p	[b]Post-hoc
[1]Pre-op	0.00-50.00	0.91 ± 5.39 (0.02)	0.001**	1 < 4 < 3 < 2
[2]Post-op 1st hour	0.07-98.0	24.82 ± 23.30 (17.50)		
[3]Post-op 24th hours	0.99-84.51	16.55 ± 15.18 (12.21)		
[4]Post-op 48th hours	0.00-153.00	11.65 ± 19.57 (6.83)		

** p< 0.01
[a] Friedman test,
[b] Wilcoxon signed ranks test

Table 3. Diagnostic scanning features of 24th hour troponin levels and analysis of ROC curve

	Diagnostic Scan	ROC Curve	p					
	Cut off	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Area	95% Confidence Interval	
24th hours troponin levels	≥ 15	58.82	67.69	48.78	75.86	0.655	0.552-0.747	0.009*

* Mann-Whitney U test

Table 4. Evaluation of postoperative 24th hour troponin I levels

	Postop 24th hours Troponin < 15 ng/mL (n= 58)	Postop 24th hours Troponin ≥ 15 ng/mL (n= 41)	p
	Mean ± SD	Mean ± SD	
Cross time (min); (median)	64.51 ± 38.47 (52.50)	89.56 ± 48.46 (80.00)	[e]0.003**
Bypass time (min); (median)	90.46 ± 46.42 (75.50)	125.68 ± 67.86 (109.00)	[e]0.003**
Intubation time (hour); (median)	31.50 ± 42.82 (12.00)	72.86 ± 110.02 (24.00)	[e]0.022*
ICU staying time (day); (median)	3.53 ± 3.60 (2.15)	6.31 ± 7.06 (4.00)	[e]0.003**

* p< 0.05
** p< 0.01
[e] Mann-Whitney U test

Table 5. Relation between postoperative 24th hour troponin levels and morbidity

	Morbidity (-) (n= 66)	Morbidity (+) (n= 33)	p
	Mean ± SD (median)	Mean ± SD (median)	
Postop 24th hour troponin	14.22 ± 13.26 (10.35)	21.22 ± 17.74 (16.20)	0.029*

* p< 0.05
Mann-Whitney U test

Table 6. Relation between postoperative 24th hour troponin levels and morbidity and/or mortality

	Morbidity and/or mortality		p
	No (n= 65) Mean ± SD (median)	Yes (n= 34) Mean ± SD (median)	
Postoperative 24th hour troponin	13.48 ± 11.93 (10.24)	22.42 ± 18.82 (16.42)	0.012*

* p< 0.05
Mann-Whitney U test

Table 7. Troponin levels and mortality rates

Troponin	Mortality		p
	No (n= 65) Mean ± SD (median)	Yes (n= 34) Mean ± SD (median)	
Preop	0.94 ± 5.47 (0.02)	0.02±0.01 (0.02)	0.603
Postop 1st hour	24.12 ± 22.42 (16.97)	47.12 ± 44.23 (25.60)	0.198
Postop 24th hours	16.03 ± 14.67 (11.72)	33.31 ± 25.15 (22.80)	0.086
Postop 48th hours	10.50 ± 17.54 (6.59)	48.75 ± 44.91 (38.19)	0.023

* p< 0.05
Mann-Whitney U test

The cases without any morbidity and/or mortality had significantly lower 24th hour troponin levels than those who suffered morbidity and/or mortality (p= 0.012; p< 0.05) (Table 6).

Regarding the mortality rates, there was no statistically significant difference between preoperative, postoperative, 1st, and 24th hours troponin levels (p> 0.05). However, postoperative 48th hour Troponin levels were significantly higher in deceased patients than the survivors (p< 0.023; p< 0.05) (Table 7).

DISCUSSION

The heart, in pediatric population, faces more metabolic changes when exposed to ischemia, cardioplegic arrest, and reperfusion. Myocardial injury was demonstrated to be the most important reason of mortality and morbidity in pediatric cardiac surgery[5-8]. Therefore, operator should pay attention to protect myocardial tissue in congenital cardiac surgery. The presence of complex defects and intervention to more than one anomaly affect morbidity and mortality[9].

Troponin T and I have been found to be more specific in pediatric cardiac surgery rather than CK-MB and myoglobin in determining myocardial tissue injury[8,9].

Data regarding troponin T and I for diagnosis and follow up of infantile and pediatric population have recently been reported. Previous studies demonstrated the superiority of Troponin I to Troponin T in determining myocardial injury after surgery[10-12]. Therefore, we preferred troponin I in our study as it reflects injury better. According to troponin I cut-off values of 15 ng/mL at postoperative 24th hour, we classified patients into two groups. In our study, the highest troponin I levels were recorded in the postoperative 24th hour[13].

Immer et al. performed a study in 73 patients who underwent congenital cardiac surgery[14]. Patients were assigned in two groups according to postoperative 24th hour troponin I levels (higher or lower than 35 ng/mL). The group with higher troponin levels significantly had more liver and kidney dysfunction, necessity of vasoactive agents, and longer intubation times[14]. In our study, the patients with postoperative 24th hour troponin I levels higher than 15 ng/mL, had significantly longer intubation time. Contrary to findings reported by Immer et al.[14], there was no statistically significant difference relationship between troponin I levels and necessity of inotropic agents in our study.

Several studies demonstrated that troponin I level higher than 100 ng/mL was related with increased mortality in pediatric population[12,14,15]. However, recently studies pointed out that high troponin levels were not associated with high cardiovascular risk or mortality in infants who underwent congenital cardiac surgery[16,17].

In our study, troponin levels were found under 100 ng/mL in 2 of the 3 deceased patients. Troponin values of these patients in postoperative 48th hour were significantly higher compared with remaining living patients. Consequently, troponin levels continued to stay higher in patients who ended up with mortality.

Recent studies showed that variety of congenital cardiac disorders and surgery altered troponin levels[8,12,18]. Imura et al.

stated that troponin I levels, aortic cross-clamp and CPB time, and frequency of postoperative inotropic medication were significantly higher in complex TGA group than basic TGA in pediatric population[18]. This difference was related with myocardial injury due to incision. In our study, aortic cross-clamp time and duration of bypass were significantly longer in patients who had troponin I levels higher than 15 ng/mL in postoperative 24th hour.

Previous studies pointed out the relation of higher postoperative troponin I levels with major complications in adult cardiovascular surgery[1]. Following pediatric surgery, intubation and intensive care unit stay time which have effects on morbidity and mortality, were found significantly longer, as shown in our study[19]. Despite, high levels of troponin I in infant population; Bojan et al. declared the unnecessity of routine troponin I use in infants under 1 years old [12,13,20].

Consequently, the use of cardiac markers has been increasing during treatment of patients with congenital heart disease; however, there is no valid guideline regarding the routine use of these markers. Troponin I is one of the most significant markers establishing myocardial injury in congenital cardiac surgery. In our study, postoperative 24th hour Troponin I levels higher than 15 ng/mL were significantly related with longer CPB, aortic cross-clamp, intubation, and intensive care unit staying time in patients who underwent congenital cardiac surgery. Routine use of troponin I during follow up in congenital cardiovascular surgery may be useful in estimation of postoperative morbidity and mortality.

CONFLICT of INTEREST

The authors reported no conflict of interest related to this article

AUTHORSHIP CONTRIBUTIONS

Concept/Design: DO

Analysis/Interpretation: ŞDÖ, HYA

Data Acquisition: HYA

Writting: DÖ, HYA, MY

Critical Revision: HKC, ŞDÖ

Final Approval: All of authors

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Sağ Renal Arter Çıkış Seviyesinin Aortoiliyak Bifurkasyona Göre Kestirimi: Bilgisayarlı Tomografi Çalışması

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ÖZET

Giriş: Çeşitli anatomik işaret noktaları renal arter (RA) çıkış seviyesinin yaklaşık olarak belirlenmesinde kullanılmaktadır. Bu çalışmada aortoiliyak bifurkasyon (AİB) seviyesinin RA çıkış seviyesi ile ilişkisini araştırmayı amaçladık.

Hastalar ve Yöntem: Kontrastlı serviko-torako-abdominal bilgisayarlı tomografi (BT) çekimi yapılan ve vasküler hastalığı olmayan 113 hasta (71 erkek, ortalama yaş 42 ± 18 yıl) retrospektif olarak çalışmaya dahil edildi. BT ile vertebralar numaralandırıldı. Ardından AİB ve sağ RA çıkış seviyelerinin karşılık geldiği vertebralar 1'den 4'e kadar olacak şekilde proksimalden distale (AİB için sırasıyla L3, L3/4 arası, L4, L4'ün distali ve sağ RA için sırasıyla T12/L1 arası, L1, L1/2 arası, L2) seviyelendirildi. Bu seviyelerin ilişkisi, Spearman korelasyonu yöntemiyle analiz edildi. Aynı analiz, cinsiyet ve yaş alt-gruplarında da yapıldı. Yine AİB ve RA seviyelerinin çıkış seviyesi sıklıkları cinsiyet ve yaş alt grupları arasında karşılaştırıldı.

Bulgular: AİB en sık L4 (seviye 3), sağ RA ise L1 (seviye 2) vertebra hizasında saptanmıştır. Seviye 1'den 4'e görülme sıklıkları sağ RA için sırasıyla %10.6, %56.6, %17.7 ve %15, AİB için sırasıyla %6.2, %18.6, %47.8, %27.4 idi. AİB ile sağ RA seviyeleri arasında anlamlı düzeyde pozitif korelasyon saptandı [korelasyon katsayısı (KK): 0.7, p< 0.001]. Bu korelasyon kadınlarda bir miktar azalırken (KK: 0.59, p< 0.001), erkeklerde daha yüksek idi (KK: 0.74, p< 0.001). Hastalar yaşlarına göre genç ve yaşlı olacak şekilde iki gruba ayrıldı (< 60 ve ≥ 60 yaş). Korelasyon genç (KK: 0.71, p< 0.001) ve yaşlılarda (KK: 0.65, p< 0.001) yine pozitif ve anlamlı idi.

Sonuç: Sağ RA'nın abdominal aortadan çıktığı vertebra seviyesi, AİB vertebra seviyesi ile anlamlı ve pozitif koreledir. Sağ RA çıkış seviyesinin tahmin edilmesi gerektiği durumlarda, AİB seviyesi anatomik işaret noktası olarak kullanılabilir.

Anahtar Kelimeler: Sağ renal arter; aortoiliyak bifurkasyon; bilgisayarlı tomografi

Prediction of Right Renal Artery Take-off Level in Relation to Aortoiliac Bifurcation: A Computed Tomography Study

ABSTRACT

Introduction: Several anatomical landmarks are used to approximately assess the renal artery (RA) take-off level. We aimed to evaluate the relationship between aortoiliac bifurcation (AIB) and the RA take-off levels.

Patients and Methods: Overall, 113 patients (71 male; mean age, 42 ± 18 years) without a history of vascular disease and who had undergone cervico-thoraco-abdominal computed tomography (CT) scan were retrospectively studied. The corresponding spinal levels of AIB and the right RA take-off level were craniocaudally set at levels 1-4 (for AIB, L3, L3/4 intervertebral disc, L4, and distal to L4, respectively, and for right RA, T12/L1 intervertebral disc, L1, L1/2 intervertebral disc, and L2, respectively). The relationship between two levels was analyzed by correlation analysis.

Results: The most prevalent level for AIB was L4 (level 3) and for right RA was L1 (level 2). The prevalences of levels 1-4 for right RA were 10.6%, 56.6%, 17.7% and 15%, respectively, and those for AIB were 6.2%, 18.6%, 47.8%, and 27.4%, respectively. There was a positive significant correlation between the levels of AIB and right RA [correlation coefficient (CC), 0.7; p< 0.001]. This correlation was slightly less in women (CC, 0.59; p< 0.001) and more in men (CC, 0.74; p< 0.001). The patients were divided into the following two groups according to their ages: young (< 60 years) and old (≥ 60 years). There was a similar positive significant correlation between the age groups (CC, 0.71 and 0.65, respectively; p< 0.001).

Conclusion: The spinal level of right RA is positively and significantly correlated with the AIB level. Therefore, AIB can be used as a landmark for approximation of RA take-off level.

Key Words: Right renal artery; aortoiliac bifurcation; computed tomography

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GİRİŞ

Renal arterin (RA) selektif kanüle edilmesi, konvansiyonal renal anjiyografi ve perkütan renal girişimler için temel bir basamaktır[1]. Çoğu olguda, operatör floroskopi altında çeşitli anatomik işaret noktaları kullanarak RA'nın abdominal aortayı terkettiği seviyeyi tahmin etmeye çalışır. Çıkış seviyesi bilinmediğinde, RA ostiyumuna kateterle her zaman kolaylıkla angajman sağlanamayabilir. Bu durumda, aortaya rastegele olarak çeşitli seviyelerden kateter aracılı radyokontrast ajan enjeksiyonu yapılarak RA ostiyumu aranır. Bir renal arterin bulunması, diğerinin seviyesinin abdominal aortun kontralateralinde daha kolay bulunmasını sağlayabilir. RA çıkışının sıklıkla değişkenlik gösterebildiği kadaverik ve anjiyografik çalışma verilerinden anlaşılmaktadır[2-4]. Bu durum, renal arter anjiyografi veya girişimin süresini uzatarak, daha çok radyasyon ve radyokontrast ajan maruziyetine sebep olabilir.

Renal transplant hastalarında da doğru böbreğin seçiminde renal arter orijinlerinin doğru belirlenmesi laparoskopik teknik yönünden önem arz eder.

Genel olarak, sağ ve sol RA'nın L1-L2 intervertebral disk seviyesinden, superiyor mezenterik arterin hemen distalinden abdominal aortayı terkettiği bildirilmiştir[5]. Sol renal arterin sağa göre daha proksimalden çıktığı gözlenmiştir. Nadiren renal arter tek bir "ana renal arter" şeklinde çölyak akstan, mezenterik arterlerden, ana iliyak veya eksternal iliyak arterlerden kaynaklanabilir[6,7]. Renal arter çıkış seviyesi, hastanın ırksal ve habitüel özelliklerinden, yaşından ve cinsiyetinden etkilenebilir. Ancak RA çıkış seviyesi bir başka işaret noktası ile ilişkilendirilebilirse, hastadan hastaya farklılık gösterecek özellikler bakımından bir iç düzeltmeye gidilmiş olur. Bu çalışmada aortoiliyak bifurkasyonun (AİB) vertebra seviyesinin, sağ RA çıkış vertebra seviyesi ile ilişkisi BT görüntüleri üzerinden araştırılarak, cinsiyet ve yaşın buna etkileri incelendi.

HASTALAR ve YÖNTEM

İstanbul Medeniyet Üniversitesi Göztepe Eğitim ve Araştırma Hastanesi Klinik Araştırmalar Etik Kurulundan 2017/0123 Sayılı etik kurul onayı alınmıştır.

2014-2016 yılları arasında Göztepe Eğitim ve Araştırma Hastanesi acil servisine ciddi politravmaya neden olmamış düşme veya araç içi/dışı trafik kazası nedeniyle başvuran ve bilinen kardiyovasküler hastalığı olmayan ve kontrastlı servikotorakoabdominal bilgisayarlı tomografi (BT) çekilen 113 hasta araştırmaya dahil edilmiştir. Belirgin intervetebral disk dejenerasyonu, vertebral fraktür veya geçirilmiş vertebra cerrahisi, abdominal aorta veya iliyak arter yaralanması olanlar, AİB veya RA çıkış seviyesindeki verterbra numarasını etkileyebileceğinden çalışma dışı bırakılmıştır. Tüm hastaların yaş ve cinsiyeti kaydedilmiştir.

Çekimlerde servikal BT'nin şart koşulma nedeni, vertebra numaralandırmada anatomik varyasyonlara bağlı hata yapmamak için servikal 2. vertebradan başlayarak kraniyokaudal sayım yapılması ve kesin doğru numaralandırma yapılmasıdır. BT görüntülerinde, aksiyal kesitlerde sağ RA'nın aorttan çıktığı ve AİB'nin karşılık geldiği vertebralar işaretlenerek sagital kesitte kaçıncı vertebra oldukları belirlenmiştir. Sağ RA çıkış seviyesi proksimalden distale doğru 4 seviyeye ayrılmıştır;

Seviye 1: T12 ile L1 arasındaki intervertebral disk düzeyi

Seviye 2: L1 vertebra düzeyi

Seviye 3: L1 ile L2 arasındaki intervertebral disk düzeyi

Seviye 4: L2 vertebra düzeyi

Benzer şekilde AİB de proksimalden distale doğru 4 seviyeye ayrıldı;

Seviye 1: L3 vertebra düzeyi

Seviye 2: L3 ile L4 arası intervertebral disk düzeyi

Seviye 3: L4 vertebra düzeyi

Seviye 4: L4 vertebradan daha distal düzey

Sağ RA çıkış seviyesi ile AİB seviyesi sıklıkları karşılaştırılmıştır. AİB seviyesi ile sağ RA seviyesinin uyumu korelasyon analizi ile belirlenmiştir. Hastalar cinsiyet durumuna göre iki alt gruba ayrılarak, gruplar arası seviye karşılaştırılmıştır. Ayrıca grup içi korelasyon katsayıları kıyaslanmıştır. Benzer analizler, hastalar genç (< 60 yaş) ve yaşlı (≥ 60 yaş) altgruplarında da çalışılmıştır.

İstatistiksel Analiz

Kategorik değişkenler yüzde ile belirtilmiştir. Sürekli değişkenlerin dağılımı Shapiro-Wilk testi ile araştırılmıştır. Sürekli değişkenlerin normal dağılanları ortalama ± standart sapma ile normal dağılmayanları ortanca (alt üst sınır) ile belirtilmiştir. Gruplar arası karşılaştırma normal dağılmayan ortalamalar ve kategorik değişkenler için parametrik olmayan testlerle (Mann-Whitney U) kullanılmıştır. Korelasyon analizi için Spearman yöntemi kullanılarak korelasyon katsayısı elde edilmiştir. Tüm analizlerde iki yönlü $p< 0.05$ istatistiksel anlamlılık için eşik değer kabul edilmiştir.

BULGULAR

Toplam 113 hastanın ortalama yaşı 42 ± 18 idi. < 60 yaş hasta sayısı 91, ≥ 80 yaş hasta sayısı 22 idi. Hastaların 71 (%62.8)'i erkek, 42 (%37.2)'si kadındı. Tüm hastalar değerlendirildiğinde sağ RA çıkış düzeyleri ile AİB seviyeleri sıklıkları Tablo 1'deki gibidir. Buna göre sağ RA en sık seviye 2'den (L1 seviyesi) aortayı terk ederken (%56.6), AİB ise en sık seviye 3 (L4 seviyesi) düzeyindedir (%47.8). Hem sağ RA hem AİB, sadece 51 (%45.1) olguda eşlenik seviyelerdedir (seviye1-1, seviye 2-2, seviye 3-3, seviye 4-4 eşleşmeleri). Buna göre AİB L3 düzeyinde olanların tümünde sağ RA çıkışı T12-L1 arasındadır. AİB L3 ile L4 arasında olanlarda en sık

Tablo 1. Aortoiliyak bifurkasyon seviyelerine göre sağ renal arter çıkış seviyelerinin prevalansı

		Sağ Renal Arter çıkış seviyelerinin dağılımı				
Seviye 1 (T12-L1)		**Seviye 2 (L1)**	**Seviye 3 (L1-2)**	**Seviye 4 (L2)**	**Toplam**	
Aortoiliyak bifurkasyon seviyelerinin dağılımı	Seviye 1 (L3)	7 (%100)	0 (%0)	0 (%0)	0 (%0)	7
	Seviye 2 (L3-4)	2 (%9.5)	18 (%85.7)	1 (%4.8)	0 (%0)	21
	Seviye 3 (L4)	3 (%5.6)	40 (%74.1)	10 (%18.5)	1 (%1.9)	54
	Seviye 4 (L4 distali)	0 (%0)	6 (%19.4)	9 (%29)	16 (%51.6)	31
	Toplam	12	64	20	17	113

sağ RA çıkışı L1 düzeyindedir (%85). AİB L4 düzeyinde olanlarda en sık sağ RA çıkışı yine L1 düzeyindedir (%74.1). AİB L4'ten daha distalde olanlarda sağ RA çıkışı en sık L2 (%51.6) düzeyi ve L1-L2 arasındadır (%29). Sağ RA ile AİB seviyeleri anlamlı düzeyde ve pozitif yönde koreledir (Spearman Rho: 0.70, p< 0.001). Lineer regresyon analizinde AİB seviyesi, sağ RA seviyesinin bağımsız ve anlamlı bir prediktörüdür (R^2= 0.49, p< 0.001) ve sağ RA çıkışı ile AİB seviyeleri arasında şu doğrusal ilişki bulunmuştur. Bu denklemde sağ RA sağ renal arterin çıkış seviyesini, AİB ise aortoiliyak bifurkasyonun seviyesini göstermektedir.

Hastalar yaşa göre alt gruplara ayrıldığında gençler (< 60 yıl) ortalama 35 ± 12, yaşlılar (≥ 60 yıl) ortalama 67 ± 6 yaşındadır. Hem gençlerde (Spearman Rho: 0.71, p< 0.001) hem de yaşlılarda (Spearman Rho: 0.65, p< 0.001) sağ RA ile AİB seviyeleri yine anlamlı düzeyde ve pozitif yönde koreledir. Gençlerde ve yaşlılarda sağ RA çıkış seviyeleri sıklıkları arasında fark gözlenmemiştir (p= 0.66). Yine yaş alt grupları arasında AİB seviyeleri sıklıkları bakımından benzerdir (p= 0.1).

Kadınlarda sağ RA ile AİB seviyeleri arasında anlamlı pozitif korelasyon (Spearman Rho: 0.59, p< 0.001) olmakla birlikte korelasyon katsayısı erkeklerde belirgin daha yüksektir (Spearman Rho= 0.74, p< 0.001). Kadınlarda ve erkeklerde sağ RA çıkış seviyeleri sıklıkları arasında fark gözlenmemiştir (p= 0.46). Yine yaş alt grupları arasında AİB seviyeleri sıklıkları bakımından benzerdir (p= 0.29).

TARTIŞMA

Bu araştırmada, kontrastlı BT ile AİB ile sağ RA çıkışının verterbral düzeyleri arasında anlamlı ve pozitif yönde bir korelasyon olduğu, yaşlı veya gençlerde ilişkinin korunduğu, kadınlarda ise erkeklere göre daha zayıf ancak yine de anlamlı bir ilişki olduğu saptanmıştır. Çalışmamızda Sağ RA çıkışı daima T12-L3 arasında, AİB ise daima L3-L5 arasındadır. Bulgularımıza göre AİB en distal düzeyde (seviye 4) olan hiçbir hastada sağ RA en proksimal düzeyde (seviye 1) değildir. Yine AİB en proksimalde olan hiçbir hastada sağ RA çıkışı L1'den daha distalde gözlenmemiştir. Buna göre, AİB ne kadar proksimalde ise, sağ RA çıkışı da o oranda proksimaldedir. Nitekim lineer regresyon analizine göre AİB seviyesi biliniyorsa sağ RA seviyesi hesaplanabilir. Örneğin AİB seviye 3 iken, Sağ RA seviyesi formüle göre 0.24 + (3 x 0.72)= 2.4. Bu sonuca göre sağ RA çıkışı 2.4'üncü seviyeye yani seviye 2 ile 3 arasında bir noktaya tekabül eder. Bu nokta da L1 ile L1-2 intervertebral disk bölgesidir. Bu kestirim gücü sayesinde, floroskopik işlemler sırasında rastgele radyokontrast ajan enjeksiyonu yerine sağ RA çıkış seviyesi hesaplanarak sağ RA'nın daha hızlı bulunması ve daha az kontrast madde kullanımı avantajı getirebilir.

Alt grup analiz sonuçlarına göre yaş, AİB seviyesi ile sağ RA çıkış seviyesi arasındaki ilişkiyi etkilememektedir. Her ne kadar her iki cinsiyet için ilişki pozitif yönde korele ve anlamlı ise de ilişki gücünün erkeklerde kadınlara kıyasla yüksek olduğu saptanmıştır. Bu durum, erkek hastalar için AİB seviyesi kullanılarak sağ RA seviyesi kestirilirken daha doğru sonuçlar elde edilebileceği izlenimini vermektedir.

Çalışmamızda, literatürdeki kadavra ve görüntüleme çalışmalarına kıyasla bazı farklılıklar gözlenmiştir. AİB'nin birçok serideen sık bulunduğu vertebra düzeyi %64-%83 arasında L4 iken, bizim çalışmamızda bu oran daha az gözükmüştür (%47.8)[8-10]. Az hasta sayılı bir seride AİB seviyesi oldukça düşük oranda L4 (%38) seviyesinde bildirilmiştir[11]. Yine sağ RA'nın anjiyografik olarak %75 oranında L1-2 intervertebral disk düzeyinden çıktığı bildirilmişse de, başka araştırmalarda bunun çok altında (%23) prevalans elde edilmiştir[2,12]. Bizim çalışmamızda sağ RA en sık L1 vertebra seviyesinde abdominal aortu terkettiği görülmüştür (%56.6). Sağ RA çıkışının L1-L2 vertebra arasına denk gelişinin prevalansı bu çalışmada %17.7'dir. Sağ RA'nın L2 seviyesinden çıkması oldukça düşük oranda bildirilmiş olup bu bulgu bizim çalışmamızla uyumludur[13].

Çalışmamızın en önemli kısıtlılığı retrospektif dizaynıdır. Bu durum hasta seçiminde yanlılığa sebep olmuş olabilir. İkinci önemli kısıtlılık çalışmamızda aterosklerotik hastalığı bulunan bireylerin dahil edilmemesidir. Özellikle ateroskleroz nedeniyle aortta elongasyon, tortuozite varsa hem AİB hem de

sağ RA çıkışına denk gelen vertebra numarasını değiştirebilir[14]. Bu durumda verilerimiz deforme aortu olan hastalara uyarlanamayabilir.

SONUÇ

Sağ RA seviyesi, AİB seviyesiyle yakın ilişki göstemektedir. AİB ne kadar proksimaldeyse, sağ RA da o kadar proksimalden çıkar. Floroskopik işlemler esnasında AİB'in denk geldiği vertebral düzeye göre sağ RA ostiyumunun kestirilerek kateterle kanüle edilmesinin işlem süresi ve radyasyon ve kontrast madde maruziyeti üzerine etkisi prospektif araştırmalarla ortaya konmalıdır.

ÇIKAR ÇATIŞMASI

Yazarlar bu makale ile ilgili herhangi bir çıkar çatışması bildirmemişlerdir

YAZAR KATKISI

Anafikir/Planlama: NG, GD
Analiz/Yorum: NG, GD
Veri sağlama: NG, GD
Yazım: NG, GD
Gözden Geçirme ve Düzeltme: NG, GD
Onaylama: Tüm yazarlar

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Safety and Efficacy Outcomes of Bioresorbable Scaffolds in Long Segment Coronary Lesions

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ABSTRACT

Introduction: There is limited knowledge about the use of bioresorbable scaffolds (BRSs) in long segment coronary artery lesions. We aimed to evaluate the clinical outcomes of BRS-BRS and drug eluting stents (DESs)-BRS overlapping applications.

Patients and Methods: Cross-sectional, single-center study between 2013 and 2016 enrolled 97 patients and 100 lesions scheduled for BRS placement in long segment lesions (> 28 mm). BRS-BRS overlap was performed in 30 patients and 30 lesions, DES-BRS overlap was performed in 67 patients and 70 lesions. Acute procedural success and major adverse cardiac events (MACE) (death, stent thrombosis, and target lesion reintervention) were assessed.

Results: Acute procedural success was 97.1% in the overall group. MACE was observed in 6 patients (6.2%) in the entire group, 4 (5.9%) in the DES-BRS group, and 2 (6.6%) in the BRS-BRS group.

Conclusion: BRS use might be a safe and effective option for the treatment of long segment lesions. Both BRS-BRS overlap and BRS-DES overlap may be performed with short overlap segment.

Key Words: Bioresorbable scaffolds; overlapping; hybrid strategy

Uzun Segment Koroner Lezyonlarda Biyoeriyebilen Stentlerin Güvenlik ve Etkinlik Sonlanımları

ÖZET

Giriş: Uzun segment lezyonlarda biyoeriyebilen stentlerin (BRS) kullanımı ile ilgili sınırlı bilgimiz olduğundan hem BRS-BRS hem de İlaç salınımlı metal stent (DES)-BRS overlap uygulanan hastaların klinik sonuçlarını değerlendirmeyi planladık.

Hastalar ve Yöntem: Tek merkezli, kesitsel planlanan; Ocak 2013-Haziran 2016 tarihleri arasında uzun segment lezyonlara (> 28 mm) BRS yerleştirilmesi planlanan 97 hasta ve 100 lezyon çalışmaya alındı. Otuz hasta ve 30 lezyonda BRS-BRS overlap uygulanırken , 67 hasta 70 lezyona DES-BRS overlap uygulandı. Akut işlem başarısı ve MACE (ölüm, stent trombozu, hedef damara yeniden girişim) değerlendirildi.

Bulgular: Akut işlem başarısı %97.1 idi. Tüm hasta grubunda toplam MACE 6 (%6.2) hastada gelişirken, DES-BRS grubunda 4 (%5.9), BRS-BRS grubunda 2 (%6.6) hastada MACE gerçekleşti.

Sonuç: Uzun segment lezyonlarda BRS kullanımı seçenek olarak değerlendirilebilinir. BRS-BRS veya BRS-DES overlap yapacak şekilde yerleştiriken kısa segment overlap olacak şekilde gerçekleştirilmelidir.

Anahtar Kelimeler: Biyoeriyebilen stentler; overlap; hibrit tekniği

INTRODUCTION

Bioresorbable coronary stents have been developed to overcome biocompatibility problems associated with drug-eluting stents through the advantage of gradual degradation [1]. Capability of treating coronary lesions without permanent scaffolds and restoration of reactive vasomotion offer no constriction on any probable future surgical revascularization[2]. Despite initial high expectations for bioresorbable scaffolds (BRSs), reports have shown improved efficacy and safety outcomes limited to uncomplicated, short, and stable lesions[3].

In current daily interventional practice, a second stent is used in almost 10% of percutaneous coronary interventions (PCI) due to inadequate coverage of lesion or edge dissections[4]. Studies related with drug-eluting stents (DESs) demonstrated that increased amount of drug released

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at the site of overlap versus segments without overlapping sites and strut thickness stimulated increased neutrophil and eosinophil release and fibrin deposition, resulting in enhanced inflammation, impaired healing, increased late lumen loss, and stent restenosis rates when compared with single stent use [4,5]. Nevertheless, studies with second-generation DESs showed that overlapping technique can safely be used in contrast with the results of first-generation DESs[6].

Clinical studies using ABSORB, the first commercially available BRS, excluded lesions requiring overlapping; however, the UNDERDOGS trial demonstrated that overlapping of BRSs is as safe as second-generation DESs[7,8].

Here we aimed to evaluate clinical outcomes of hybrid heterogeneous DES-BRS and BRS-BRS overlapping applications in long segment coronary lesions.

PATIENTS and METHODS

An approval of the İstanbul Medipol University Ethics Committee was obtained as ID 10840098-604.01.01.E.3982.

Study Population

In this single center study with cross-sectional design, we enrolled 100 lesions in 97 patients who underwent PCI for long-segment lesions (> 28 mm) that could not be covered with single BRS and therefore overlapping with BRS-BRS or BRS-DES was performed in our clinic between 2013 and 2016. Patients were treated with everolimus-eluting BRS device (Absorb BVS; Abbott Vascular, SantaClara, CA, USA) or novolimus-eluting BRS device (DESolve, Elixir Medical Corporation) and everolimus-eluting DES (XIENCE PRO, Abbott Vascular, Santa Clara, CA, USA). Baseline clinical characteristics, angiographic variables, and procedural characteristics were defined. Informed consent was obtained from all patients before the procedures.

Both patients with stable coronary artery disease and acute coronary syndrome were recruited. Native coronary artery lesions with stenosis > 50% and length > 28 mm and reference vessel diameter (RVD) ≥ 2.5 mm were included. Major exclusion criteria were left ventricular ejection fraction less than 35%, lesions located in the left main coronary artery, arterial or saphenous vein graft lesions, acute ST-elevation myocardial infarction, and lesions extending to coronary ostium.

After the index procedure, the follow-up data were obtained from outpatient clinic visits or emergency department admissions and monitoring of patients was also done by regular telephone calls. When patients decided to undergo coronary angiography or PCI during follow-up visit or emergency department admission, details about control angiography and PCI were recorded.

Procedures and Medications

Procedures were performed in accordance with current PCI standards. All patients received upstream 300 mg acetylsalicylic acid (ASA) plus a loading dose of 300 to 600 mg clopidogrel or 180 mg ticagrelor or 60 mg prasugrel during the procedure. Unfractionated heparin (100 U/kg) was used for anticoagulation in all patients during interventions; additional bolus might be required to achieve an active clotting time of 250 s. None of the patients received glycoprotein IIb/IIIa inhibitors.

Predilation was performed before all interventions, scaffold implantation was achieved by gradually increased (1 atm increase per 5 s) pressure, which did not exceed the rated burst pressure. In the first place, BRS was implanted at the distal site followed with overlapping proximal BRS or DES in all patients. Stent overlap was defined as angiographically 1 mm overlapping of 2 stents (Figure 1)[4]. Postdilation that would not exceed the BRS diameter of 0.5 mm was performed in all patients to stent overlapping region.

Angiographic Parameters and Quantitative Coronary Angiographic Analysis

Bending more than 45 degrees proximal to the lesion was defined as tortuosity. Single bend between 45 and 90 degrees proximal to the lesion was defined as mild tortuosity, while 3 or more bends between 45 and 90 degrees or one or more bends over 90 degrees were defined as severe tortuosity. Bendings out of these criterias (mild and severe tortuosity) were defined as moderate tortuosity[8].

Calcification was defined as overt radiopacity of the vessel wall across the lesion site. It was classified as moderate (radiopacity noted only during the cardiac cycle before contrast injection) and severe (radiopacity noted across both sides of the vessel wall before contrast injection and independently from cardiac motion)[9].

Quantitative coronary angiography (QCA) was evaluated at 1 angiographic core laboratory with use of CAAS 5.9 (Pie Medical Imaging) in the hospital's angiographic analysis center. Baseline and postprocedural minimal lumen diameter (MLD), mean lumen diameter (MnLD), RVD, residual diameter stenosis (%DS), lesion length and acute gain were measured. Angiographic measurements were made by contrast-filled standard calibration. These images were analyzed from same angiographic projection to minimize foreshortening.

Study Endpoints and Definitions

Acute procedural success was defined as final angiographic residual stenosis of < 30% with thrombolysis in myocardial infarction flow grade 3. categorization of complications was made. Instent restenosis was defined as reduction in the percent DS > 50% within the stented segment.

Primary endpoints of this study were major adverse cardiac events (MACE) including cardiac death, myocardial infarction (MI), target vessel revascularization (TVR), target lesion revascularization (TLR), and stent thrombosis.

MLD was defined as the minimum lumen diameter of lesion area, and MnLD was defined as the mean lumen diameter

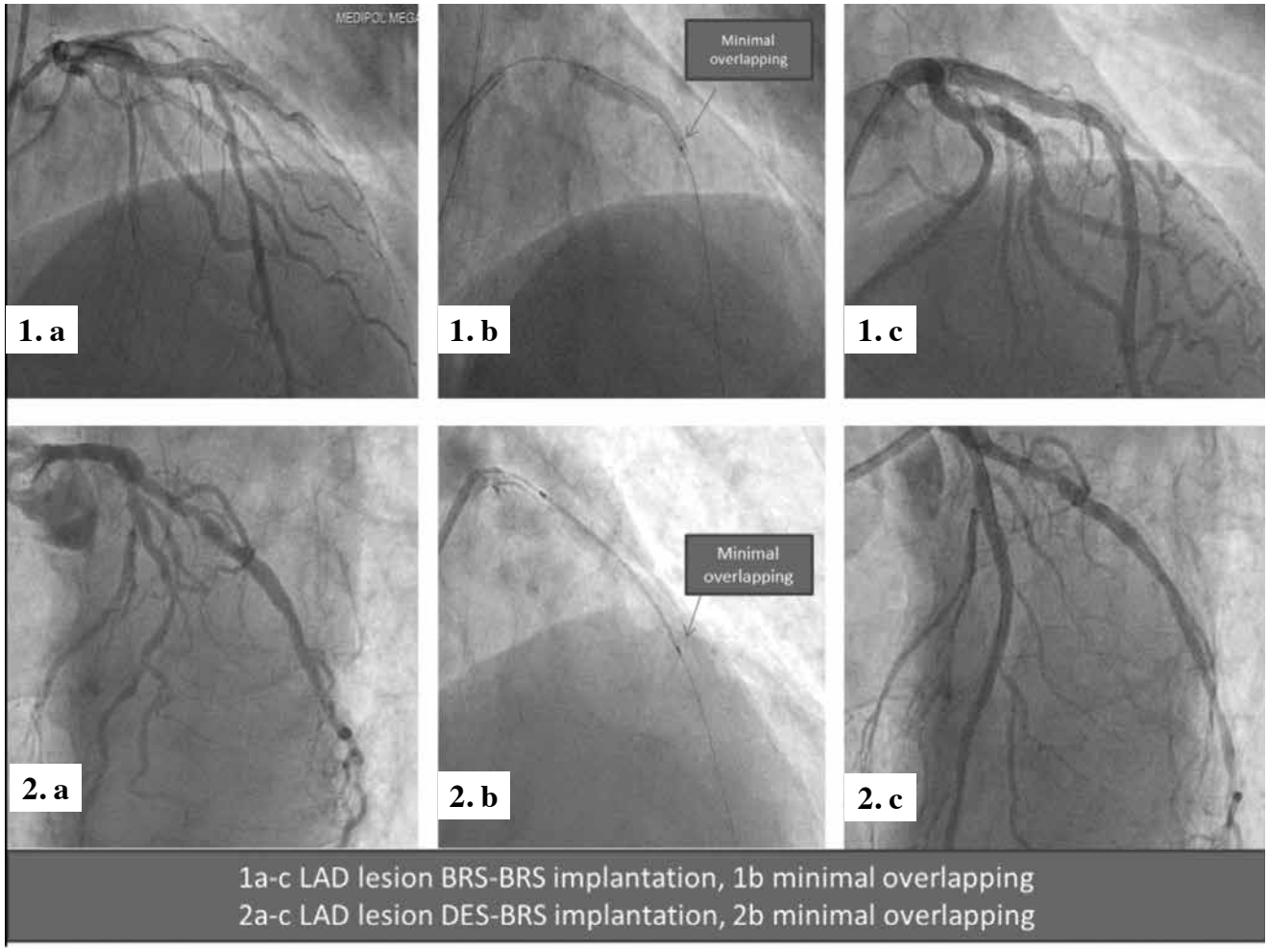

Figure 1. Angiographic images.

of lesion area. TLR was defined as repeat PCI or surgical revascularization within the index procedure stent or 5 mm edge, meanwhile TVR was defined as any revascularization procedure occurring within the treated vessel outside the margins of the stent or 5 mm.

MI was defined as elevation of cardiac troponin values (> 5 x 99th percentile) with symptoms of ischemia or new ECG changes in the periprocedural period or elevation > 99th percentile in the postprocedural period or new echocardiographic changes suggestive of ischemia.

Minimum follow-up duration was 6 months, although patients with 2-year follow-up were also present. Last follow-up visit was performed in January 2017.

Statistical Analysis

SPSS 23.0 statistical software (SPSS Inc., Chicago, IL, USA) was used for performing statistical analysis. Continuous variables were expressed as mean ± standard deviation or median and interquartile range as appropriate. Categorical variables were expressed as percentages. The Kolmogorov-Smirnov test was used to test normality of distribution of continuous variables. Group means for continuous variables were compared with Student t-test, the Mann-Whitney U test, ANOVA, or Kruskal-Wallis test, as appropriate. Categorical variables were compared with the use of chi-square test. Descriptive statistics for MACE was presented as percentage and minimum, maximum, and median follow-up time of patients. Kaplan-Meier curves were generated to analyze the impact of BRS-BRS versus DES-BRS overlapping on the endpoint of TLR during the follow-up. The results were expressed as Log rank and p values and demonstrated with a graphic. A p value of ≤ 0.05 was considered statistically significant.

RESULTS

In the first place, 100 patients with a total of 103 lesions to be treated with overlapping were planned for enrollment; however, 3 patients and 3 lesions could not be recruited due to lack of acute procedural success (97.1%); thus, 97 patients with 100

lesions were enrolled (Figure 2). Inability to advance BRSs to the lesion area due to severe calcification and tortuosity was the common characteristic in 3 patients with acute procedural failure; the scaffold stripped off during advancement in one of them, stent could not be crossed to the lesion area in another, whereas residual stenosis > 30% was present despite advancement to the lesion area in the last patient. Mean age of the patients were 57.8 ± 10.4 years, and 82 of them (84.5%) were men. When risk factors of the patients were evaluated, 59 (60.8%) had hypertension, 39 (40.2%) had diabetes mellitus, 56 (57.7%) were active smokers, and 76 (78.4%) had dyslipidemia. Sixteen (16.5%) patients underwent PCI for unstable angina pectoris, while mean left ventricular ejection fraction (LVEF) and glomerular filtration rate (GFR) of the patients were 54.5 ± 9.3 ml/min and 96.9 ± 27.5 ml/min, respectively (Table 1).

There were no significant differences in demographic characteristics between patients in the DES-BRS Hybrid overlapping group and BRS-BRS overlapping group (Table 2). Femoral access was used in 81 (83.5%) patients, and new P2Y12 inhibitors were preferred in combination with ASA for dual antiplatelet therapy in 45 (46.4%) patients. Thirty (44.8%) patients in the DES-BRS group and 15 (50%) patients in the BRS-BRS group received new P2Y12 inhibitors (p= 0.398). Of the scaffolds, DESolve BRS was preferred in 36 (51.4%) and ABSORB-BRS was preferred in 34 (48.6%) DES-BRS group lesions, whereas DESolve BRS and ABSORB BRS were the preferred scaffolds in 32 (53.3%) and 28 (46.7%) lesions in the BRS-BRS group, respectively.

Baseline angiographic characteristics such as lesion type, severe calcification, severe tortuosity, treated vessel, and lesion length were similar between the two groups; however, implanted

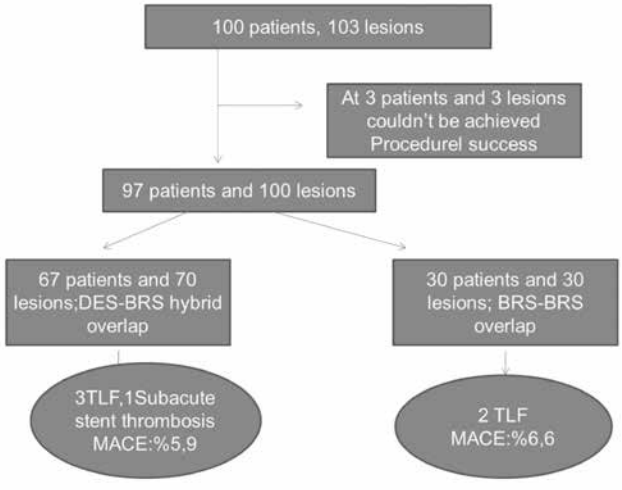

Figure 2. Summary of study population and major cardiac events.

Table 1. Baseline clinical characteristics of the patients

Age, years	57.8 ± 10.4
Male gender, n (%)	82 (84.5)
Hypertension, n (%)	59 (60.8)
Diabetes mellitus, n (%)	39 (40.2)
Current smoker, n (%)	56 (57.7)
Dyslipidemia, n (%)	76 (78.4)
Family history, n (%)	47 (48.5)
Previous MI, n (%)	16 (16.5)
Stable angina, n (%)	81 (83.5)
Unstable angina, n (%)	16 (16.5)
Heart failure, n (%)	15 (15.5)
LVEF (%)	54.5 ± 9.3
Hemoglobin (g/dL)	13.5 ± 1.6
GFR (mL/min/1.73 m^2)	96.9 ± 27.5
Platelet	251.1 ± 98.3

LVEF: Left ventricular ejection fraction, GFR: Glomerular filtration rate.
MI: Mycardial infarction.

stent length was significantly different between the DES-BRS group (45 mm ± 9 mm) and the BRS-BRS group (53 mm ± 5 mm) (p< 0.0001) (Table 3). BRS was implanted distally in both groups and the length of BRS was not different between the DES-BRS (27 mm ± 3 mm) and BRS-BRS (27 mm ± 2 mm) groups (p= 0.141). Furthermore, diameters of distal BRSs were not different between the DES-BRS (3 ± 0.4) and BRS-BRS (2.9 ± 0.4) groups (p= 0.440).

Predilation and postdilation were applied in all patients and the two groups were similar in terms of PTCA balloon size (Table 4). As shown in Table 4, parameters measured by QCA method were not different between the two groups. When stents used for proximal overlapping, BRS or DES, were compared, diameters were not different (DES: 3 ± 0.4; BRS: 2.9 ± 0.5; p= 0.268), whereas BRSs were longer than DESs (BRS: 25.8 ± 41 mm; DES: 18.9 ± 7.8 mm; p< 0.0001) (Table 4).

Procedural complications occurred in 2 (2.1%) patients. Coronary rupture after postdilation at high pressure due to inadequate expansion of the calcified site of overlap developed in one patient that was controlled with extended balloon inflation, whereas other patient experienced a cerebrovascular event during postprocedural follow-up period in hospital which recovered without any sequela.

During the in-hospital stay period, none of the patients had death, reintervention, or adverse cardiac events. The mean duration of follow-up of the patients was 492 days

Table 2. Clinical differences between BRS-BRS and DES-BRS hybrid groups

Variables	DES-BRS n= 67	BRS-BRS n= 30	p
Age	57.7 ± 10.7	58 ± 9.8	0.870
Male gender, n (%)	56 (83.6%)	26 (86.7%)	0.772
Hypertension, n (%)	39 (58.2%)	20 (66.7%)	0.503
Diabetes mellitus, n (%)	25 (37.3%)	14 (46.7%)	0.502
Dyslipidemia, n (%)	49 (73.1%)	27 (90%)	0.069
Current smoker, n (%)	38 (56.7%)	18 (60%)	0.826
Family history, n (%)	33 (49.3%)	14 (46.7%)	0.830
Previous MI, n (%)	10 (14.9%)	6 (20%)	0.562
Unstable angina, n (%)	11 (16.64%)	5 (16.7%)	0.999
Heart failure, n (%)	7 (10.4%)	8 (26.7%)	0.066
LVEF	55.7 (47.6-59.3)	54.9 (47.9-58.12)	0.828
Hemoglobin	12.8 (12.1-13.4)	12.9 (12.1-13.7)	0.744
Platelet	244 (175-299)	255 (166-291)	0.382
GFR	95.2 (77.4-112.8)	93.8 (75.3-122.1)	0.644

BRS: Bioresorbable scaffold, DES: Drug eluting stent, LVEF: Left ventricular ejection fraction, GFR: Glomerular filtration rate.

Table 3. Angiographic characteristics of BRS-BRS and DES-BRS lesions

Variables	DES-BRS n= 70	BRS-BRS n= 30	p
Type C lesion, n (%)	18 (25.7%)	5 (16.7%)	0.251
Severe tortuosity, n (%)	11 (15.7%)	6 (20%)	0.576
Severe calcification, n (%)	40 (57.1%)	15 (50%)	0.520
Percentage stenosis %	85 ± 9.4	83 ± 8.4	0.369
Lesion length, mm	44.4 ± 8.7	45.4 ± 5.9	0.568
Total stent length, mm	45.4 ± 8.8	53 ± 5.4	< 0.0001
Treated vessel, n (%)			
LAD	44 (62.9%)	19 (63.3%)	0.860
CX	14 (20%)	7 (23.3%)	
RCA	12 (17.1%)	4 (13.3%)	

BRS: Bioresorbable scaffold; DES: Drug eluting stent.

(minimum, 212 days; maximum, 755 days). One patient in the DES-BRS group experienced subacute stent thrombosis 15 days after implantation that ended-up with failed attempt for revascularization and the patient was discharged with medical therapy. Three patients in the DES-BRS group and 2 in the BRS-BRS group were revascularized for TLR. As shown with the Kaplan-Meier curves in Figure 3, no statistical significance was observed between two groups in terms of TLR during the follow-up. In the whole study population, MACE were reported in 6 (6.2%) patients, of whom 4 (5.9%) were in the DES-BRS group and 2 (6.6%) were in the BRS-BRS group (Figure 2).

DISCUSSION

We report procedural success and clinical outcomes in patients with long segment coronary lesions that required more than one stent and treated with distal BRS (everolimus-eluting ABSORB or novolimus-eluting DESOLVE scaffolds) and proximal BRS or DES (everolimus-eluting XIENCE) for overlapping. Our findings can be shortly described as follows:

1. When procedural success and clinical outcomes are considered, BRS-BRS or DES-BRS hybrid overlapping technique is effective and safe.

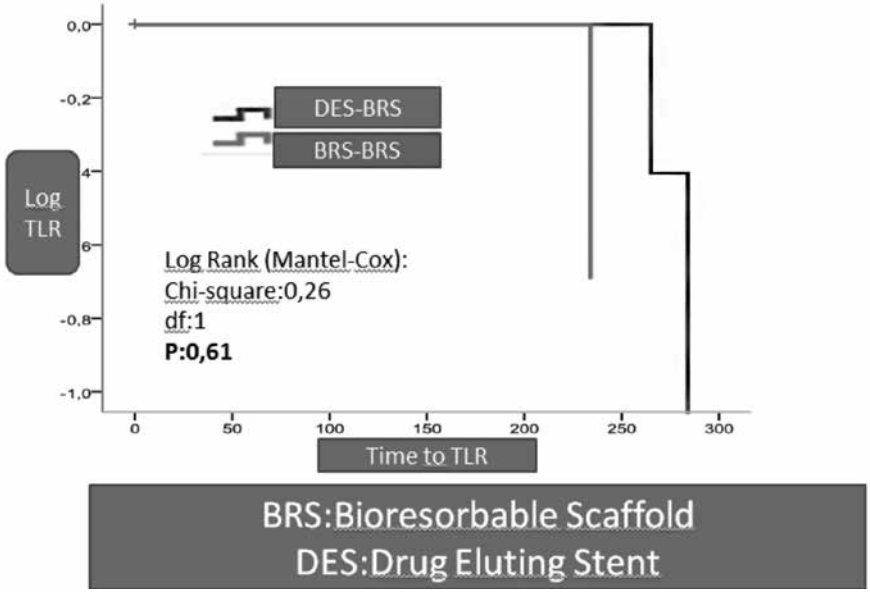

Figure 3. Kaplan-Meier curve to determine TLR between the BRS-BRS and the DES-BRS overlapping groups.

Table 4. Procedural and QCA related features in DES-BRS and BRS-BRS groups and differences between proximal DES and BRS characteristics

Variables	DES-BRS n= 70	BRS-BRS n= 30	p
Predilatation, PTCA, mm	2.80 ± 0.3	2.78 ± 0.3	0.787
Postdilatation, PTCA, mm	3.13 ± 0.5	3.15 ± 0.4	0.851
Pre min diameter, mm	0.91 ± 0.5	0.88 ± 0.4	0.745
Pre mean diameter, mm	1.76 ± 0.6	1.73 ± 0.6	0.858
Final min diameter, mm	2.56 ± 0.4	2.53 ± 0.4	0.712
Final mean diameter, mm	2.84 ± 0.4	2.83 ± 0.4	0.904
Reference diameter, mm	3.07 ± 0.4	3.11 ± 0.4	0.647
%DS	17.8 (12.3-24.1)	18.0 (12.5-23.8)	0.195
	Proximal DES n= 70	Proximal BRS n= 30	
Stent diameter, mm	3 ± 0.4	2.9 ± 0.5	0.268
Stent length, mm	18.9 ± 7.8	25.8 ± 4.1	< 0.0001

QCA: Quantitative calculation angiography, BRS: Bioresorbable scaffold, DES: Drug eluting stent, PTCA: Percutaneous transluminal coronary angioplasty, DS: Diameter stenosis (residual stenosis), Pre min: Minimum basal diameter of native vessel at lesion point.

2. Some of the BRSs used for overlapping were DESolve; hence, the efficacy and safety of DESolve in this lesion group have been evaluated for the first time.
3. Although clinical outcomes for DES-BRS and BRS-BRS were similar, shorter total stent length, lower total strut thickness at the site of overlapping, and easier reimbursement by insurance companies in the DES-BRS group make hybrid technique a more favorable option for long lesions when BRSs are preferred.

Advantages associated with BRS including late lumen enlargement, freedom from permanent cage, cyclical strain, restoration of vasomotion and thus having no restriction on any future percutaneous or surgical revascularization has made BRS an attractive option in recent years[2]. Previous reports largely suggested BRS use in simple lesions; however, recent studies have confirmed the safety and efficacy of BRS in chronic total occlusions, bifurcation lesions, and acute coronary syndromes[3,10-12].

Approximately 10% of PCIs (in particular, complex lesions) may require overlapping technique due to lesion length or edge dissections[4]. Edge-to-edge implantation of 2 stents without an overlapping technique is associated with an increased risk of stent thrombosis and restenosis due to gap possibility; nevertheless, increased thrombogenicity and thrombus formation, as well as delayed reendothelialization, were associated with overlapping as well[13,14]. Rikthegar et al. assessed hemodynamics of coronary arteries with stent overlap and demonstrated that overlap geometry could lead to adverse clinical outcomes through unfavorable flow condition[15].

In their study about overlapping everolimus-eluting BRS in a porcine coronary artery model, Farooq et al. demonstrated increased neointimal hyperplasia and delayed stent coverage because of thicker strut configuration, which might serve a key role for scaffold restenosis and thrombosis[16]. In addition, with the hypothesis that minimalization of overlap area could reduce the risk of adverse clinical outcomes, Farooq et al. reported increased risk of geographical miss due to both poor visibility of scaffold edge markers and difficulty of positioning scaffold edges in the same plane in their in-vitro phantom study[17]. In our study, use of minimal overlapping technique might have limited disadvantages associated with BRS use such as thicker struts by avoiding both long overlapping segment and gap formation (Figure 1).

In the first study comparing BRS-BRS overlapping and DES-DES overlapping in long-segment lesions, Bigaclia et al. detected lower rates of acute/subacute stent thrombosis and increased periprocedural myocardial injury in the BRS group and similar 1-year device-oriented endpoint in the DES group [7]. Besides, Robert et al. demonstrated that DES-ABSORB BRS hybrid overlapping can be safely used in patients with long segment lesions with high procedural success and low MACE and complication rates[18]. We investigated BRS-BRS and DES-BRS hybrid overlapping together in this study, which provided similar results with previous studies, thus suggesting that both techniques can safely be used for overlapping.

One of the reasons underlying our preference for DES-BRS overlapping was unavailability of BRS size longer than 28 mm. Implantation of BRS at the distal site allows proximal implantation of DESs, which have longer size options (38 mm, 48 mm) in diffuse long coronary lesions (> 55 mm), which saves the patient from more BRS use and overlapping segments. Kuan Leong Yew suggested implantation of DES at the first place and advancement of BVS through DES and keeping BVS over the overlap site; otherwise, when BRS is implanted at the under site of overlapping, degradation of scaffold could cause disruption and malapposition of DES struts[19]. When eventual degradation of scaffolds is taken into account, it might seem reasonable to place DES under the overlap site; however, both bulky, thick structure and low delivery profile of BRS may reduce procedural success rate. Moreover, we detected high procedural success and acceptable adverse clinical event rates when we placed distal BRS first and second BRS for overlapping.

In a recent study, Serruys et al. demonstrated that ABSORB BRS did not show superior vasomotor reactivity or non-inferior late luminal loss and detected greater MACE rates in the ABSORB group[20]. This condition indicates the need for development of new-generation resorbable scaffolds. Ideal BRS should have thinner struts, adequate radial force, and capability of degradation in short period. Similarly, Kitabata et al. reported significantly improved outcomes of stent overlap with second-generation DESs (everolimus-eluting stent) that have thinner struts in comparison with first-generation stents and suggested that the use of DES is effective and safe for overlapping stents[6]. Performance of BRS implantation procedures by a single, senior operator with extensive experience with BRS may have been associated with improved outcomes in our study. Appropriate predilation and postdilation in all patients may be another factor that contributed to procedural success.

A meta-analysis by Polimeni et al. detected increased stent thrombosis associated with BRS in the first 30 days and 2-year outcomes (very late stent thrombosis) and concluded that follow-up duration longer than 2 years would provide more accurate information about the safety of BRS[21]. Taking this recommendation into account, limitation of our follow-up at 2 years (despite favorable outcomes) shows that further studies with larger sample size and longer follow-up periods are required for guidance of BRS overlapping in daily clinical practice.

The incidence of MACE in our study was comparatively low and stent thrombosis was not observed. This instance was explained by utilization of novel potent P2Y12 inhibitors in the majority of the patients and complying strictly with BRS deployment during the procedures, which were performed by the same experienced operator.

CONCLUSION

Patients with long segment coronary lesions might be treated with ABSORB or DESolve scaffolds and DESs by performing BRS-BRS or DES-BRS hybrid overlap with good safety and efficacy in short/mid-term outcomes. Development of new BRSs with characteristics including thinner struts, adequate radial force, faster degradation, improved delivery profile, and more visible edges under fluoroscopy should help better clinical outcomes in long segment lesions.

Study Limitations

Our study had a cross-sectional design. Angiographic procedural success was assessed by QCA, which is a practical method providing substantial information about lesion characteristics; however, use of techniques such as IVUS or OCT

might have provided more accurate data. Similarly, assessment of overlapping site by means of OCT or IVUS could have better elucidated the presence of non-endothelialized areas under DES after degradation of BRS. Another limitation of our study was lack of routine control angiography. We could therefore have missed non-clinical scaffold restenosis because we only evaluated clinical outcomes in short/mid-term follow-up. Small sample size and lack of follow-up for longer periods are other limitations of the present study.

CONFLICT of INTEREST

The authors reported no conflict of interest related to this article.

AUTHORSHIP CONTRIBUTIONS

Concept/Design: HG

Analysis/Interpretation: GG

Data Acquisition: HG, Eİ

Writting: HG, TG

Critical Revision: TG, BB

Final Approval: All of authors

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How to Change Ceruloplasmin Levels in Heart Disease?

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ABSTRACT

Ceruloplasmin (CP) is a blue serum protein found in human serum; it carries approximately 95% of the total circulating copper (Cu) in healthy individuals. The relationship of CP with OS, inflammation, and DNA damage is known. Oxidative stress (OS), inflammation, and DNA damage are the main causes underlying atherosclerotic heart disease. Several studies have indicated a close association between high serum CP and several types of heart disease. However, the CP levels are still unknown in many heart diseases. To gather the studies of CP in heart disease and to prepare the ground for new studies for researchers, we designed this review.

Key Words: Ceruloplasmin; oxidative stress; heart disease

Kalp Hastalıklarında Seruloplazmin Değerleri Nasıl Değişir?

ÖZET

Kanda yaygın olarak bulunan ve mavi protein olarak adlandırılan seruloplazmin (CP) sağlıklı kişilerde kanda bakırın %95'ini taşır. Oksidatif stres, inflamasyon ve DNA hasarı ile ilişkisinin varlığı bilinmektedir. Oksidatif stres, inflamasyon ve DNA hasarı, başta koroner arter hastalığı olmak üzere pek çok kalp hastalığı etyolojisinde de suçlanmaktadır. Çok sayıda çalışma kalp hastalıklarında CP'nin yerini ortaya koymuştur. Ancak çoğu kalp hastalığında halen CP seviyelerinin nasıl değiştiği bilinmemektedir. Literatürdeki CP ile yapılmış kalp hastalıklarındaki çalışmaları bir araya getirmek ve yapılacak yeni çalışmalara zemin hazırlamak için bu derlemeyi yaptık.

Anahtar Kelimeler: Seruloplazmin; oksidatif stres; kalp hastalıkları

INTRODUCTION

Ceruloplasmin (CP) is a blue serum protein found in humans; it carries approximately 95% of the total circulating copper (Cu) in healthy individuals[1,2]. CP has been known for a long time and was first purified from the α-2-globulin fraction of human serum by Holmberg and Laurell[3,4]. CP is mainly synthesized in the hepatocyte (95%) but is also produced by other cell types, such as monocytes, astrocytes, and Sertoli cells[5]. Currently, heart disease is the leading cause of death in the world[6]. Oxidative stress (OS), inflammation, and DNA damage are the main causes underlying atherosclerotic heart disease (AHD)[7-9]. The relationship of CP with OS, inflammation, and DNA damage has been demonstrated in previous studies[10-12]. Several studies have also indicated a close association between high serum CP and several types of heart disease[13-16]. However, the status of CP is still unknown in many heart diseases. This review aims to gather studies regarding CP in heart disease and also to prepare the ground for new studies for researchers.

Structure and Functions of Human Ceruloplasmin

CP contains seven Cu atoms per molecule, and its average concentration is approximately 300 μg/ml in plasma[1,2]. Its best-known function is Cu transport. In addition, CP plays a role in coagulation, angiogenesis, iron (Fe) homeostasis, defense against oxidant stress, and inactivation of biogenic amines[1-4,17-21]. CP is a member of the inflammation-sensitive plasma protein family that includes fibrinogen, haptoglobin, αl-antitrypsin, and

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orosomucoid[15,16,21-26]. It facilitates Fe transport and storage by the catalyzed oxidation of Fe^{2+} to Fe^{3+} along with ferroxidase activity[1,2]. Hence, CP provides Fe without generating a toxic product by binding to transferrin in the plasma[27]. Because there are free ferric ions and ferritin binding sites, CP can act as an oxidant or an anti-oxidant[27]. CP helps control membrane lipid peroxidation by providing the oxidation of the cation; it takes place in the structure of high-density lipoproteins (HDL) and also blocks the function of oxidants by binding to it[28]. CP also has the ability to bind to and transport magnesium[27,28].

A CP molecule is formed from a single polypeptide chain comprising 1046 peptides[27,28]. Its total carbohydrate content is 8% to 9.5%[27,28]. It carries three glucosamine-linked oligosaccharide side chains[27,28]. First, the peptide chain is formed, after which Cu is added through the ATPase[27,28]. Carbohydrate side chains are then added to the endoplasmic reticulum[27,28]. In addition to transport by CP, Cu also plays a role in the formation of CP proteins[27,28].

Heart Failure

There have been numerous studies regarding CP in heart failure (HF). The main anti-oxidant function of CP is related to its ferroxidase I activity, which in turn influences Fe-dependent oxidative and nitrosative radical species generation [29]. Peroxynitrite, whose production is increased in HF, may decrease the anti-oxidant function of CP by amino acid modification[29]. In addition, it is believed that CP decreases the bioavailability of nitric oxide (NO) in HF.

Studies have reported that increased CP levels are related with poorer prognosis of HF. It is believed that elevated CP levels can be a marker for hospitalization, all-cause mortality and cardiovascular event frequency, and death from HF. Hammadah et al. showed that increased serum CP levels were an independent predictor of all-cause mortality. Researchers suspect that CP measurement may help identify patients with HF who have an increased mortality risk[30]. A community-based study showed that CP was associated with the incidence of HF, death from HF, and cardiovascular disease[31]. This previous study included 9240 individuals and followed them up for a total of 10.5 years[31]. As a result of 22 years of follow-up, Engström et al. showed that CP and other low-grade inflammatory markers were significantly related with a high incidence of HF[32]. However, the presence of an association between serum CP levels and increased mortality has not been confirmed by peripartum cardiomyopathy[33].

High CP levels typically occur independently from HF causes, and both are correlated with low ejection fraction (EF) and increased C-reactive protein (CRP). A previous study found increased CP levels in patients with ischemic or nonischemic cardiomyopathy and a linear correlation with CRP and left ventricular EF[34]. Another study showed increased serum CP levels in patients with idiopathic dilated cardiomyopathy compared with controls[35]. There are also studies that have reported a relationship between serum natriuretic peptides and CP as well as a linear relationship between CP and BNP in HF. In the study by Hammadah et al., there was a weak but positive relationship between HF and serum CP levels[30]. In addition, NT-proBNP may be correlated with serum CP levels in acute decompensated HF[36].The existence of a positive relationship between serum CP levels and the functional class of HF has also been observed[29].

CP is high in both compensated and decompensated HF. In another study, we found an increased serum CP value both in compensated and decompensated HF compared with control patients[37]. Interestingly, in that previous study, there were higher CP levels in compensated HF than there were in decompensated patients[37].

Coronary Artery Disease

CP is a serum protein that has been the subject of numerous studies concerning coronary artery disease (CAD). In an isolated heart model, CP was reported to be protective of ischemia/reperfusion injury because of its anti-oxidant activity[38,39]. However, it is also able to act to as an oxidant under certain circumstances. Studies have shown that protein nitration is associated with CAD[40-42]. Impaired ferroxidase I activity and/or nitrated CP may reflect global OS. In vitro, CP may show nitric oxide (NO) oxidase activity via the catalytic consumption of NO[43]. There is diminished plasma NO oxidase activity in humans with congenital aceruloplasminemia[43]. Because CP lacks NO oxidase activity, its elevation may diminish the NO bioavailability; hence, endovascular dysfunction may occur, leading to increased OS. A close relationship between the presence of CAD and increased OS has been demonstrated in several studies[44-46].

Several studies have connected CP levels with increased cardiovascular risks in the normal population and also in patients with acute coronary syndromes[24,47-50]. In addition, two case-controlled studies have identified serum CP as a risk factor for CAD[9]. A prospective cohort study showed a relationship between serum CP levels and subsequent myocardial infarction (MI)[51]. In 4177 stable cardiac patients who underwent a three-year follow-up, Tang et al. reported an increased incidence of major cardiovascular events (death, MI, and stroke) in participants with higher CP levels [25]. Grammer et al. showed that increased CP levels were independently associated with increased risk of cardiovascular and all-cause mortality in CAD represented by angiography results[51]. In stable cardiac patients, a three-year follow-up cohort study showed that high serum CP levels were associated with

increased risk for cardiovascular events[52]. In another study conducted in patients with chronic renal failure, increased CP has been associated with CAD-related cardiac events, including nonfatal MI, nonfatal stroke, or death[53].

Both acute and chronic CAD are associated with increased serum levels of CP. Singh showed that CP levels transiently increase as an acute-phase response following MI[52]. Changes in some acute-phase parameters, including CP, were found when predicting the development of complications and the likelihood that the disease would have a fatal outcome[54]. Another study also showed high-levels of CP in patients with acute and chronic CAD compared with that in the control participants[55].

Cardiac Arrhythmia

In clinical studies, elevated CP may cause cardiac arrhythmias. CP was analyzed in patients with atrial fibrillation, the most frequent cardiac arrhythmia, and was shown to be important in the pathophysiology of the condition[56]. In another study, elevated CP levels were associated with an increased risk of hospitalization from AF[57]. Although not reported in clinical studies, in a rat heart with induced ischemia, CP treatment decreased both reversible and irreversible ventricular fibrillation, but had no effect on ventricular tachycardia[58].

Rheumatic and Valvular Heart Disease

There are few studies concerning CP in induced rheumatic and valvular heart disease. A study conducted in children with acute rheumatic fever revealed high CP levels at the time of diagnosis[59]. Another study carried out in dogs with degenerative mitral valve disease showed that CP levels were no different in significant valvular disease than they were in patients with nonsignificant diseases[60]. CP levels were also significantly higher in patients with acquired valvular heart disease than in controls[61].

Lipids

CP has been known to play a role in the oxidative modification of low-density lipoprotein (LDL). CP has also been shown to have pro-oxidant activity and to contribute to the oxidative modification of LDL under some conditions. Atorvastatin use may also increase CP levels; a previous study demonstrated increased anti-oxidant capacity and decreased OS with statin use[62].

Hypertension

Few studies on CP have been conducted in hypertensive patients. Vasconcelos et al. indicated that compared with the controls, the hypertensive group had increased serum CP levels[63]. Another study reported that the presence of hypertension and elevated blood pressure readings were associated with increased serum CP levels[32].

CONCLUSION

CP is a serum protein that has been investigated in a number of studies concerning heart diseases. In heart diseases, CP may be an etiologic or diagnostic agent or a prognostic marker. It is not known how it varies in different forms of heart disease, and its contribution to the etiology or prognosis is also unclear. Apart from studies concerning HF and CAD, CP awaits the attention of researchers in several areas.

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Mekanik Ventilasyona Pratik Yaklaşım

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ÖZET

Bu derlemede mekanik ventilasyon endikasyonları, mekanik ventilatör ayarlamalarındaki temel parametreler, temel mekanik ventilasyon modları ve mekanik ventilatörden ayırma (weaning) konuları pratik olarak özetlenmiştir.

Anahtar Kelimeler: Mekanik ventilasyon; modlar; parametreler; klinik pratik

Practical Approach to Mechanical Ventilation

ABSTRACT

In this review, we summarize the practical issues concerning mechanical ventilation including mechanical ventilation indications, basic parameters of mechanical ventilation settings, basic mechanical ventilation modes, and separation of mechanical ventilation (weaning).

Key Words: Mechanical ventilation; modes; parameters; clinical practice

Mekanik ventilasyon, oksijenlenmesi yeterli olmayan hastalarda, hastanın kendi solunum fonksiyonları ile yeterli oksijenlenme sağlanana kadar, bu fonksiyonun cihaz aracılığı ile dışarıdan sağlanmasıdır. Günümüzde mekanik ventilasyon ameliyathane, yoğun bakım, acil servis ve ev gibi değişik ortamlarda çeşitli amaçlarla kullanılmaktadır.

Mekanik Ventilasyonun Amaçları

A. Fizyolojik amaçlar:

- Arteriyel oksijenizasyonu desteklemek (PaO_2 ve SaO_2),
- Alveolar ventilasyonu sağlamak ($PaCO_2$ ve pH),
- Akciğer volümünü arttırmak,
- Fonksiyonel rezidüel kapasite (FRK)' yi arttırmak,
- Solunum kaslarını dinlendirmek.

B. Klinik amaçları:

- Hipoksiyi düzeltmek (SaO_2 > %90),
- Solunumsal asidozu düzeltmek,
- Solunum sıkıntısını ortadan kaldırmak,
- Solunum kaslarının yorgunluğunu ortadan kaldırmak,
- Atelektazileri önlemek veya ortadan kaldırmak,
- Sedasyon veya nöromusküler blokaja imkan tanımak,
- İntrakraniyal basıncı azaltmak,
- Sistemik veya miyokart oksijen tüketimini azaltmak,
- Toraks duvarını stabilize etmek.

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Mekanik Ventilasyon Endikasyonları

Mekanik ventilasyon, endikasyon dahilinde kullanımı hastanın içinde bulunduğu solunum sıkıntısının yaratabileceği mortalite ve morbiditeyi önlemektedir[1,2].

1. Genel fizyopatolojik endikasyonlar:

- Apne,
- Akut solunum yetersizliği ($PaCO_2$ > 50 mmHg ve pH < 7.30),
- Tedaviye dirençli hipokarbi ve asidoz,
- Ağır hipoksemi (PaO_2 < 60 mmHg/SaO_2 < 90, FiO_2 > %60),
- Ağır solunum sıkıntısının klinik bulguları (bilinç kaybı, dispne, takipne, paradoksal solunum gibi).

2. Sık rastlanan klinik endikasyonlar:

- Akut solunum yetersizliği [akut respiratuar distres sendromu (ARDS), kalp yetmezliği, pnömoni, sepsis, cerrahi komplikasyonlar, travma] (%66),
- Koma (%15),
- Kronik obstrüktif akciğer hastalığı (KOAH) alevlenmeleri (%13),
- Nöromusküler bozukluklar (%5).

Mekanik Ventilatörde Ayarlanması Gereken Parametreler

FiO_2 (inspire edilen O_2 konsantrasyonu): FiO_2'yi ayarlarken hastaya kabul edilebilir PaO_2 (ya da SaO_2) değerini sağlayacak en düşük O_2 yüzdesini vermek gerekir. Hasta ventilatöre %100 O_2 ile bağlansa bile sonrasında FiO_2 < 0.6'da tutulmaya çalışılmalıdır[3]. Oksijen toksisitesinden kaçınmak için hastaya uzun süre %100 O_2 verilmemelidir.

F (solunum frekansı): Solunum frekansı seçilen ventilatör moduna, hastanın spontan solunum sayısına ve solunum eforuna, $PaCO_2$ seviyesine bağlıdır. Yetişkinlerde sıklıkla F 10-16/dakika olarak ayarlanır[3]. Yüksek frekanslarla oto-PEEP oluşabilir. Hiperventilasyonla hipokarbi ($PaCO_2$ < 25 mmHg) gelişebilir.

TV (tidal volüm): Çoğu zaman TV 7-10 mL/kg arasında uygulanırsa da bunun üzerinde ve altında uygulanması gereken durumlar da olabilir. Ventilatör kaynaklı akciğer hasarını en aza indirmek için düşük tidal volümler ve düşük ventilasyon basıncı önerilir. Birçok kaynakta ARDS'de özellikle 6 mL/kg'dan TV kullanılması önerilmektedir. TV çok düşükse atelektazi, hipoksemi, hipoventilasyon; çok yüksekse barotravma, solunumsal alkaloz ve kardiyak outputta azalma olabilir[4].

İ/E oranı (inspiryum ekspiryum oranı): Çoğu zaman inspirasyon ekspirasyon oranı 1:2 olarak ayarlanır. Ekspirasyonun inspirasyona göre biraz daha fazla olması beklenir. İ:E oranı direk ventilatörden ayarlanabildiği gibi bazı manevralarla da değişebilir. Akım hızı, solunum hızı, inspirasyon zamanı ve dakika ventilasyonunun değişmesiyle İ:E oranı da değişir. İ:E oranının 1'den büyük olduğu durumlarda ters orantılı ventilasyon gerçekleşir. Bu da oto-PEEP ve sonucunda hiperinflasyon ve barotravmaya neden olabilir[3].

PEEP (pozitif ekspiryum sonu basıncı): Ekspiryum sırasında hava yolu basıncının atmosferik basıncın (0 cmH_2O) üzerinde tutulmasıdır. Diğer modlar ile birlikte uygulanır. PEEP akciğer kompliyansında azalma, rezidüel kapasitede azalma ve refrakter hipoksinin giderilmesi için kullanılır[3]. PEEP kollabe olan akciğer alveollerinin açılmasını sağlar. Oksijenizasyonu ve akciğer kompliyansını iyileştirir. PEEP uygulamasına genellikle 5-10 cmH_2O ile başlanır. PO_2 > 60 ve FiO_2 < 0.50 olacak şekilde ikişer cmH_2O azaltılır veya arttırılır. ARDS, akciğer ödemi, atelektazi, oto-PEEP varlığında ve KOAH alevlenmesinde oldukça faydalıdır[5].

Pik inspirasyon basıncı (Ppik): Hastaya ventilatör tarafından inspiryumda verilen soluk ile hava yolunda oluşan en yüksek basınç değeridir. Ppik, hava yolu rezistansından ve kompliyansından etkilenir. Hava yolu rezistansını arttıran ve kompliyansını azaltan durumlarda Ppik artar. Barotravma sebebiyle dikkat edilmeli ve Ppik 40-45 cmH_2O'un üzerine çıktığı durumlarda müdahale edilmelidir [5].

Pplato (inspiratuvar plato basıncı): İnspiratuvar volüm akciğerlerde tutulduğunda hava yolu basıncı başlangıçta azalır ve daha sonra plato basıncı denen kararlı bir düzeye erişir. Pplato doğrudan göğüs duvarı ve akciğer ile ilişkilidir. Bu sebepten Ppik ve Pplato arasındaki fark hava yollarında akım direnci ile orantılıdır[3]. Pplato'nun < 35 cmH_2O olması istenir.

Tetikleme duyarlılığı (trigger sensitivity): Hastanın solunum isteği belli bir akım seviyesinde ya da belirli bir basınç üreterek gerçekleştirdiğinde tetikleme gerçekleşir. Mekanik ventilatörün tetiklemesi hastanın spontan solunumunu tetikleyecek; fakat ventilatörün kendini tetiklemesini önleyecek en hassas seviyede olmalıdır. Bu değer genellikle basınç tetikli ventilatörlerde -0.5 ile -1.5 cmH_2O arasında, akım tetikli ventilatörlerde 1-3 L/dakika olarak ayarlanır.

Temel Modlar

Günümüzde teknolojinin de gelişmesiyle mekanik ventilatörlerde çok çeşitli modlar ortaya çıkmaktadır. Modların çeşitliliği attıkça klinisyenin hangi modu seçeceği zorlaşmaktadır. Biz bu yazımızda tüm ventilatörlerde olan en temel modlardan behsedeceğiz. Temel modlar, günümüzde tüm modern ventilatörlerde standart olarak bulunmaktadır; fakat farklı cihazlarda, farklı adlandırılmış olabilirler. Soluk içindeki kontrol değişkenlerine bağlı olarak ve soluk özelliklerine göre farklı modlardan yararlanılabilir[6].

Soluk içindeki kontrol değişkenlerine göre:

a. Hacim kontrollü

b. Basınç kontrollü

Soluk özelliklerine göre:

a. Sürekli zorunlu ventilasyon (CMV, continuous mandatory ventilation)

b. Eş zamanlı aralıklı zorunlu ventilasyon (SIMV, synchronized intermittent mandatory ventilation)

c. Basınç destekli ventilasyon (PSV, pressure support ventilation)

d. Sürekli spontan solunum (CSV, continuous spontaneous ventilation) (örneğin CPAP, BIPAP, APRV) olarak sınıflamak mümkündür.

CMV; Hacim veya basınç kontrollü olabilir; VC-CMV, PC-CMV.

SIMV; Hacim veya basınç kontrollü olabilir; VC-SIMV, PC-SIMV.

PSV; Sadece basınç kontrollüdür.

a. CMV (sürekli zorunlu ventilasyon):

VC-CMV (volüm kontrollü sürekli zorunlu ventilasyon): Bu modda ventilatör klinisyenin ayarladığı frekansta istenen sabit volümü hastaya verir. Bu modda belirlenen hacim sabit tutulup basınç değişkendir. Zorunlu soluklar ister hasta tarafından [Asist kontrol ventilasyonda (ACV); hastanın soluklarını ventilatör destekler ve zorunlu soluklardan kabul eder], ister ventilatör tarafından tetiklensin ayarlanan soluk hacmine ulaştırılır[6]. VC-CMV modun avantajları dakika ventilasyonun garantili olması, hipoventilasyon riskinin çok az olması, hastanın soluma işinin az olması ve böylece istirahat edebilmesidir. CMV modunun dejavantajı, her ne kadar hasta solunumu tetiklese ve soluma işine bir ölçüde katılsa da bunun büyük kısmını ventilatör üstlenmiş durumdadır. CMV uzun süre kullanılacaksa solunum kaslarının güçsüzlüğü ve atrofisi ortaya çıkabilir. Aynı zamanda CMV'de zorunlu solukların dışında hastanın solumasına izin verilmez; bu da hasta ventilatör uyumsuzluğuna sebep olur. Bu sebeple bu modun genellikle sedatize hastalarda kullanılması önerilir.

PC-CMV (basınç kontrollü sürekli zorunlu ventilasyon): Bu modda klinisyen inspiryum basınç düzeyi, İ:E oranı, F, PEEP ve FiO_2'yi ayarlar[6]. Basınç sabitken hacim değişkendir. Bu modda kontrol değişkeni basınçtır. Her soluk ayarlanan tepe hava yolu basıncına (PEEP + inspiratuar pressure) ulaştırılır ve inspiryum süresince bu basınç düzeyi korunur. VC-CMV'de olduğu gibi zorunlu soluklar hasta (asist kontrol) ya da ventilatör tarafından tetiklenebilir[7]. PC-CMV'de en büyük dezavantaj TV ve dakika ventilasyon değerinin sabit olmamasıdır. Solunum işinin büyük kısmını ventilatörün üstlendiği ve zorunlu soluklar dışında hastanın solumasına izin vermediği için VC-CMV'de olduğu gibi solunum kaslarında atrofi ve hasta ventilatör uyumsuzluğu riski mevcuttur.

b. SIMV (eş zamanlı aralıklı zorunlu ventilasyon): VC-SIMV, PC-SIMV olarak iki farklı şekilde kullanılabilir. Önceden klinisyenin belirlediği zorunlu soluklar belirli hacimde (VC-SIMV) ya da belirli basınçta (PC-SIMV) hastanın solunum eforuyla senkronize olarak, istenen hacimde hastaya verilir. Hastanın spontan solunumu zorunlu soluklardan fazla ise hastanın solunumuna izin verilir; ancak bu solukları cihaz desteklemez. CMV modundan avantajı, hastanın spontan solumasına izin vermesidir. Bu sebeple hasta ventilatör uyumu CMV'ye göre daha iyidir. Aynı zamanda hastanın solumasına izin verildiği için solunum kaslarının atrofisi engellenir. Bu özelliği ile uzun süreli mekanik ventilasyon ihtiyacı olan hastalar için uygun bir moddur[6]. Hastanın solunum eforuna göre zorunlu soluklar ayarlanmalıdır. Eğer spontan solunumu az ve zorunlu soluklar da az ayarlandıysa hipoventilasyon meydana gelebilir; ya da tam tersi spontan solunumu fazla, zorunlu soluklar da fazla ise hiperventilasyonla sonuçlanabilir.

c. PSV (basınç destekli ventilasyon): Spontan soluyabilen hastalarda sıklıkla kullanılan bir moddur. PSV, soluyabilen hastada fizyolojik solunuma daha yakın bir moddur. Bu modda kullanıcı insipiryum basıncı, PEEP ve FiO_2'yi ayarlar. Modun en önemli özelliği, hastanın her soluma çabasının pozitif basınçla desteklenmesidir. Ekspirasyon ise pasiftir[6,7]. Bu modda herhangi bir sebeple apne gelişimi hayati tehlike oluşturabilir. Bu riski ortadan kaldırmak için çeşitli ventilatörlerde bu moda apne ventilasyon desteği eklenmiştir. Hastanın soluma çabası yoksa, apne ventilasyon modu devreye girer ve hastaya zorunlu soluk verilir. Ancak ventilasyonun apne ventilasyon özelliği yoksa; PSV modunda takip edilen hastanın, spontan solunumunun olduğundan emin olunmalıdır.

SIMV + PSV: SIMV modda, zorunlu soluklar dışında hastanın solumasına izin verilir; ancak bu soluklar ventilatör tarafından desteklenmez. SIMV + PSV modunda ise zorunlu soluklar dışındaki hastanın spontan solukları basınçla desteklenir. Kullanıcı bu modda SIMV moduna ek olarak inspiryum basıncını ayarlar.

d. CSV (sürekli spontan solunum) (örnekleri CPAP, BIPAP):

CPAP (Sürekli pozitif hava yolu basıncı): Spontan solunum modudur. Bu mod için hasta mutlaka yeterli solunum çabası yapmalıdır. Kullanıcı tarafından ayarlanan sabit bir hava yolu basıncı tüm spontan solunum döngüsü boyunca korunur. CPAP ile istenen; hava yolu basıncının atmosfer basıncının üzerinde tutularak alveollerin sönmesinin engellenmesi ve fonksiyonel rezidüel kapasite (FRK)'nin arttırılarak gaz değişiminde iyileşme sağlanmasıdır. CPAP noninvaziv ventilasyon

ile de uygulanabilir. Uyku apne sendromu, KOAH, akciğer ödemi gibi durumlarda son yıllarda daha sık kullanılmaktadır. Ayrıca bu mod mekanik ventilatörden ayırma sürecinde (weaning) geçiş modu olarak da kullanılmaktadır.

BIPAP (çift düzeyli pozitif hava yolu basıncı): Klinisyen bu modda iki farklı seviyede pozitif hava yolu basıncını ayarlar (üst PEEP, alt PEEP). Hasta her iki basınç düzeyinde de spontan solunum yapar. Ayarlanan iki PEEP seviyesi ve bu seviyelerin ne kadar süre uygulanacağı kullanıcı tarafından belirlenir. Noninvaziv ventilasyonda sıklıkla kullanılan bir moddur.

CPAP ve PEEP'in pulmoner etkileri: CPAP ve PEEP modlarının akciğerler üzerine belirli etkileri vardır[6,8].

- FRK artar,
- TV artar,
- Kompliyans artar,
- Ventilasyon/perfüzyon oranı düzelir,
- Şant oranı azalır,
- Oksijenizasyon düzelir.

Aşırı CPAP ve PEEP dezavantajları:

- Alveolleri aşırı şişirebilir.
- Bronşlar aşırı genişleyebilir.
- Kompliyans düşer.
- Solunum işi artar.
- Kapillerler üzerine aşırı basınç mikrosirkülasyonu bozar ve sağ ventrikül etkilenir.
- 20 cmH_2O'un üzerindeki basınç değerlerinde barotravma riski çok artar (pnömomediastinum, pnömoperitoneum, subkutanöz amfizem gibi).

PEEP'in düşük seviyeleri (örn. 5 cmH_2O) bile hipovolemi ve kardiyak disfonksiyonu olan hastalar için oldukça tehlikelidir[8].

Pozitif basınçlı ventilasyonun komplikasyonları: Mekanik ventilasyon yararları yanında, çok çeşitli komplikasyonlara da sebep olabilir[9].

- Barotravma,
- Oksijen toksisitesi (Özellikle yüksek O_2 düzeylerinde),
- VİP (ventilatör ilişkili pnömoni),
- Pulmoner emboli,
- Kardiyovasküler komplikasyonlar (Venöz dönüşün engellenmesiyle pulmoner vasküler direnç artar, PEEP'in eklenmesiyle de sağ ventrikül boşalması engellenerek intraventriküler septum hareketi sınırlanır ve sol ventrikül kompliyansı düşer. Bunların sonucunda kardiyak output ve arteriyel basınç düşer),
- Sedasyon ve paralizinin yan etkileri,
- Gastrointestinal sistem komplikasyonları (kanama, erozif gastrit, stres ülseri, diyare, ileus, akut mezenterik iskemi, akut pankreatit gibi),
- Diğer komplikasyonlar (renal disfonksiyon, ajitasyon, deliryum gibi).

Mekanik ventilatörün sonlandırılması (weaning): Mekanik ventilatör desteğinin gerektiğinden erken sonlandırılması, gereksiz yere uzatılması kadar risklidir. Re-entübasyon sıklığı %5-15 arasında değişmektedir. Reentübasyon mortalite oranını yaklaşık altı kat, nazokomiyal pnömoni gelişime oranını ise yaklaşık sekiz kat arttırmaktadır[9]. Ventilatörden ayırma işleminde hekimin bilgi ve tecrübesi gerekli olmakla birlikte bir takım objektif parametrelere de ihtiyaç vardır.

Mekanik ventilatörden ayırmaya yardımcı kriterler: Mekanik ventilasyondan ayırma (weaning) ve ekstübasyon işleminin zamanlaması hayati önem teşkil etmektedir. Erken ayrılma, infeksiyon, akciğer hasarı gibi uzamış mekanik ventilasyon komplikasyonları risklerini düşürmek ile beraber, vaktinden önce ekstübasyon re-entübasyona yol açabildiğinden ciddi mortalite ve morbidite riski yaratmaktadır. Mekanik ventilasyona son vermede aşağıdaki maddeler kullanılabilir[10].

Respiratuar kriterler:

- $FiO_2 \leq$ %40-50 ve PEEP ≤ 5-8 cmH_2O iken $PaO_2 \geq$ 60 mmHg olmalı,
- $PaCO_2$ normal veya bazal düzeyde olmalı,
- Hasta bir inspirasyon başlatabilmeli.

Kardiyovasküler kriterler:

- Miyokart iskemisi bulgusu olmamalı,
- Kalp hızı ≤ 140 atım/dakika olmalı,
- Kan basıncı vazopressör kullanmadan veya minimum vazopressör desteği ile normal düzeyde olmalı.

Mental durumun yeterliliği:

- Hasta uyanık veya Glaskow koma skoru ≥ 13 olmalı.

Düzeltilebilir sebepler:

- Hastanın ateşi olmamalı,
- Önemli elektolit bozukluğu olmamalıdır.

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Successful Catheter Cryoablation for Atrial Fibrillation in Patients with Permanent Cardiac Pace-maker Implants

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ABSTRACT

In daily practice, several methods including electrocardiography, 24-hour Holter ECG monitoring, or event recorders are frequently used for diagnosis and follow-up of patients with atrial fibrillation (AF). Although these tests provide crucial information, they may be insufficient in selected cases. In this case, we utilized intracardiac electrocardiogram recordings for both diagnosis of AF and detection of its recurrence in a patient with a permanent pace-maker who underwent AF ablation because of symptomatic and asymptomatic paroxysmal AF episodes. Because patients with permanent pacemakers are continuously monitored via intracardiac recordings, we believe that it is the most definite method for both diagnosis and monitoring of treatment success.

Key Words: Atrial fibrillation ablation; intracardiac recordings

Kalıcı Kalp Pili İmplantı Olan Atriyal Fibrilasyonlu Hastada Başarılı Kateter Kriyoablasyon

ÖZET

Günlük pratikte hastalarda atriyal fibrilasyon ataklarının tanı ve takibinde sıklıkla elektrokardiyografi, ritim holter ve olay kaydedici kullanılmaktadır. Bu testler önemli bilgi sağlasa da yetersiz kaldıkları olgular olabilmektedir. Biz olgumuzda daha önce kalıcı kalp pili implante edilmiş, semptomatik ve asemptomatik atriyal fibrilasyon atakları olan hastanın tanısının koyulmasında ve atriyal fibrilasyon ablasyonu sonrası rekürrensin takibinde kalp içi kayıtlardan faydalandık. Kalıcı kalp pili olan hastalarda, intrakardiyak kayıtlarla devamlı takip sağladığından, hem tanı koymada hem de tedavi başarısını belirlemede kullanılabilecek en kesin yöntem olduğunu düşünüyoruz.

Anahtar Kelimeler: Atriyal fibrilasyon ablasyonu; intrakardiyak kayıtlar

INTRODUCTION

Catheter-based ablation methods are recommended as the first-line treatment for symptomatic patients with atrial fibrillation (AF) or for those having symptoms despite medical treatment[1]. Although diagnosis of symptomatic patients with AF is easy, it may be challenging to diagnose AF in asymptomatic patients. Monitoring pharmacological or interventional treatment efficacy requires utilization of several methods including the most commonly used electrocardiogram (ECG) or 24-hour ambulatory ECG monitoring, which may not always provide satisfactory data. Here, we detected symptomatic and asymptomatic AF episodes by examining intracardiac electrocardiograms (IEGM) of a patient with a permanent pace-maker and then performed pulmonary vein isolation using the cryoballoon technique leading to curative success, which was confirmed by the absence of AF recurrence in IEGMs.

CASE REPORT

A 70-year-old female patient was admitted with complaints of palpitation and shortness of breath. The patient was implanted with a permanent pace-maker for sick sinus syndrome a year ago in our clinic. Although she was receiving amiodarone and metoprolol therapy for rate and rhythm control, she was noted to have symptomatic (consistent with event time) and asymptomatic AF episodes when examined for IEGMS. Echocardiographic examination

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revealed normal left ventricle ejection fraction (55%), left atrial enlargement (43 mm), and mild mitral regurgitation. AF ablation using cryoballoon was scheduled. Following trans-septal puncture, all the four pulmonary veins were isolated using a cryoballoon catheter (Arctic front©, Medtronic Cryocath LP, Kirkland, Canada). Isolation of pulmonary veins was confirmed during and after ablation using a circular mapping catheter. In addition, programed atrial stimulation and "burst pacing" maneuvers were performed, and no tachycardia was induced. Her symptoms improved, and her follow-up visits confirmed that IEGMs revealed no AF episode (Figure 1).

DISCUSSION

AF is common in patients with pacemakers and is associated with adverse outcomes, particularly in patients with sick sinus syndrome history [2]. AF ablation using radiofrequency catheters is a common and effective treatment for such patients[3]. Monitoring recurrence after ablation is generally based on the symptoms of the patients in conjunction with 24-hour ambulatory ECG recordings, transtelephonic ECG, or event recorders[4].

Certain forms of pacing modes in patients with pacemakers may not detect very short-lasting AF episodes; however, IEGMs are usually adequate for AF diagnosis and follow-up after ablation. Different from other follow-up methods, more precise records can be obtained using continuous recording. Absence of any AF episode 24-hours after the ablation procedure suggests that IEGM may be an optimal method for the diagnosis and follow-up of patients with pacemakers

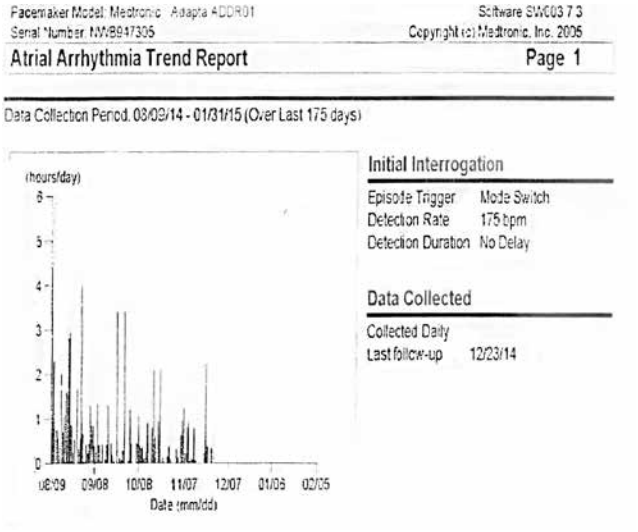

Figure 1. Atrial arrhythmia trend report.

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Successful Surgical Pulmonary Embolectomy for Massive Pulmonary Embolism with Multiple Thrombogenic Risk Factors: A Case Report

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ABSTRACT

We report a 36-year old woman who suffered from massive pulmonary embolism with multiple thrombogenic risk factors. She was successfully treated with pulmonary embolectomy. Our report reinforces the importance of early diagnosis in the presence of a high clinical suspicion for pulmonary embolism. Furthermore, surgical pulmonary embolectomy remains one of the most effective treatment methods.

Key Words: Massive pulmonary embolism; multiple thrombogenic risk factors; surgical pulmonary embolectomy

Çoklu Trombojenik Risk Faktörüne Sahip Masif Pulmoner Emboli Olgusunun Başarılı Bir Şekilde Cerrahi Pulmoner Embolektomi ile Tedavisi: Olgu Sunumu

ÖZET

Otuz altı yaşında, çoklu trombojenik risk faktörüne sahip ve masif pulmoner emboli tablosu ile başvuran hastanın pulmoner embolektomi ile başarılı bir şekilde tedavi edilişini sunuyoruz. Olgumuz pulmoner emboli de erken tanının önemini belirtmektedir. Ayrıca, cerrahi pulmoner embolektominin en etkin tedavi yöntemlerinden biri olduğunu vurgulamaktadır.

Anahtar Kelimeler: Masif pulmoner embolizm; çoklu trombojenik risk faktörü; cerrahi pulmoner embolektomi

INTRODUCTION

Acute pulmonary embolism (PE) is one of the major challenging diseases in the emergency setting. On average, 90% of all mortalities occur within 2 h of the onset of symptoms[1]. Therefore, rapid treatment of massive PE is a high priority. The optimization of emergency structures has been demonstrated to significantly reduce the mortality rate from unstable PE[2]. The reliable exclusion of PE in hemodynamically stable patients remains an additional problem, since in many of these patients the symptoms of PE are barely evident or manifest atypically. Previous studies have shown that PE has been frequently overlooked, and therefore, the mortality rate in such cases is significantly increased[3,4]. One of the most important diagnostic methods in suspected cases of PE is computed tomography (CT) scans of the pulmonary artery[5,6]

CASE REPORT

A 36-year-old woman was admitted our hospital because of dyspnea. She has been smoking 20 cigarettes per day for 20 years and using oral contraceptive for 5 years. Physical examination at the emergency department showed a blood pressure of 90/50 mmHg and a pulse rate of 110 beats/min. The patient was tachypneic throughout her hospitalization, with a respiratory rate ranging from 20 to 24 breaths/min. On auscultation, crepitant rales were heard in the right basal pulmonary area. Cardiac findings included prominent pulmonic component of the second heart sound. The electrocardiogram showed sinus tachycardia and incomplete right bundle branch block. Laboratory tests showed mild anemia (hemoglobin level, 11.2 g/dL), increased white blood cells (12.4 K/μL), an elevated d-Dimer level (941 ng/mL), slightly increased C-reactive

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protein (14.04 mg/dL), a PaO_2 of 35 mmHg, a $PaCO_2$ of 42 mmHg, an SO_2 of 62.3%, and a pH of 7.465. Chest radiography revealed a consolidation view on the right basal pulmonary area. She immediately underwent transthoracic echocardiography, which revealed a normal sized left ventricle, normal systolic function, and severe dilatation in the right ventricle. Contrast-enhanced CT angiography of the chest demonstrated a large, contiguous filling defect extending from the main pulmonary artery to the right and left pulmonary arteries (Figure 1,2). She was referred for an emergency pulmonary embolectomy, since her hemodynamic condition was unstable.

During the operation, after performing a median sternotomy, cardiopulmonary bypass was established by cannulation of the ascending aorta and two caval cannulations. We detected dilatation of the right ventricle. In the setting of partial cardiopulmonary bypass and beating heart, embolectomy was performed through a right and a left pulmonary incision (Figure 3). The patient was weaned off cardiopulmonary bypass, and stable hemodynamics was maintained without inotropic support.

On postoperative day 2, she was discharged from the intensive care unit. All parameters improved markedly. Postoperative transthoracic echocardiography showed marked improvement in right ventricular functions. Lower-extremity Doppler ultrasound was negative for deep venous thrombosis. Results of the hypercoagulability workup including antinuclear antigen, high levels of factor VIII, protein C and protein S activity, protein C and protein S antigen, antithrombin III activity, antithrombin antigen, plasminogen activity, phospholipid IgG/IgM, and hyperhomocysteinemia were negative. Our patient had heterozygous Factor V Leiden mutation and multiple risks for thromboembolism (smoking and oral contraceptive use).We planned the prothrombin time/international normalized ratio (PT/INR) to range from 2 to 3 to control warfarin postoperatively. The patient was discharged without morbidity 3 weeks later.

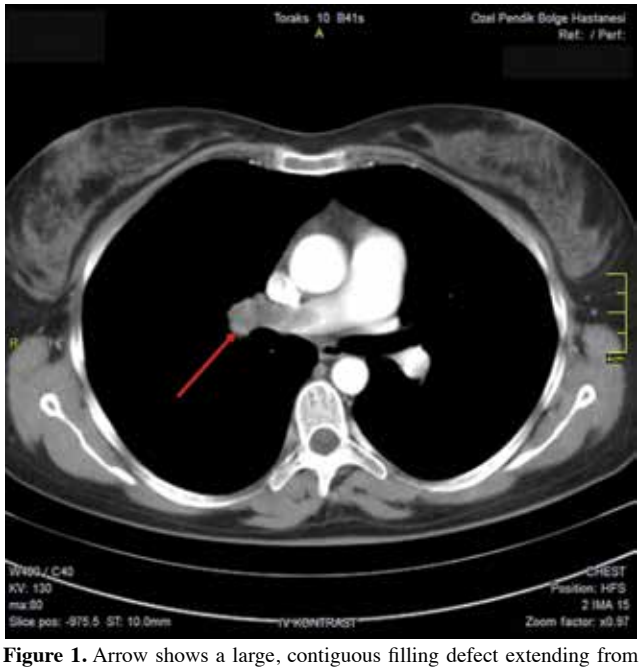

Figure 1. Arrow shows a large, contiguous filling defect extending from the main pulmonary artery to the right pulmonary artery.

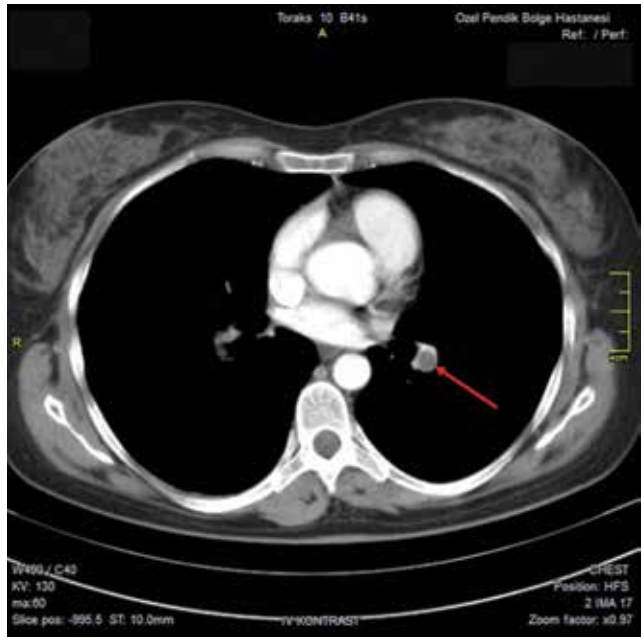

Figure 2. Arrow shows filling defect in the branch of the left pulmonary artery.

Figure 3. Arrows show thrombogenic materials extracted from the pulmonary arteries.

DISCUSSION

Factor V Leiden mutation is the most common hereditary hypercoagulable disease in the United States and involves 5% of the Caucasian population[7]. It leads to activated protein C resistance that has been demonstrated as risk factor for venous thrombosis development[8]. Approximately one out of 1000 patients will develop deep venous thrombosis (DVT) or pulmonary thromboembolism each year. The heterozygous Factor V Leiden increases the risk of developing DVT by 5-7 fold, whereas the homozygous Factor V Leiden increases the risk of developing clots by 25-50 fold[9]. The association between oral contraceptives and PE is established, although only a limited number of studies address the issue[10,13]. Of these, the study by Lauque et al. comprised only 11 case reports and is not recent[10]. Significantly, more data exist regarding the association between DVT and contraceptive use. A metaanalysis by Manzoli et al. included many studies and confirmed a significantly increased risk of thrombosis with oral contraceptive use[13]. Despite the wealth of data, the results concerning DVT cannot be directly converted to PE. Nevertheless, the association between oral contraceptives and PE remains undisputed. Regarding the association between thrombophilia and PE, the data from Lauque et al.'s study is insufficient as well. Data from a large retrospective study by Wu et al. indicated a significantly increased risk of PE associated with different thrombophilia subgroups; the risk increased further upon concomitant intake of contraceptives[14]. Thus, the risk factors, i.e., contraceptive use and thrombophilia, in addition to a history of DVT/PE, are of tremendous importance in the context of PE[15]. Our patient predisposing factors were convenient of literature.

The first successful surgical pulmonary embolectomy was performed in 1924, several decades before the introduction of medical treatment for PE. Pulmonary embolectomy is technically a simple operation. Following the induction of anesthesia and median sternotomy, normothermic cardiopulmonary bypass should be started. Aortic cross-clamping and cardioplegic cardiac arrest should be avoided[16,17]. With bilateral PA incisions, clots can be extracted from both pulmonary arteries down to the segmental level under direct vision. Prolonged periods of postoperative cardiopulmonary bypass and weaning may be necessary for recovery of right ventricular function. With a rapid multidisciplinary approach and individualized indications for embolectomy before hemodynamic collapse, perioperative mortality rates of ≤ 6% have been reported[18]. Preoperative thrombolysis increases the risk of bleeding, but it is not an absolute contraindication to surgical embolectomy[19].

This case report emphasizes the importance of early diagnosis in the presence of a high clinical suspicion of PE. An extended workup, including transthoracic echocardiography and CT scan of the pulmonary arteries are mandatory in such a patient, particularly when there are clinical findings suggestive of PE. Furthermore, surgical pulmonary embolectomy is one of the most effective treatment methods besides thrombolytic and percutaneous catheter-directed treatment, particularly when the patient's hemodynamic condition is unstable.

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Cardiac Resynchronization Therapy After Percutaneous Valve Repair in Functional Mitral Regurgitation Management

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ABSTRACT

We present a case of a 72-year-old female with symptomatic heart failure and ischaemic functional mitral regurgitation (FMR), who underwent a successful percutaneous trans-coronary venous mitral annuloplasty with the Carillon™ system. The procedure resulted in some clinical improvement but patient was still very symptomatic. Six months later, the patient underwent cardiac resynchronisation (CRT) device implantation, resulting in a further improvement in clinical and echocardiographic measures of FMR. This case suggests a possible synergistic effect between CRT and percutaneous trans-coronary-venous mitral annuloplasty.

Key Words: Mitral regurgitation; percutaneous mitral annuloplasty; cardiac resynchronization therapy

Fonksiyonel Mitral Yetersizliği Tedavisinde Perkütan Kapak Tamiri Sonrası Kardiyak Resenkronizasyon Tedavisi

ÖZET

Bu olgu sunumunda kalp yetersizliği semptomları ve iskemik fonksiyonel mitral yetersizliği (FMR) sebebiyle Carillon™ sistemiyle başarılı olarak koroner venöz mitral annüloplasti yapılan 72 yaşındaki kadın hasta anlatılmaktadır. İşlem sonrası bir miktar klinik iyileşme olan hastanın semptomları devam etmekteydi. Altı ay sonra hastaya kardiyak resenkronizasyon tedavisi (CRT) uygulandı ve hastanın klinik bulgularında ve ekokardiyografik olarak FMR'sinde olumlu ek iyileşme sağlandı. Bu olgu CRT ile perkütan trans-koroner-venöz mitral annüloplastinin olası sinerjistik etkisinden söz etmektedir.

Anahtar Kelimeler: Mitral yetersizliği; perkütan mitral annüloplasti; kardiyak senkronizasyon tedavisi

INTRODUCTION

Functional mitral regurgitation (FMR) and left ventricular dyssynchrony (LVD) may coexist in most patients with heart failure with reduced ejection fraction (EF). In this case, percutaneous treatment of mitral regurgitation (MR) is a promising alternative for patients with FMR who are unsuitable for surgery and are unresponsive to optimal medical and cardiac resynchronization therapy (CRT). Carillon™ is a percutaneous mitral annuloplasty system, and its effect on the pre-implanted pacemaker lead in coronary sinus (CS) causes security concems. There are insufficient data regarding the implementation efficacy of the Carillon system as a first-step treatment method in patients with FMR, who are suitable for percutaneous mitral annuloplasty and have CRT indications. This paper presents the application of CRT to a patient that previously underwent annuloplasty with Carillon system.

CASE REPORT

A 72-year-old female with hypertension, chronic obstructive pulmonary disease, ischemic heart failure, and severe FMR was referred to our clinic. An electrocardiogram revealed left bundle branch block. Left ventricular dilatation, systolic dysfunction (EF= 35%), and severe FMR were confirmed by echocardiography. LVD was highly visible in electrocardiography. Coronary angiography revealed no significant stenosis. Because of a high surgical risk (Society of Thoracic Surgeons score= 10.5%) and annular dilatation as the possible mechanism of MR, percutaneous annuloplasty was performed in the patient. The patient underwent percutaneous mitral annuloplasty with the Carillon™ system, which resulted in a slight decrease in the degree

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of MR and no change in EF as observed on echocardiography. Six months after Carillon™ device implantation, patient was still symptomatic [New York Heart Association (NYHA) Class II-III]. We decided on the implantation of an implantable cardioverter-defibrillator device with CRT function. CS catheterization was easily accomplished owing to the visibility of proximal anchor of Carillon™ device (Figure 1). After the CS angiography, the lateral branch was detected, and the left ventricular lead was implanted in this branch. A second CS catheterization was performed because of instability, and it was fixed with a coronary stent (Figure 2). After this procedure, the echocardiography revealed an increased left ventricle EF. Degree of MR was considered to be mild (Figure 3). During the 6-month follow-up period, the patient's functional capacity recessed to NYHA class I-II.

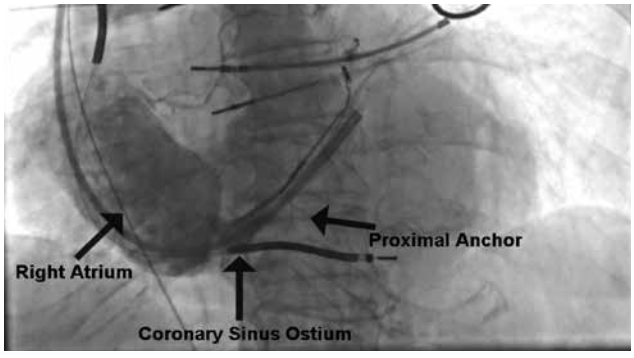

Figure 1. Coronary sinus angiography.

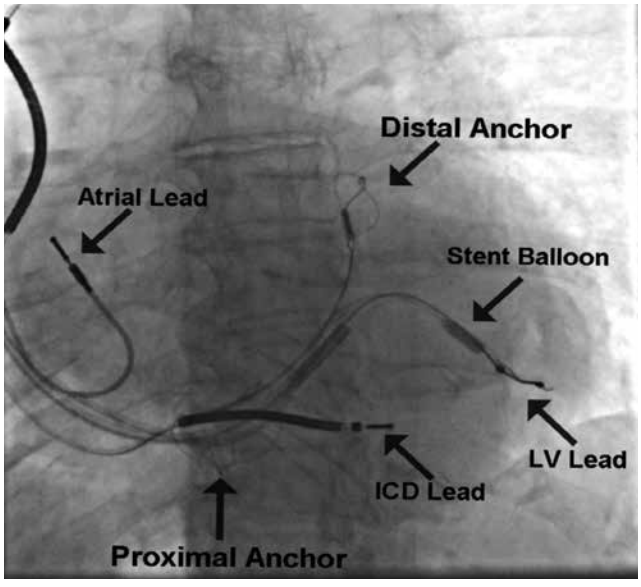

Figure 2. Coronary stent was introduced beside the lead into the side branch.

Figure 3. Follow-up monitoring using 4-chamber transthoracic echocardiography in which color Doppler ultrasound shows mild-to-moderate mitral regurgitation.

DISCUSSION

The prognosis of patients with FMR is poor. Even the slightest degree of FMR can impact the survival of patients with LV dysfunction with or without coronary artery disease[1]. Besides its positive effects on the ventricular geometry in the long run, CRT corrects dyssynchrony in the sub-valvular structure as well[2]. Current guidelines recommend an operative intervention for FMR only after optimal medical therapy (including CRT, if indicated)[3]. Because of the presence of a CS lead remains as an exclusion criterion for Carillon™ device implantation, patients have to undergo mitral annuloplasty before CRT. Even though there are cases in which this strategy has synergistic benefits, there are no data solely comparable to device implantation in CRT. Although there was a decreased MR after Carillon™ procedure in our case, the response to CRT was much more remarkable both clinically and echocardiographically[4].

The efficacy of percutaneous mitral contour device as the first-step treatment approach is unknown in cases with CRT indication and apparent LVD. Future clinical trials are warranted.

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An Unexpected Cause of Hepatotoxicity and Myopathy in A Patient with Coronary Artery Disease: It Is Not Statin

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ABSTRACT

Sertraline is a selective serotonin reuptake inhibitor; it is safe and effective for treating depression in patients with coronary artery disease. Although nausea, diarrhea, and dyspepsia are common adverse effects, less frequent reactions such as maculopathy, hepatotoxicity, and rhabdomyolysis have also been reported. In patients receiving multiple drugs for co-morbid conditions (heart failure, coronary artery disease, etc.), these side effects can be underdiagnosed. Here, we present a patient with coronary artery disease and elevated liver function tests and skeletal muscle enzymes who had multiple admissions and prolonged follow-ups in the emergency room because of elevated creatine kinase and creatine kinase-MB levels, which delayed his appropriate management including discontinuation of sertraline instead of statin.

Key Words: Coronary artery disease; hepatotoxicity; myopathy; sertraline

Koroner Arter Hastalığı Olan Bir Hastada Beklenmedik Bir Hepatotoksisite ve Miyopati Nedeni: Statin Değil

ÖZET

Sertralin koroner arter hastalığına eşlik eden depresyon durumlarında etkinliğini ve güvenirliliğini kanıtlamış bir selektif serotonin geri alım inhibitörüdür. Sık görülen yan etkileri yanında (bulantı, ishal, dispepsi) daha nadir görülen (makülopati, hepatotoksisite, rabdomiyoliz) gibi yan etkileri de bildirilmiştir. Çoklu ilaç kullanımının sık olduğu hastalarda (kalp yetersizliği, koroner arter hastalığı gibi) depresyon tedavisinde sertralin kullanımına bağlı yan etkiler gözden kaçabilmektedir. Biz karaciğer fonksiyon testleri ve kas enzimleri yükselmiş bir koroner arter hastasında sertralinin; statinlerden sonra etyolojik ajan olarak değerlendirildiği ve bu sürede kreatinin kinaz, kreatinin kinaz-MB yüksekliği nedeniyle uzamış acil servis takipleri olan bir olguyu sunuyoruz.

Anahtar Kelimeler: Koroner arter hastalığı; hepatotoksisite; miyopati, sertralin

CASE REPORT

A 46-year-old male patient with complaints of chest pain and fatigue was admitted to our outpatient clinic. His medical history was unremarkable except for primary stenting in the right coronary artery for inferior myocardial infarction in January 2014. He was prescribed clopidogrel (75 mg), metoprolol (50 mg), ramipril (5 mg), acetylsalicylic acid (100 mg), and atorvastatin (20 mg) therapy. The patient suffered symptoms related to anxiety disorders (fear of death, sense of refractory chest pain, and multiple hospital admissions) after acute coronary syndrome (ACS); thus, control angiography had been performed, which revealed stent patency. A consultant psychiatrist prescribed sertraline (50 mg once a day), which was later increased to 100 mg once a day. Although most of his symptoms related to anxiety disorder had improved significantly with sertraline treatment, his visits to the emergency room for chest pain persisted. Detection of elevated creatine kinase (CK) and creatine kinase-MB (CK-MB) levels at his multiple visits led to prolonged and repeated cardiac troponin follow-ups, which were all negative. Prolonged ER follow-ups for serial testing gave rise to increased anxiety. Meanwhile, his fatigue persisted. On admission to our clinic, his laboratory findings were as follows: CK [733.2 U/L (range, 24-170 U/L)], lactate dehydrogenase [LDH; 546 U/L (range, 225-450 U/L)], aspartate aminotransferase [AST; 93.6 U/L (range, 0-35 U/L)], alanine transaminase [ALT; 168.1 U/L (range, 0-45 U/L)], gamma-glutamyltranspeptidase

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[GGT; 63.6 U/L (range, 0-55 U/L)]. His medical history did not include any abnormalities (history of hepatitis, active infection, or vigorous exercise) potentially associated with those high levels. Thereafter, his statin dose decreased by half-dose. A follow-up visit six weeks later revealed insignificant decreases in laboratory tested levels as follows: CK [720 U/L (U/L 0-200 U/L)], CK-MB [32 U/L (range, 0-25 U/L)], AST [50 U/L (range, 0-40 U/L)], ALT [77 U/L (range, 0-50 U/L)], LDH [(356 U/L (range, 0-225 U/L)], GGT [51 U/L (range, 0-61 U/L)]; thus, liver ultrasound exam, serological markers for hepatitis, prothrombin time, and bilirubin tests were evaluated, and no abnormality was detected. The patient was subsequently consulted with psychiatry, and sertraline was replaced with a selective serotonin reuptake inhibitor (SSRI) excreted via the kidney. His liver tests performed eight weeks later were within the normal ranges: AST [40 U/L (range, 0-40 U/L)], ALT [0-31 U/L (range, 7-49 U/L)], GGT [26 U/L (range, 10-71 U/L), as well as his CK [174 U/L (range, 20-190 U/L)] and CK-MB [0-30 U/L (range, 0-25 U/L)] levels. Statin therapy was re-initiated, and his liver function tests were not elevated.

DISCUSSION

SSRIs are widely prescribed agents for treatment of depression caused by cardiovascular side effects (tachycardia and orthostatic hypotension) less common than old-generation tricyclic antidepressants[1]. Sertraline, a popular member of this group, was shown to be safe and effective for treating depression in patients with heart disease[2]. SADHART (Sertraline antidepressant heart attack randomized trial) compared sertraline and placebo in patients diagnosed with depression within 30 days after ACS and demonstrated that sertraline was a safe and well-tolerated agent[3]. Although growing numbers of evidence confirmed the safety of sertraline, the number and variety of reported adverse effects continue to increase. In this report, we aimed to show that sertraline therapy induced hepatotoxicity and myositis in a patient with coronary artery disease whose appropriate diagnosis and treatment were delayed because of concurrent statin therapy.

Multi-drug use is common in patients with heart diseases because of comorbidities; thus, concerns for drug interaction and safety ensue in this patient population. In an in vitro study, it was demonstrated that sertraline is metabolized as cytochrome isoforms by multiple enzymes[4]. Sertraline has mild effects on inhibition of CYP isoenzymes; thus, it is associated with uncommon drug-drug interactions[5]. To our knowledge, there is no data about the additive effect of sertraline and statin use with regard to liver and muscle toxicity. However, it is likely to occur when dominant hepatic metabolism for both these drugs are taken into account. In our patient, although statin therapy was interrupted, transaminase levels remained elevated with a mild decrease.

The most commonly observed adverse events associated with the use of sertraline were nausea, diarrhea/loose stools and dyspepsia, male sexual dysfunction (mainly delayed ejaculation), insomnia and somnolence, tremor, increased sweating and dry mouth, and dizziness in product information[6]. Incidence of asymptomatic increases in serum transaminases with sertraline use was 0.5%; meanwhile, acute fatal hepatitis related to sertraline use had been reported in literature[7]. Hepatotoxic effects of sertraline comprise complex mechanisms; however, the most attributed ones include apoptosis induced by prolonged endoplasmic reticulum stress and apoptosis mediated by mitogen-activated protein kinase signaling pathways[8,9]. It is not surprising to see hepatotoxic effects of a drug that is highly metabolized by the liver; however, the underlying mechanism for skeletal muscle injury remains yet to be elucidated. Rhabdomyolysis in a 71-year-old patient with dementia was claimed to be induced by vasoconstriction/vasospasm associated with sertraline and comorbidities as an underlying cause of muscle ischemia[10].

CONCLUSION

Mechanisms for liver and muscle toxicity associated with sertraline use continue to be unclear. When considering the co-existence of coronary artery disease and psychiatric disorders, it would be wise to emphasize that a combination of statin and sertraline seems to be an issue, which both cardiologists and psychiatrists need to be cautious about. We suggest keeping in mind the risk of hepatotoxicity and myositis associated with sertraline use in this specific but common patient population.

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Sandwich Stenting Technique Successfully Performed for Acute Carotid Artery Stent Thrombosis: A Case Report

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ABSTRACT

Even though acute carotid stent thrombosis is a rare complication of carotid artery stenting (CAS), it can cause fatal thromboembolic events. There are limited numbers of techniques that can be applied during such emergencies. In this study, we report a case in which the sandwich technique was successfully performed in the acute in-stent thrombosis. Conclusively, in-procedural in-stent thrombosis following CAS must be rapidly evaluated and treated, allowing the efficient prevention of catastrophic events. Thus, sandwich stent technique is a rapid and efficient method for treating acute in-stent thrombosis.

Key Words: Carotid stenting; in-stent thrombosis; complications; sandwich technique

Akut Karotis Stent Trombozunda Başarılı Sandviç Tekniği Olgusu

ÖZET

Akut karotis arter stent (KAS) trombozu nadir bir komplikasyon olmasına rağmen fatal tromboembolik olaylara neden olabilir. Akut olaylarda uygulanabilecek sınırlı sayıda teknik olmakla birlikte bu olgu bildirimizde akut KAS trombozunda başarılı bir şekilde uygulanan "sandviç stent tekniğini" sunmaktayız. Prosedürel akut KAS trombozu hızlı ve etkin bir şekilde değerlendirilerek tedavi edilmesi gereken bir durumdur. Bu olgumuzda kullandığımız teknik böyle katastrofik durumlarla başetmede hızlı ve güvenli alternatif bir yöntem olarak kullanılabilir.

Anahtar Kelimeler: Karotis stentleme; instent tromboz; komplikasyon; sandviç tekniği

INTRODUCTION

Even though acute carotid artery stent thrombosis is a rare complication of carotid artery stenting (CAS), it can lead to fatal thromboembolic events[1]. In such cases, rapid intervention should be performed to limit cell death following cerebral ischemia. Herein, we present a case of percutaneous mechanical thrombectomy that was successfully performed using the sandwich technique for treating acute carotid stent thrombosis.

CASE REPORT

A 65-year-old diabetic male patient was admitted to our hospital with a complaint of recent transient ischemic attack (TIA) involving the left internal carotid artery (LICA). He was diagnosed with the bilateral internal carotid stenosis (90% on the left and 75% on the right) (Figure 1A). The patient was under Acetylsalicylic acid (100 mg) + Clopidogrel (75 mg) treatment that was initiated 30 days ago and he was examined in the laboratory. The patient was evaluated in the laboratory on day 32 of the TIA for CAS. Extracranial lesions were observed and intracranial carotid angiography was performed. The patient was administered unfractionated heparin and his ACT was measured between 250 and 350. We implanted an 8/6/30-mm self-expanding closed-cell nitinol stent [TheProtégé/SpiderFx (ev3 Endovascular Inc., Plymouth, Minnesota)] under Angio Guard (Cordis Corp., Miami, FL) protection. Furthermore, post-dilation was performed with the stent together with Omnipass 5/20-mm balloon (Cordis Corporation, Warren, NJ). In the control angiogram, instant massive thrombus image was observed (Figure 1B-E; insent massive thrombus can be seen in the control angiogram). The patient was decompensated and became rapidly unconscious and hemodynamically

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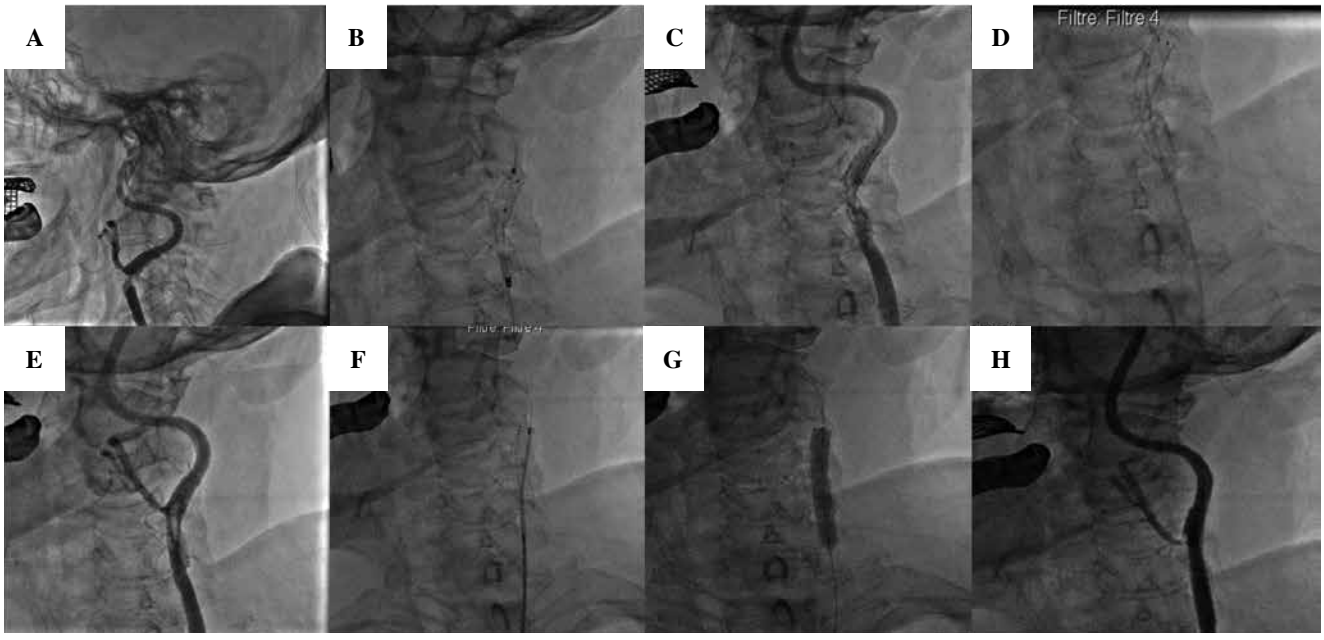

Figure 1. Angiographic images of procedures which were performed to solve the left carotid artery stenosis can be seen. (**A)** The left carotid internal artery stenosis can be observed prior to intervention. (**B)** The first closed-cell self-expandable stenting. (**C)** In-stent acute massive thrombus after stent implantation. (**D)** Aspiration catheter application to in-stent intensive thrombosis. (**E)** Persistent intense thrombus was observed upon thrombus aspiration. (**F)** Placing a second closed-cell self-expandable stent in-stent "sandwich technique." (**G)** Post-dilation. (**H)** Patency and flow were observed upon a successfully performed sandwich technique.

unstable. He was immediately intubated and hemodynamic support was initiated. The ACT was measured again and was noted to be 265. Next, additional 5000 U unfractionated heparin was intravenously administered to the patient. Shortly after, postdilatation was performed using a 4 × 20 mm balloon (Guidant Corp., Indianapolis, IN). However, insent thrombus was persistent. Thus, we primarily performed a percutaneous aspiration of thrombus (Export; Medtronics, Mineapolis, MN, USA) but it was observed that the thrombus was not dissolved. The desired flow and patency were not ensured. Upon this, additional in-stent implantation was performed using the sandwich technique to limit the thrombus between two stents (F;G). Post-procedural control angiogram showed that there was a recanalization of the LICA. In addition, complete clot dissolution, desired flow, and patency were observed in the end of the procedure (H). Meanwhile, the distal vessel patency was shown by performing intracranial angiography. Furthermore, intense yellow debris and fresh thrombus were observed in the filter basket in the distal protection device. The patient was consulted in Neurology clinics after the intervention. There was no neurological deficit upon intervention even though small bright lesions were observed in the left cerebellar hemisphere on diffusion-weighted MRI. We discharged the patient seven days later. The dual antiplatelet treatment of the patients was planned for 6 months. A patency was observed in the stent on carotid CT angiography, which was performed after 6 months (Figure 2).

DISCUSSION

In this study, we reported the 6-month follow-up recordings of the 65-year-old male patient who had an acute carotid stent thrombosis. The following conditions can increase the risk of thrombogenicity while performing CAS procedures: antiplatelet monotherapy, antiplatelet resistance, early discontinuation of treatment, thrombocythemia, diabetes mellitus, heparin resistance, vessel dissection, severe plaque protrusion, stent under expansion, and stent fracture[2,3]. The aspirin/clopidogrel resistance was not included for study in this case report because the rapid clinical and hemodynamic recovery was considered to be achieved by placing the thrombus/plaque/tissue prolapse or protrusion between two stents using the sandwich technique. Furthermore, no new clinical event was noted in the follow-ups of the patient during the 6 months of dual antiplatelet treatment. Meanwhile, stent patency was observed via CT imaging after 6 months. Furthermore, there is also the presence of procedural risks, such as the guiding catheter which cannot be frequently rinsed with flushing due to heparin production. Furthermore, expiry date issues and thus thrombus can also be formed[4]. According to the literature, emergent treatment procedures of the acute carotid thrombosis after CAS can be as follows: removing the thrombus by open surgery and performing thromboendarterectomy, thrombolysis or facilitated thrombolysis can be ensured with the rescue use of glycoprotein IIb/IIIa receptor inhibitors (GPIs), postdilatation can be performed using distal in-stent protection

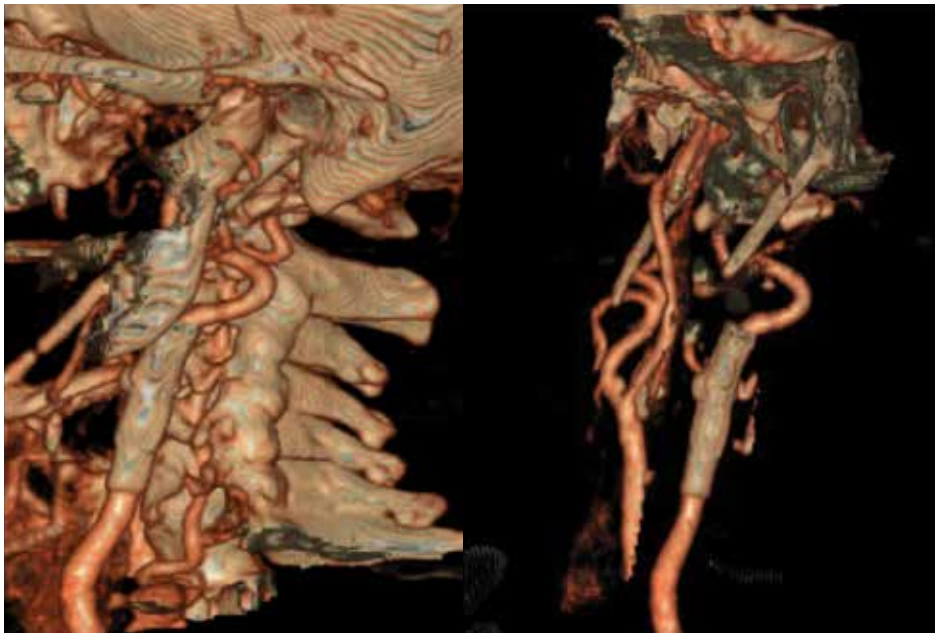

Figure 2. After 6 months, stent patency was still present according to the control CT angiogram.

filter during the percutaneous transluminal angioplastyor additional stent can be implanted together with the intravenous administration of recombinant tissue plasminogen activator[2,5-7]. The tPA was not preferred because of the low body weight (54 kg) and HASBLED score was 4. In this case, stent-filling defect is referred to as "image" and we believe that the thrombus occurs together with plaque/tissue prolapsed or protrusion because the clinical outcome of the patient was prominently improved and there was no thrombus in the intracranial angiogram. It has already been reported that the stent used in the intervention can lead to such complications. Upon implantation, the stent can increase the protrusion risk due to the "free cell area"[8]. This risk is lower when closed-cell stents are used compared with the use of open cell stents. Upon this catastrophic event, we primarily performed thrombus aspiration using a catheter and thrombus retrieval was partially achieved. However, we could not achieve thrombus dissolution. Therefore, we aimed to limit the thrombus between the two stents using a secondary closed-cell stent instead of an emergency surgery or thrombolytic therapy. The sandwich technique can be successfully used in the deployment of consecutive closed-cell self-expandable stents. The sandwich technique is reportedly being used in peripheral artery interventions and in coping with carotid artery stent thrombosis[7,9]. The procedure was successfully performed as an alternative treatment without causing complications.

In conclusion, in-procedural in-stent thrombosis following CAS must be rapidly evaluated and treated for the efficient prevention of catastrophic events. Percutaneous mechanical thrombectomy which can be performed using the sandwich technique is a useful tool in the treatment of acute in-stent thrombosis after CAS.

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A Rarely Seen Type-I Kounis Syndrome Caused By Tetanus Vaccine

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ABSTRACT

The pathogenesis mechanism of Kounis syndrome is defined by mast-cell degranulation that has been amplified to induce acute myocardial infarction in susceptible individuals. Here, we report a case of Kounis syndrome presented with acute coronary syndrome after a tetanus vaccine. In addition, all possible other etiologies, especially ischemia, were excluded.

Key Words: Allergic myocardial infarction; Kounis syndrome; tetanus vaccine

Oldukça Nadir Görülen Tetanoz Aşısının Neden Olduğu Tip 1 Kounis Sendromu

ÖZET

Patolojik mekanizması mast hücrelerinin degranülasyonuna bağlı hassas kişilerde görülen akut miyokardiyal enfarktüsü Kounis sendromu olarak tanımlanır. Biz burada tetanoz aşısı sonrası akut koroner sendrom ile başvuran bir Kounis sendromu bildirdik. Ek olarak, tüm olası sebepler özellikle de iskemi dışlandı.

Anahtar Kelimeler: Allerjik kalp krizi; Kounis sendromu; tetanoz aşısı

INTRODUCTION

Acute coronary syndrome accompanied by activation of mast cells induced by hypersensitivity or allergic and anaphylactic or anaphylactoid reactions has not frequently been reported. First, Kounis explained it as "hypersensitive angina syndrome" advancing to "allergic myocardial infarction." Hence, it was referred to as "Kounis syndrome" recently[1,2]. In this case, we report a patient who developed Kounis syndrome following an allergic reaction to a tetanus vaccine. We also describe clinical implications and possible pathophysiological mechanisms involved.

CASE REPORT

A 35-year-old man was admitted to our hospital's emergency department with typical chest pain and moderate pruritic skin rashes. His symptoms had begun roughly half an hour after ingesting a tetanus vaccine for a minor injury. He was admitted to our department for a period of 45 minutes after the onset of the tetanus vaccine's side effects. Furthermore, he displayed none of the risk factors for coronary artery disease. After the confirmation, his electrocardiogram demonstrated ST elevations in leads d-II, d-III, and aVF and reciprocal changes in anterior leads (V 1-4) reflecting inferior myocardial infarction (Figure 1A). Subsequently, the patient was taken to our coronary angiography unit. The patient was given 300 μg intravenous glycerol trinitrate for chest pain before the coronary angiography. His chest pain was resolved after the administration of glycerol trinitrate. However, the left and right selective coronary angiography was normal (Figure 2A,B). Next, the patient was taken to the hospital's coronary care unit, and his electrocardiogram was normal (Figure 1B). Despite this, Troponin-I level was 27 ng/mL (reference esteem: 0.015 ng/mL) and peak creatine kinase-MB fraction was 107 U/L at the peak of his subsequent period, individually. In addition, a moderate increase in leukocyte count (15.4 x $10^3/\mu$L) and eosinophils (4.9%) was also observed. The immunoglobulin-E level was significantly higher (180 mg/L) (reference esteem: 150 mg/L). According to these results, the

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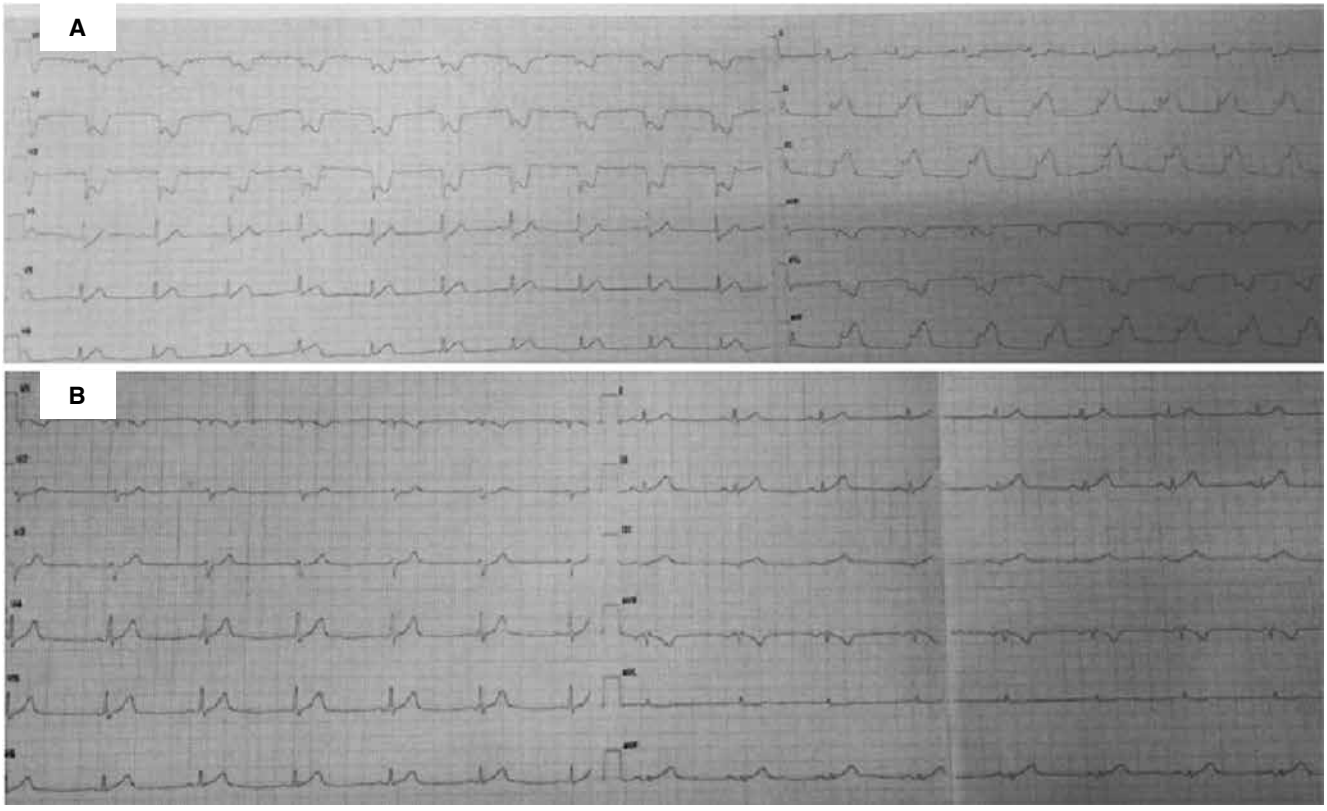

Figure 1. (**A**) Electrocardiogram demonstrating ST elevations in leads d-II, d-III, and aVF and reciprocal changes in anterior leads (V 1–4), (**B**) Normal electrocardiogram.

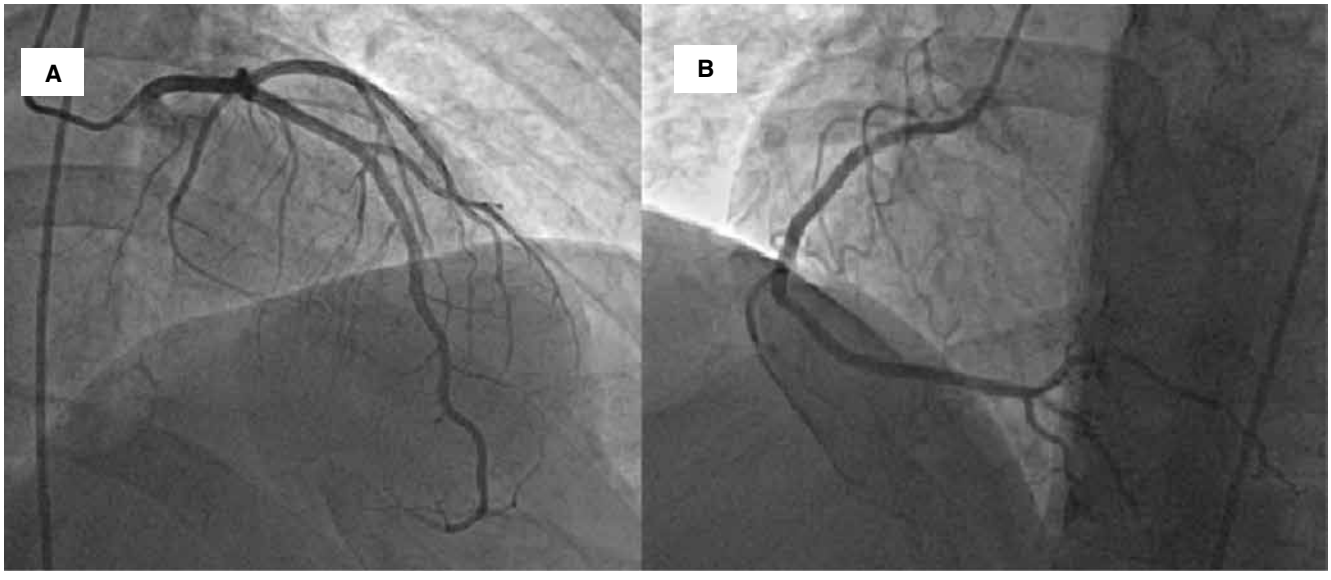

Figure 2. Normal coronary arteries, (**A**) Left selective coronary angiography, (**B**) Right selective coronary angiography.

diagnosis was an allergic reaction as the chest pain had started immediately after administration of a tetanus vaccine. Therefore, the patient was treated with an oral antihistamine therapy as a measure against allergic reactions. Finally, the patient was discharged on the fourth day of admission.

DISCUSSION

To the best of our understanding, this seems to be a very rarely encountered case of Kounis syndrome induced by a tetanus vaccine in literature. Kounis syndrome, also known as allergic myocardial infarction, can be classified into three types. In the first category, patients display coronary vasospasms actuated by mediators of allergic reaction, for example, histamine, thromboxane, and leukotrienes without the availability of risk factors that cause atherosclerosis or coronary artery syndrome. In the second type, an acute coronary disorder arises because of coronary vasospasms, plaque disintegration, or rupture of plaque incited by these arbiters in patients with atherosclerotic coronary artery syndrome. It is also a fact that thrombus material contains eosinophils and mast cells extracted from several patients who suffer from stent thrombosis after stent implantation with medication discharge that makes it imperative to consider excessive hypersensitivity responses in these patients individually. Moreover, this circumstance is known as a type-III variation of Kounis Syndrome[3-5]. Therefore, based on these findings, our case was diagnosed as type-I Kounis syndrome. Increased degranulation of mast cells that induces coronary artery spasm, as well as myocardial infarction, is defined as the primary pathophysiological mechanism of Kounis syndrome. The degranulation of mast cells, particularly, can have an effect on patients more vulnerable to coronary artery spasms. On the contrary, during mast-cell degranulation, the levels of a few vasoactive molecules such as leukotrienes, serotonin and histamines, and collagen-degrading compounds, such as neutral proteases, are elevated in the peripheral circulation. All these mediators can cause a vasospasm in the coronary arteries. In addition, the platelets that trigger thrombosis are activated by histamine. This mediator can also contribute to the progression of acute coronary syndrome by initiation and provocation of plaque erosion, rupture, or coronary vasospasm [6,7]. In this case, the patient's coronary arteries were completely normal, and a coronary vasospasm could be the reason for the release of mediators owing to the tetanus vaccine. The primary cardiovascular effects of coronary vasoconstriction are plaque erosion, thrombocyte activation, dysrhythmia development, which are induced by various mechanisms and increments in the synthesis of tissue factors[8]. However, a patient suffering from Kounis syndrome, in addition to appropriate acute coronary syndrome management needs the determination of specific IgE antibodies, eosinophilia, serum histamine, and complement proteins for the identification of this disease[9]. Moreover, eosinophil, total IgE, and leukocyte levels were elevated in our patient. It can be concluded that the tetanus vaccine could be one of the core reasons for acute coronary syndrome. Clinical findings and laboratory tests might provide a suggestion that Kounis syndrome should be taken into consideration during the diagnosis of acute coronary syndromes. This case demonstrates the importance of clinical knowledge of acute coronary syndromes. Physicians need to be aware of this effect and take note of it in the diagnosis of myocardial infarction.

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A Rare Coronary Artery Anomaly: Type-4 Dual LAD

Nadir Bir Koroner Arter Anomalisi Tip 4 Dual LAD

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A 66-year old woman with a history of hypertension was admitted to our hospital with a complaint of exercise-induced chest pain. Physical examination and electrocardiogram were unremarkable. Transthoracic echocardiography was normal with a 60% left ventricular ejection fraction. The result of exercise-stress test was positive in terms of ischemia. To rule out coronary artery disease, we performed coronary angiography (CAG) (Figure 1). Left CAG revealed a short left-anterior descending (LAD) artery arising from the left coronary sinus and the circumflex (LCX) artery. Rudimentary LAD coursing through the proximal part of the anterior interventricular sulcus and 30-40% atherosclerotic stenosis was detected in the proximal short LAD. The LCX was normal. Right CAG revealed a normal right coronary artery (RCA) and an anomalous long LAD originating from the RCA coursing to the anterior interventricular sulcus and reached the cardiac apex. To better define the coronary artery anomaly, a computed tomography (CT) angiography was also performed (Figure 2). According to the classification of Spindola-Franco, our case was a rare coronary artery anomaly (CAA) known as type-4 dual LAD. The patient was discharged after the administration of anti-ischemic treatment.

CAA is rarely seen in angiographic series about 0.3%-0.8%[1]. The angiographic evaluation of CAA is essential for both coronary artery intervention and surgery involving the coronary arteries. Although CAA is benign in nature and usually asymptomatic, its clinical presentation in adults may result from myocardial ischemia manifesting as angina, syncope, arrhythmias, and even sudden cardiac death[2]. Dual LAD may be associated with congenital heart disease as tetralogy of Fallot and complete transposition of the great arteries[3]. Clinicians should be aware of coronary artery anomalies to facilitate the diagnosis and manage patients properly.

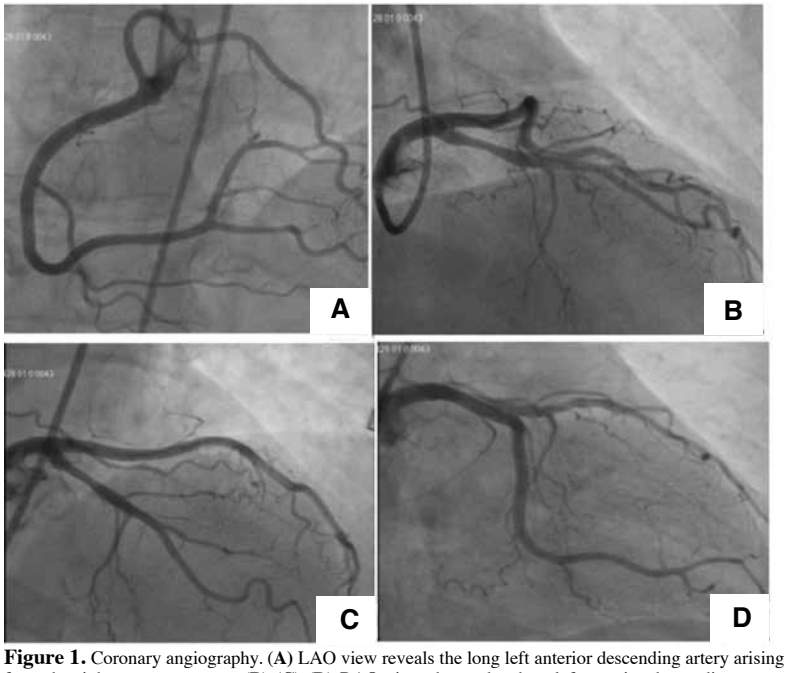

Figure 1. Coronary angiography. **(A)** LAO view reveals the long left anterior descending artery arising from the right coronary artery. **(B) (C) (D)** RAO view shows the short left anterior descending artery arising from the left main coronary artery.

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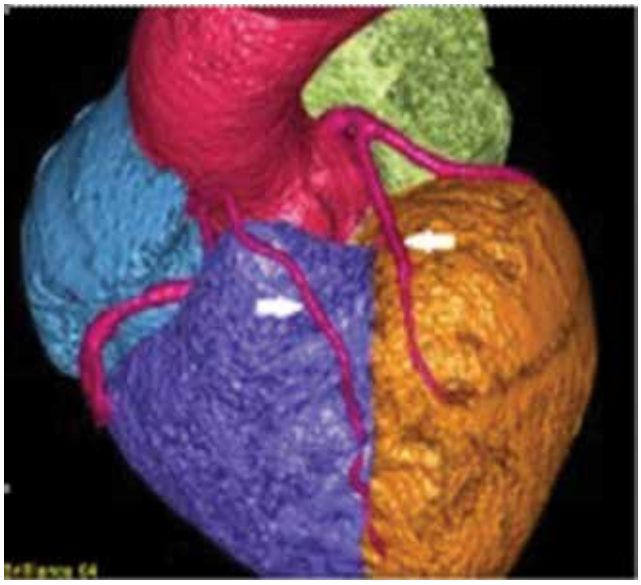

Figure 2. Multislice computed tomography (MSCT) of coronary arteries. The short left anterior descending (LAD) from the left main coronary artery,coursing through the proximal anterior interventricular septum (right white arrow) and the long LAD artery from the right coronary artery coursing along the distal anterior interventricular septum (left white arrow).

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Successful Treatment of Acute Leg Ischemia with a Hybrid Approach

Akut Bacak İskemisinin Hibrit Yaklaşımla Başarılı Tedavisi

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A 60-year-old male patient was admitted to our emergency department with left lower extremity pain. He underwent bilateral femoropopliteal bypass 3 years ago and had smoking habit and no other disease, except for Type-II diabetes mellitus. He was evaluated using bedside Doppler ultrasonography, and no flow was observed in the left popliteal artery and its distal branches. Therefore, the patient was transferred to the catheter laboratory and was found to have 100% occlusion of the left femoropopliteal graft, femoral artery, and its distal branches, and an intense thrombus in the contralateral peripheral angiography through the right femoral artery. Revascularization was not achieved with the percutaneous approach and thrombolytic therapy. The patient was followed up daily by the orthopedic team and prepared for left lower extremity amputation. On the 6th day of follow-up, acute-onset pain developed in the right lower limb; palpation showed loss of the popliteal artery and distal pulses. The thrombus developed secondary to the arterial sheath in the right femoral artery in the atherosclerotic zone, and consequently, it was considered to be thromboembolism in the right femoropopliteal graft and its distal branches. Doppler ultrasonography showed no flow in the anterior and posterior tibial arteries. Embolectomy was performed by the cardiovascular surgery team. The right femoropopliteal artery graft was incised proximally. However, inflow was not observed in the graft incision area. Successful embolectomy was not performed from the proximal anastomosis region of the graft with the Fogarty catheter. The patient was taken to the catheter laboratory for right peripheral angiography. Retrograde angiography performed through the graft incision site revealed that the right iliac artery had a total occlusion. Next, a 0.014-inch guiding wire (Choice 300 cm, Boston Scientific, USA) was pushed forward into the abdominal aorta through a retrograde approach from the graft incision site. After determining that the guide wire was in the arterial lumen by the catheter injection, successive dilatations were performed using a 4.0 × 150-mm balloon (Coyote, Boston Scientific, USA) (Figure 1A). It was seen that the inflow of the graft improved after angioplasty. Thrombectomy was performed to the distal of the graft by passing a Fogarty catheter (Edwards Lifesciences Corp., CA, USA) under fluoroscopy (Figure 1B,C). After thrombectomy, the graft incision area was repaired by suturing. During the follow-up of the patient, the symptoms of the right lower limb were regressed, the legs returned to normal from the cyanotic color, and leg temperature increased by palpation (Figure 1D). Control Doppler ultrasonography also showed triphasic flow in arterial traces.

Acute limb ischemia is a cardiovascular disorder that may begin with sudden arterial occlusion, have catastrophic consequences, and result in limb amputation in 10%-15% patients[(1)]. The prevalence of peripheral arterial disease, which usually develops on the basis of atherosclerosis increases with age [(2)]. Hybrid revascularization, i.e., endovascular treatment and open surgery in combination, can be used particularly for reaching the occluded arterial segment in patients not having an alternative intervention site [(3,4)]. In this case, we successfully treated the native artery and graft thrombo-occlusion, which caused acute leg ischemia, by revascularizing with the hybrid approach.

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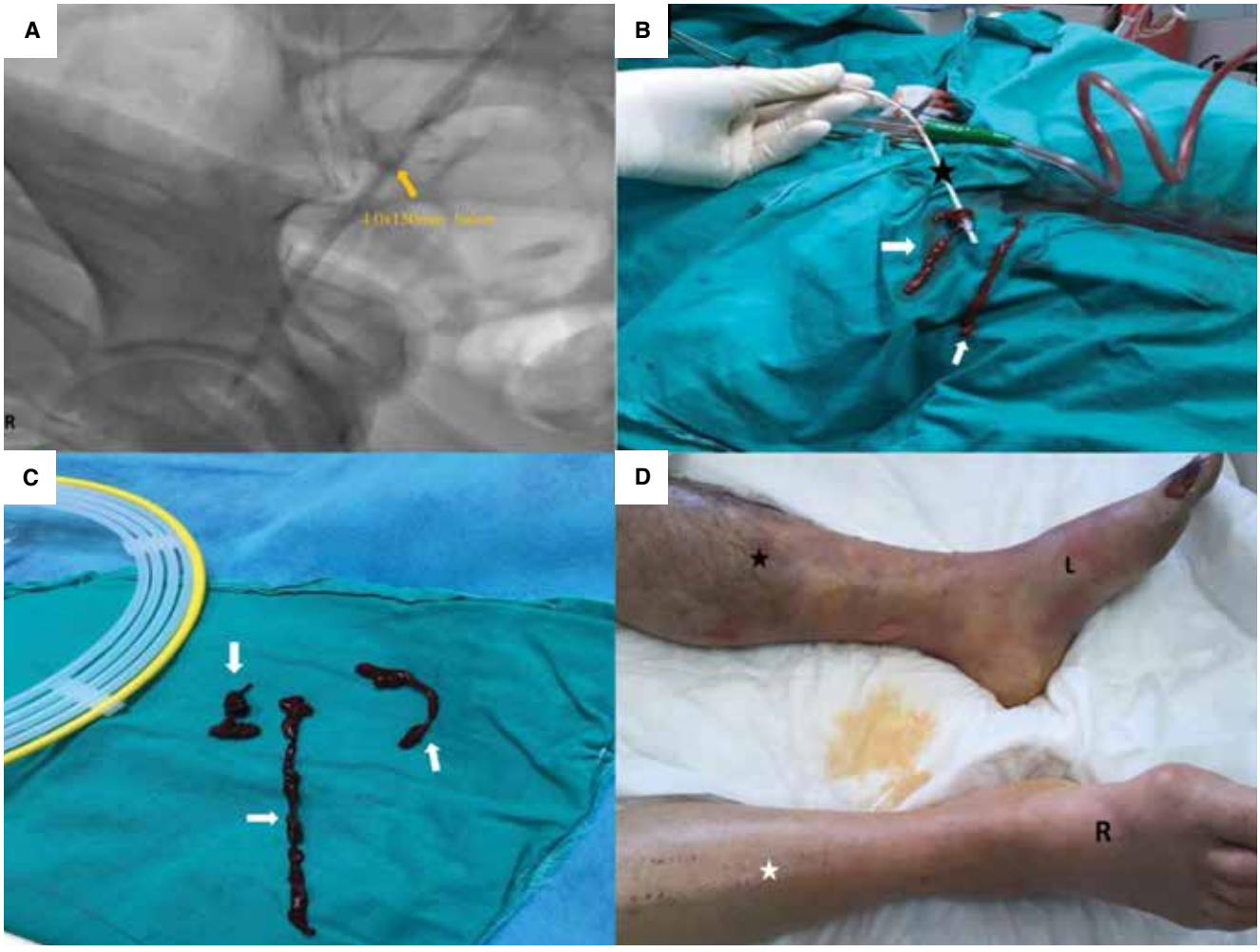

Figure 1. (A) A 4.0 × 150-mm peripheral balloon (yellow arrowhead) can be seen extending from the right external iliac artery to the main iliac artery. **(B)** A Fogarty catheter (black star) and removed thromboses can be noted (white arrow head). **(C)** Total fresh thrombus removed with the Fogarty catheter (white arrowheads). **(D)** The patient's leg on which the successful embolectomy was performed (white star) and the leg prepared for amputation (black star).

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Preventing Mechanical Complications of Median Sternotomy Using Venous Cannula Line

Venöz Kanül Hattı Kullanılarak Medyan Sternotominin Mekanik Komplikasyonlarının Engellenmesi

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Mechanical complications of median sternotomy, such as sternal dehiscence, fracture, and mediastinitis, may cause significant morbidity and mortality in patients who undergo cardiac surgery. These complications can lead to prolonged hospitalization and sometimes require surgical sternum revision[1]. In high-risk patients, such as those with chronic obstructive lung disease, morbid obesity (BMI > 30), chronic renal failure, diabetes mellitus, chronic steroid use, reoperative surgery, older age, off midline sternotomy, and osteoporosis, complications of sternotomy may occur more frequently. Although stainless steel wire closure remains the standard technique for stabilizing the sternum after sternotomy, many different and novel techniques or devices and corsets have been utilized to reinforce sternum stabilization[1-6]. All these techniques are used at the end of the surgery or during the postoperative period. However, our simple method aims to protect the sternum during the surgery, thereby reducing the rate of complications.

Technique

After median sternotomy, the sternal bone is first examined to assess whether sternotomy is in the midline or off the midline. The structure of the bone is also evaluated for the presence of fragility or inadvertent fractures. Then, a piece of large venous cannula line of sufficient length is divided into two equal pieces. Each piece is longitudinally cut to form two elastic and soft covers to fit the free sternal edges (Figure 1A,B). Initially, the free edges of the sternum are covered with sterile clothes or gauze, followed by placing the pieces of previously prepared venous cannula line on the clothes (Figure 2). Finally, a sternum retractor is placed to open the mediastinum, and the pieces of venous cannula line remain between the retractor and sternal edges (Figure 3).

Discussion

Postoperative sternal dehiscence with or without mediastinitis is a serious complication of cardiac surgery, which may lead to considerable disability. New tools or corsets are usually aimed at preventing sternal separation after surgery, but they cannot prevent sternal fracture, smash, damage, or costochondral fractures, which may be created by sternal retractor, during the surgery. Using cannula lines, we believe that the pressure on the free edges of the sternum due to the retractor may be equally distributed along the entire edge of the sternum. Thus, when the mediastinum is opened, the separation of the sternum becomes easier and safer, and the rate of occurrence of fractures may be minimized. Moreover, the technique also increases the success rate of sternal reconstruction using stainless steel wires or other new tools because of decreased sternal damage during surgery. This may also decrease the use of newly developed sternal constructing tools, which may in turn decrease the cost. Indeed, one of the main advantages of this technique is the very low cost without the need of extra tools. The venous cannula lines of the cardiopulmonary bypass tube system can be used in all open cardiac surgeries, and an appropriate length of the line can be easily cut out. This line is large, soft, elastic and sufficiently thick to form a protective cushion between the sternum and retractor. It easily molds around the sternal edge due to the initial tubal structure, making it suitable for the sternal edge. We believe that this technique is very simple, cheap, and effective for protecting the sternal bone during cardiac surgery, especially in patients with risk factors for sternal complications, such as old age, osteoporosis, fragile bones, fractures during sternotomy, and removal of sternal wires from previous cardiac surgeries.

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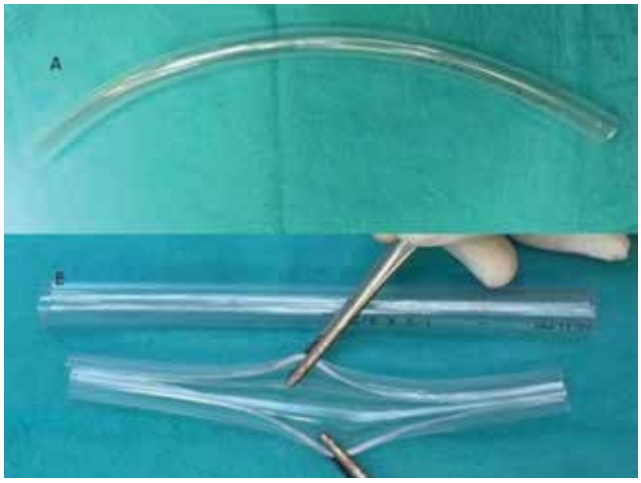

Figure 1 (**A**) Venous cannula line. (**B**) Two equal venous cannula lines which are longitudinally cut.

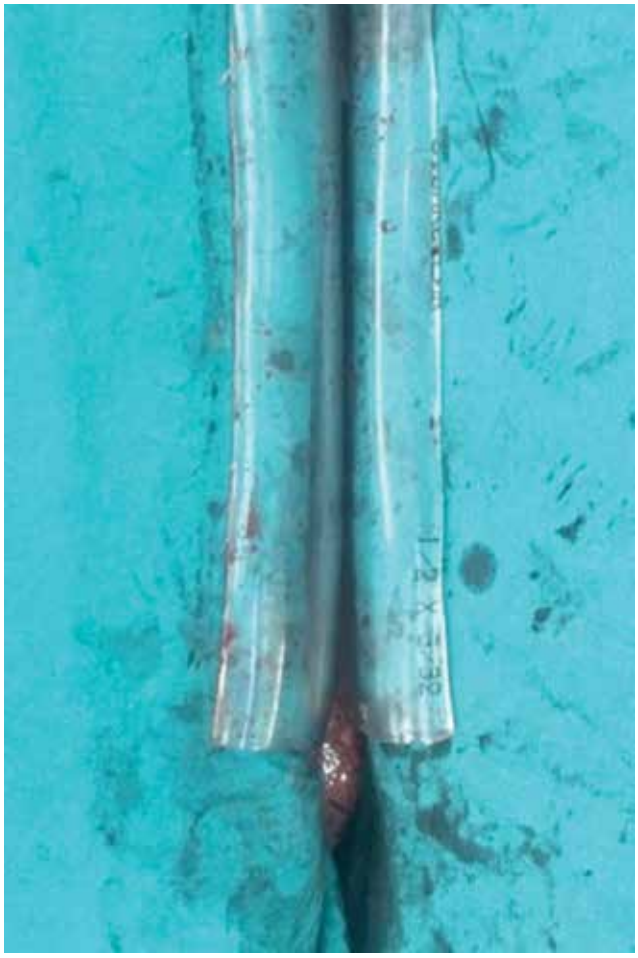

Figure 2. Prepared venous cannula lines are placed on the clothes.

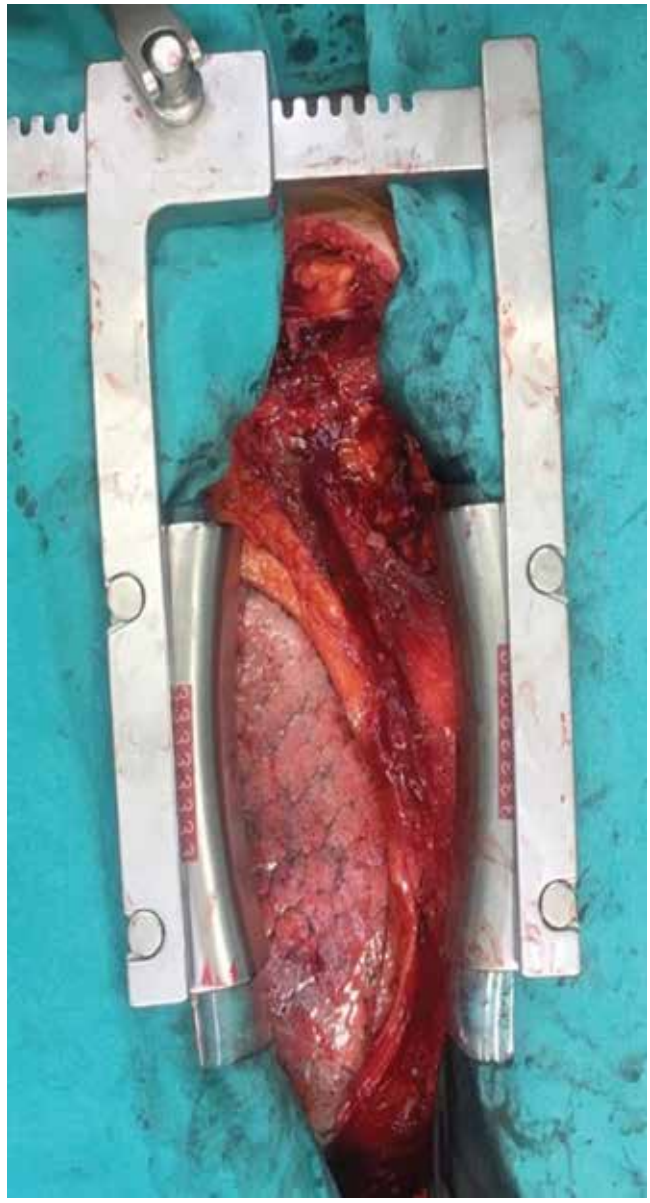

Figure 3. The venous cannula lines are between the sternum retractor and free edges of the sternum.

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Transkateter Aort Kapak İmplantasyonuna (TAVI) Anestezi Yaklaşımı

Anesthetist Approach to Transcatheter Aortic Valve Implantation (TAVI)

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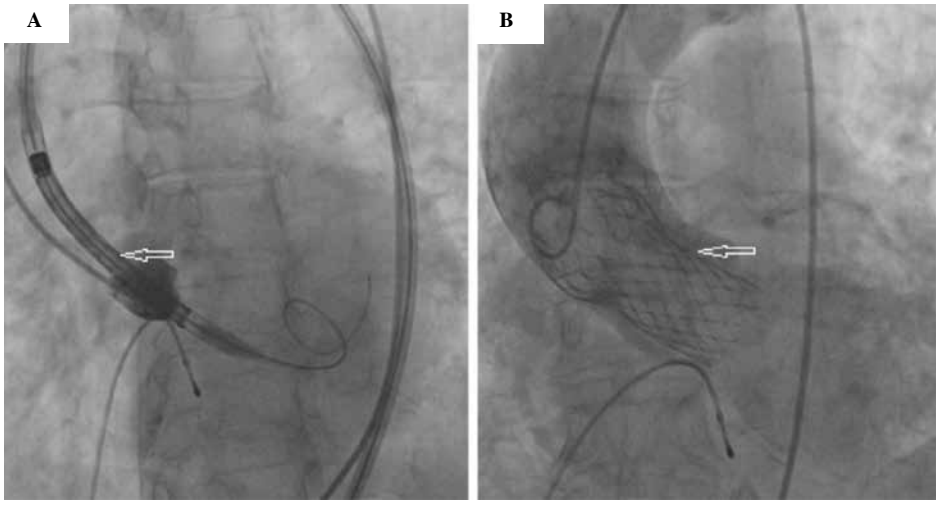
Aort stenozu en sık görülen kalp kapak hastalığıdır ve cerrahi aort kapak replasmanı ile tedavi edilir. Transkateter aort kapak implantasyonu (TAVI) son yıllarda cerrahi aort kapak replasmanına alternatif olarak ortaya çıkmış ve ciddi aort stenozu olan inoperable veya yüksek cerrahi riskli hastaların tedavisinde temel dayanak olmuştur (Resim 1A,B).

Hasta işlem öncesi kardiyoloji, anesteziyoloji ve kalp damar cerrahisi ekipleri ile birlikte değerlendirilmelidir. Bu işlemi olacak hastaların çoğu yaşlı ya da komorbiditesi yüksek hastalardır. Bu hasta grubu American Society of Anesthesiology (ASA) 3-4 olarak kabul edilirler. Anestezist hastayı ayrıntılı değerlendirmeli, olası komplikasyonlara karşı hazırlıklı olmalıdır. İşlem öncesi en az 2 ünite eritrosit süspansiyonu hazır bulundurulmalıdır. Ayrıca cerrahi ekip, perfüzyonist ve ameliyathane odası olası cerrahi müdahale için hazır bekletilmelidir.

Antitrombosit tedavi ile ilgili spesifik klavuzlar hala TAVI için mevcut olmamakla birlikte yaygın uygulama işlem öncesi 300 mg aspirin ve 300 mg klopidogrel uygulanması şeklindedir. İşlem sırasında 5000 İÜ heparin uygulanır ve ACT > 250 olması beklenir. Postoperatif dönemde 75 mg-100 mg aspirin ve 75 mg klopidogrel günlük dozu devam ettirilir. Böbrek yetmezliğinin önüne geçmek için bir gün öncesi kristalloidler ile hidrasyon sağlanmalıdır. Antihipertansif ilaçlar işlem gününe kadar devam ettirilmelidir.

Hasta monitörizasyonunda 5 elektrotlu EKG, pulse oksimetre, hasta sıcaklığı, kapnografi, mesane sonda kateteri ile saatlik idrar takibi, radiyal arter kateterizasyonu ile invaziv kan basıncı izlemi, aralıklı kan gazı takibi, harici defibrilatör pedleri, gerekirse santral venöz kateter takılması önerilir.

TAVI için anestezi tekniği seçimi yapılacak işlemin özelliğine, hastanın mevcut hastalıklarına, ekibin işlemdeki tecrübesine bağlı olarak değişebilir. Genel anestezi uygulaması



Resim 1(A,B). Kateter laboratuvarında transkateter aort kapak implantasyonu (TAVI) işlemi. **(A)** Kapak aort kapağına park edilmiş (Ok), **(B)** Kapak implantasyonu tamamlanmış (Ok).

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solunum kontrolü, hasta hareketsizliği, hemodinamik stabilite, transözefageal ekokardiyografi (TEE) kullanımına olanak sağlama, prosedürel komplikasyonların yönetimini kolaylaştırma ve arteriyel girişim yerlerinde cerrahi gereksinim durumunda avantajlıdır. Bununla birlikte genel anestezi uygulaması, işlemi gerçekleştirecek olan ekibin öğrenme eğrisi ile yakından ilişkilidir. Ekibin tecrübesi arttıkça lokal anestezi ve sedasyon kombinasyonu tercihi ön plana çıkmaktadır. Lokal anestezi ve sedasyon kombinasyonu nörolojik komplikasyonların erken tespiti, kısa işlem süresi, derlenmenin hızlı olması, postoperatif bakım gereksinimini azaltması gibi avantajlara sahiptir[1]. Prosedürün invazivitesi ve stabil bir hemodinaminin elde edilmesinin zor olması, sedasyonun başlıca kısıtlıklarıdır. Anestezi tercihi olarak lokal anestezi ve sedasyon kullanılsa da anestezist her an genel anestezi vermeye hazır olmalıdır. Mukherjee ve arkadaşlarının[2]. TAVI hastalarında torakal epidural anestezi uygulaması alternatif anestezi teknikleri sunmaktadır. Fakat bu teknik postoperatif devam eden antitrombosit ilaçlar nedeniyle tehlikeli bulunmaktadır.

Genel anestezi uygulamasında anestezik ajan seçimi değişebilir. İndüksiyonda genellikle midazolam, fentanyl, ketamin, etomidat, propofol kullanılır. Propofol dışındakiler kan basıncı ve kalp hızında klinik olarak önemli düşüşe sebep olmayan nispeten kardiyak stabil ajanlardır. Kas gevşetici olarakta rokuronyum tercih edilir. Bazen anestezi indüksiyonunda inotrop veya vazopressör desteği gerekebilir. Bu sebeple noradrenalin infüzyonu uygulamaya hazır halde bulunmalıdır.

Lokal anestezi kardiyolog tarafından iki kasık bölgesine %2'lik lidokain (maksimum 4 mg/kg) enjeksiyonu ile gerçekleştirilir. Sedasyon genelde birkaç ilacın kombinasyonuyla yapılır. Midazolam, propofol, fentanil ya da remifentanilin hedef kontrollü uygulamasını içerir. İlaçların dozaj ve uygulama hızı yaş, kilo, ASA fiziksel sınıflamasına göre bireyselleştirilir ve titre edilir.

Hemodinamik stabilite TAVI sırasında anestezik yöntemin ana hedefidir. Yeterli diyastolik doluma izin vermek için düşük kalp hızı (50-70 atım/dakika), yüksek kalp hızına (90 atım/dakika üzeri) tercih edilmeli ve sinüs ritmi korunmalıdır. Supraventriküler aritmiler ve ventriküler ektopi agresif olarak yönetilmelidir. Hipotansiyon gelişmesi durumunda α adrenejik agonistler tercih edilebilir[3].

Anestezist TAVI işlemi sırasında vasküler yaralanmalar, aritmiler, ritim-ileti blokları, böbrek yetmezliği, nörolojik komplikasyonlar, kardiyak tamponad, protez malpozisyonu, embolizasyon ve sol ana koroner arter oklüzyonu gibi potansiyel komlikasyonlara hazırlıklı olmalıdır[4].

Tüm hastalar işlem bitiminde koroner ya da kalp damar cerrahisi yoğun bakım ünitesine transfer edilmeli ve en az 24 saat gözlem altında tutulmalıdırlar.

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