Research Article (Araştırma Makalesi)

Evaluation of Postoperative Development of Saphenous Vein Graft Incision Site Infections in Patients Undergoing Isolated Coronary Artery Bypass Graft Surgery: A Single Center Experience

İzole Koroner Arter Baypas Greft Cerrahisi Sonrası Gelişen Safen Ven Greft İnsizyon Alanı Enfeksiyonlarının Değerlendirilmesi: Tek Merkez Deneyimimiz

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Özet

Amaç: Bu çalışmada, hastanemiz kardiyovasküler cerrahi kliniğinde son 12 yıl içinde yapılan izole koroner arter baypas greft cerrahisinden sonra gelişen safen ven greft insizyon alanı cerrahi alan enfeksiyonu olgularının, etken olan mikroorganizmaları, risk faktörlerini ve klinik özelliklerini ortaya koymak amacıyla değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntemler: Mart 2009-Kasım 2020 tarihleri arasında hastanemiz kardiyovasküler cerrahi kliniğinde izole koroner arter baypas greft cerrahisi yapılan ve postoperatif dönemde safen ven greft insizyon alanı enfeksiyonu gelişen ve cerrahi alan enfeksiyonu olarak kabul edilen toplam 34 hasta (23 kadın, 11 erkek; ort. yaş 68.0±9.0 yıl; dağılım 51-86 yıl) çalışmaya alındı. Çalışmaya dahil edilen hastaların demografik verileri, altta yatan hastalıkları, preoperatif, intraoperatif ve postoperatif risk faktörleri retrospektif olarak incelendi.

Bulgular: Yaklaşık 12 yıllık bir periyotta yapılan izole koroner arter baypas greft cerrahisinde safen ven greft insizyon alanı cerrahi alan enfeksiyonu oranı %0.8 olarak belirlenmiştir. Bunların 23'ü (%67.6) yüzeyel insizyonel cerrahi alan enfeksiyonu, 11'i (%32.4) derin insizyonel cerrahi alan enfeksiyonu olarak değerlendirilmiştir. Cerrahi alan enfeksiyonu gelişen hastalarda yaş, kadın cinsiyet, obezite, diabetes mellitus, sigara, acil cerrahi, 1'den fazla safen ven greft kullanımı, operasyon, kardiyopulmoner baypas ve aortik klemp sürelerinin uzun oluşu, intraoperatif kan transfüzyonu, yoğun bakım ünitesi'nde kalma süresi uzunluğu, inotrop kullanımı ve toplam hastanede yatış süresi uzunluğu anlamlı bulundu. Pürülan akıntı kültürlerinde üreyen mikroorganizmaların 18'ini (%53) Gram negatif bakteriler, 12'sini (%35.3) Gram pozitif bakteriler ve birini (%2.9) mantarlar oluşturmuştur. Beş (%14.7) hastada ise patojen mikroorganizma üretilemedi. Cerrahi alan enfeksiyonu tespit edilen hastalardan en sık izole edilen iki etken koagülaz negatif stafilokoklar (%17.6) ve Escherichia coli (%17.6) idi.

Sonuç: Kardiyovasküler cerrahi girişim geçiren hastalarda özellikle cerrahi alan enfeksiyonuna dikkat edilmelidir. Koroner arter baypas greft cerrahisi sonrası cerrahi alan enfeksiyonunun, risk faktörlerinin belirlenmesi, cerrahi tekniklerin modifikasyonu ve postoperatif dönemin sıkı tutulması ile azaltılabileceği akılda tutulmalıdır. Taburcu olduktan sonraki takip ve kişisel bakım önemlidir ve enfeksiyon ortaya çıktığında ampirik tedavi yaklaşımı hastanemizde önde gelen enfeksiyöz ajanların koagülaz negatif stafilokoklar ve E. coli olduğu dikkate alınarak belirlenmelidir.

Anahtar kelimeler: Cerrahi alan enfeksiyonu, Greft, Kardiyovasküler cerrahi, Safen ven

Abstract

Objective: This study aimed to evaluate surgical site infection patients developing saphenous vein graft incision site infection after isolated coronary artery bypass graft surgery performed in the cardiovascular surgery clinic of our hospital in the last 12 years to reveal the causative microorganisms, risk factors, and clinical characteristics.

Material and Methods: A total of 34 surgical site infection patients (23 females, 11 males; mean age 68.0±9.0 years; range 51-86 years) who underwent isolated coronary artery bypass graft surgery in the cardiovascular surgery clinic of our hospital between March 2009 and November 2020 and who postoperatively developed saphenous vein graft incision site infection were included in the study. The patients' demographic data, underlying diseases, and preoperative, intraoperative, and postoperative risk factors were analyzed retrospectively.

Results: In all isolated coronary artery bypass graft surgeries performed over a period of about 12 years, the rate of saphenous vein graft incision site surgical site infection was found to be 0.8%. Of these, 23 (67.6%) were evaluated as superficial incisional surgical site infection and 11 (32.4%) as deep incisional surgical site infection. In the patients who developed surgical site infection, the parameters of age, female sex, obesity, diabetes mellitus, smoking, emergency surgery, use of more than 1 saphenous vein graft, prolonged operation, cardiopulmonary bypass, and aortic clamp durations, intraoperative blood transfusion, length of stay in the intensive care unit, use of inotropes, and total length of hospital stay were all found to be significant. The microorganisms in purulent discharge cultures consisted of Gram-negative bacteria in 18 (53%), Gram-positive bacteria in 12 (35.3%), and fungi in 1 (2.9%). No pathogenic microorganism growth was observed in 5 (14.7%) patients. In the patients with surgical site infection, coagulase-negative staphylococci (17.6%) and Escherichia coli (17.6%) were the most frequently isolated agents.

Conclusion: Particular attention should be paid to surgical site infection in patients undergoing a cardiovascular surgery intervention. It should be noted that post coronary artery bypass graft surgery surgical site infection can be reduced by determining its risk factors, modifying surgical techniques, and postoperative close monitoring of patients. Follow-up and personal care are crucial after discharge and an empirical treatment approach should be determined when an infection occurs, taking into account that coagulase-negative staphylococci and E. coli were the two leading infectious agents in our hospital.

Keywords: Cardiovascular surgery, Graft, Saphenous vein, Surgical site infection

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INTRODUCTION

Coronary artery bypass graft (CABG) surgery provides good symptomatic improvement and long life expectancy in most coronary artery disease patients with a suitable vascular structure (1). Many complications can occur after CABG surgery. Among these complications, surgical site infections (SSI) are of particular importance. SSI ranks first (38%) among postoperative infections and third (14-16%) among nosocomial infections (2). Despite the increased use of arterial grafts in recent years, saphenous vein grafts (SVG) are still used to treat most patients undergoing isolated CABG surgery because multiple grafts are needed and they are easy to access (3). The standard conventional method for the removal of the saphenous vein has been open dissection with continuous or intermittent skin incisions. As it requires long incisions on and under the skin, wound complications are still one of the most important problems of cardiovascular surgery (CVS). SSI developing in the incision site due to the SVGs prepared during CABG surgery can prolong patients' postoperative periods, increase re-hospitalization, decrease quality of life by increasing pain, and negatively affect postoperative morbidity (4,5). The incidence of SVG incision site SSI after CABG surgery ranges from 1% to 24% (6-8). There is limited data on the risk factors and outcomes of these infections.

Therefore, this study aimed to evaluate SSI patients developing SVG incision site infection after isolated CABG surgery performed in the CVS clinic of our hospital in the last 12 years to reveal the causative microorganisms, risk factors, and clinical characteristics.

MATERIALS AND METHODS

Patient Selection and Demographic Characteristics

A total of 34 SSI patients who underwent isolated CABG surgery in the CVS clinic of our hospital between March 2009 and November 2020 and who developed SVG incision site infection postoperatively were retrospectively identified. The patients' age, sex, body mass index (BMI), preoperative hospitalization time, total hospital stay, history of diabetes mellitus (DM), renal failure, cerebrovascular event (CVE), congestive heart failure (CHF), immunosuppression, ejection fraction (EF), hypertension (HT), hyperlipidemia (HL), peripheral vascular disease (PVD), myocardial infarction (MI), smoking history, New York Heart Association (NYHA) functional class, nasal carriage of Staphylococcus aureus, and suitability of their antibiotic prophylaxis were recorded as preoperative risk factors. Their elective or emergency surgery status, ASA (American Society of Anesthesiology) physical condition classification score, use of internal mammarian artery (IMA), use of multiple SVGs, blood and blood product transfusion, operative time, cardiopulmonary bypass time, and aortic clamp time were recorded as operative risk factors. Risk categories were determined for each operation and calculated in accordance with the National Nosocomial Infections Surveillance (NNIS) risk index (9). This index performs scoring based on the degree of contamination of the surgical site, the ASA score, and operation time. Mechanical ventilation time, length of stay in the intensive care unit (ICU), >72 hours of stay in the ICU, use of an intra-aortic balloon pump (IABP), and use of inotropes were retrospectively recorded from patient files as postoperative risk factors. A BMI of 30 and above was considered as a basis for obesity (10).

Surgical Preparation

The cleaning of patients' body hair in the surgical site was performed the night before the operation using a 3M Remington 9604 medical shaver device to prevent infection. We determined that the patients were made have bath with hibitanol antiseptic solution the night before the operation (for elective operations). The surgical sites were sterilized with 10% povidone iodine before the operation. All patients received surgical prophylaxis, as is routinely performed in our clinic. The patients were given cefazolin sodium 1-2 g intravenously (3 times a day) starting 60 minutes before the operation and for 48 hours postoperatively, alternatively cefuroxime 1.5 g intravenously (twice a day).

Surgical Technique

The extremity (right/left, lower/upper) for SVG preparation was recorded. SVG was prepared by a classical incision starting anteriorly to the medial malleolus. Saphenous vein was dissected continuously without using cotherization. Surgical area of the saphenous vein was closed during the period of heparinization, and all the patients with above knee saphenous vein dissection were placed small surgical drain near surgical incisions of the above knee wound. Both the grafts and the venous side branches were ligated using 4/0 silk sutures. The veins were inflated with low-pressure using heparinized isotonic sodium chloride to check for leaks and to prevent venous spasm. Bleeding control was performed

by ligation throughout the dissection. The subcutaneous tissue was closed up with 2/0 absorbable suture and the skin was closed up with 3/0 absorbable suture. Then, the leg was intraoperatively wrapped with a sterile elastic bandage from the wrist to the groin. The removal of SVG by open surgery was often in parallel to the removal of mammarian arteries by a different surgical team. No endoscopic technique was used on any patient for the removal of SVGs.

Postoperative Care and Follow-Up

Bandages were removed at the postoperative 24th hour and incisional dressings were applied by the relevant surgeon daily during hospitalization. Povidone-iodine 10% was used during dressing. No additional product or dressing was used for wound care. All patients wore medium-pressure compression socks up to the groin. Compression socks were worn until the 3rd postoperative month. The patients were routinely invited to the polyclinic follow up on day 10 and in the first month after discharge. SSI was diagnosed based on the definition criteria published by the Centers for Disease Control and Prevention (CDC) (11) and the National Nosocomial Infections Surveillance System (12). SVG incision site SSI was defined as either superficial incisional SSI or deep incisional SSI. Superficial incisional SSI was diagnosed in the presence of at least one of the followings: pain or tenderness, localized swelling, redness, and warmth in the incised skin or subcutaneous tissue, presence of purulent discharge. Deep incisional SSI was diagnosed in the presence of at least one of the followings: tenderness in the wound including deep soft tissue, muscle, and fascia, along with fever, pus or abscess, opening in the wound lips, exposure of deep tissues (13). The cultures taken from the purulent discharge in the surgical site and the microbiological examination notes for these materials were recorded. The isolated microorganisms and their antibiotic susceptibility were defined based on standard methods (14). Medical and surgical treatment and outcomes were recorded as clinical findings.

Statistical Analysis

Statistical data analysis was carried out using the IBM SPSS Statistics for Windows Version 24.0 (Statistical Package for the Social Sciences, IBM Corp., Armonk, NY, USA) package software. Appropriate data are presented as descriptive statistics (number and percentage) and data indicated by measurements are presented as mean, standard deviation. The patients with SVG incision site SSI and those without SVG incision site SSI were compared in terms of risk factors. A Chi-squared test was used for categorical variables. We performed a multivariate logistic regression analysis to reveal the independent variables in the patients with SSI in the SVG incision site.

The ethical approval for the study was obtained by the medical research ethics committee with the Decision number of 2019-19/5 at the meeting numbered 2019/19 and dated 05.12.2019. Our study was planned in accordance with the Helsinki Declaration.

RESULTS

A total of 4349 patients underwent isolated CABG surgery between March 2009 and November 2020 in the CVS clinic of our hospital and SVG was used on 4201 patients. Of the 34 patients included in the study, 11 (32.4%) were males and 23 (67.6%) were females. The mean age was 68.0±9.0 years (age range: 51-86 years). The patients' demographic data, underlying diseases, risk factors, and perioperative findings are presented in **Table 1**. There was no statistically significant difference between patients with and without SSI in terms of preoperative length of hospital stay, renal failure, history of CVE, CHF, immunosuppression, EF, HT, HL, PVH, history of MI, or NYHA functional class 3 or 4, all of which were considered as preoperative risk factors. There was a statistically significant difference in terms of age, sex, DM, high BMI, length of hospital stay, and smoking (**Table 1**). Regarding nasal carriage, preoperative nasal swab cultures were obtained from all patients and Staphylococcus aureus growth was observed in none.

There was a statistically significant difference in terms of emergency surgery status, blood or blood product transfusion, use of more than 1 SVG, operative time, cardiopulmonary bypass time, and aortic clamp time, all of which were considered as operative risk factors (**Table 1**). All operations were isolated CABG surgeries and SVG was removed from the right leg in 3290 (78.3%), from the left leg in 208 (5%), and from both legs in 703 (16.7%) of the cases. The left internal mammarian artery (LIMA) was used on all of our patients and more than 1 SVG was used on 31 (91.2%) of the patients.

All operations were evaluated as the clean wound class. Concerning the ASA scores, all patients were found to be ASA 3. The mean operative time of the patients developed SSI was 125.2±27.4 minutes. Accordingly, the NNIS risk index was calculated for each patient, with no statistically significant difference with SSI ($p>0.05$).

There was no statistically significant difference in terms of mechanical ventilation time and the use of IABP, but there was a significant difference in terms of use of inotrope, length of stay in the ICU, and ICU stay >72 hours, all of which were considered as postoperative risk factors (**Table 1**).

The multivariate logistic regression analysis showed that sex, age, smoking, DM, emergency surgery, ICU stay >72 hours, length of stay in the ICU, total length of hospital stay, use of inotrope, and use of >1 SVG were all determined to be independent risk factors for SSI in the SVG incision site (**Table 2**).

In isolated CABG surgery performed over a period of about 12 years, the rate of SVG incision site SSI was found to be 0.8%. These included 23 (67.6%) superficial incisional SSIs and 11 (32.4%) deep incisional SSIs. Cultures of purulent discharge were obtained from the surgical sites of all patients postoperatively. Wound debridement was performed on 11 patients with deep incisional SSI and cultures of purulent discharge were obtained from the surgical site. In the patients who developed postoperative SSI in the SVG incision site, the most frequent finding was the presence of prominent purulent discharge from the SVG incision site. This was followed by, fever in 16 (47%) patients, dehiscence in the incision site in 11 (32.3%) patients, and pain in the incision site in 30 (88.2%) patients.

Table 1. Demographic characteristics and preoperative and perioperative findings of patients

Characteristics	Patients with SSI, n=34	Patients without SSI, n=4167	p
Age (years)	68.0±9.0*	59.5±10.0*	<0.05
Female sex, n (%)	23 (67.6)	1569 (37.6)	<0.01
Obesity or BMI> 30 kg/m², n (%)	16 (47.1)	1305 (31.3)	<0.05
Diabetes mellitus, n (%)	19 (55.9)	1130 (27.1)	<0.01
Peripheral vascular disease, n (%)	1 (2.9)	85 (2.0)	>0.05
Renal failure, n (%)	1 (2.9)	103 (2.5)	>0.05
Congestive heart failure, n (%)	4 (11.8)	467 (11.2)	>0.05
Ejection fraction	60.0±8.73*	58.2±8.9*	>0.05
History of MI, n (%)	12 (35.3)	1435 (34.4)	>0.05
Hypertension, n (%)	12 (35)	1562 (37.5)	>0.05
Hyperlipidemia, n (%)	9 (8.8)	379 (9.1)	>0.05
Cerebrovascular event, n (%)	1 (2.9)	93 (2.2)	>0.05
Immunosuppression, n (%)	1 (2.9)	115 (2.8)	>0.05
Smoking, n (%)	13 (38.2)	1388 (33.3)	<0.05
NYHA 3 or 4, n (%)	6 (17.6)	668 (16)	>0.05
Emergency surgery, n (%)	3 (8.8)	201 (4.8)	<0.05
Use of >1 SVG, n (%)	31 (91.2)	3241 (77.8)	<0.05
Operative time (min)	125.2±27.4*	116.7±21.7*	<0.05
Cardiopulmonary bypass time (min)	73.2±28.7*	67.4±28.8*	<0.05
Aortic clamp time (min)	41.3±24.0*	36.4±16.1*	<0.05
Intraoperative blood transfusion, n (%)	26 (76.5)	2784 (66.8)	<0.05
NNIS risk index 2, n (%)	2 (5.9)	241 (5.8)	>0.05
Length of stay in the ICU (hours)	40.4±34.8*	28.1±12.3*	<0.01
>72 hours of stay in the ICU, n (%)	5 (14.7)	365 (8.8)	<0.05
Use of inotropes, n (%)	14 (41.2)	1390 (33.4)	<0.05
Use of intraaortic balloon pump, n (%)	-	18 (0.5)	>0.05
Mechanical ventilation time (hours)	5.7±2.1*	5.5±2.1*	>0.05
Total length of hospital stay (days)	7.3±3.6*	5.7±0.7*	<0.01
Preoperative length of hospital stay (days)	1.4±0.8*	1.4±0.8*	>0.05

*Mean ± standard deviation, BMI:Body Mass Index, MI:Myocardial Infarction, NYHA:New York Heart Association, NNIS:National Nosocomial Infections Surveillance, ICU:Intensive Care Unit, SVG:Saphenous Vein Graft, SSI: Surgical site infections

Table 2. Multivariate analysis results of risk factors for the development of SVG incision site SSI			
Variables	**p**	**OR**	**95% CI**
Body mass index (kg / m²)	0.104	0.564	0.283-1.126
Diabetes mellitus	0.006	2.36	1.28-4.35
Sex	0.009	0.257	0.123-0.538
Age	0.023	0.922	0.884-0.961
Smoking	0.005	2.743	1.362-5.523
Emergency surgery	0.008	0.005	0.001-0.018
>72 hours of stay in the ICU	0.009	0.60	0.14-0.248
Aortic clamp time (min)	0.908	1.001	0.984-1.019
Cardiopulmonary bypass time (min)	0.524	0.998	0.992-1.004
Use of >1 SVG	0.018	0.416	0.202-0.861
Operative time (min)	0.410	0.426	0.056-3.236
Intraoperative blood transfusion	0.309	0.991	0.973-1.009
Length of stay in the ICU (hours)	0.008	0.508	0.22-0.925
Use of inotropes	0.038	0.853	0.645-0.957
Total length of hospital stay (days)	0.027	1.002	0.927-1.215

OR: Odds Ratio, CI: Confidence İnterval, ICU: Intensive Care Unit, MI: Myocardial Infarction
SVG: Saphenous Vein Graft, SSI: Surgical site infections

Of the patients, 28 (82.4%) were diagnosed with SVG incision site SSI in the first month postoperatively, while 6 (17.6%) were diagnosed in the first three months postoperatively, with a mean diagnosis time of 27.2 days. All patients were treated with long-term parenteral antibiotics based on their culture antibiogram results and they all recovered and were discharged. None of the patients died. The mean treatment duration was 2-6 weeks.

Regarding the purulent discharge cultures, Gram-negative bacteria were isolated more dominantly than Gram-positive bacteria and fungi. The microorganisms grown in purulent discharge cultures consisted of Gram-negative bacteria in 18 (53%) patients, Gram-positive bacteria in 12 (35.3%) patients, and fungi in 1 (2.9%) patient. Single growth was detected in 26 (76.5%) patients and mixed growth was found in three (8.8%) patients. No pathogenic microorganism growth was observed in 5 (14.7%) patients. In the patients with SSI, the two most common isolated agents were coagulase-negative staphylococci (17.6%) and Escherichia coli (17.6%). The distribution of the microorganisms is presented in **Table 3**. Considering the antimicrobial resistance patterns in Gram-positive bacteria, methicillin resistance was found as 25% in Staphylococcus aureus strains and as 83% in CNS. No vancomycin resistance was detected in the enterococci. No carbapenem resistance was detected in Gram-negative enteric bacteria.

Table 3. Distribution of microorganisms in purulent discharge cultures [Number (%)].	
Microorganisms	**n (%)**
Coagulase-negative staphylococcus	6 (17.6)
Escherichia coli	6 (17.6)
Proteus mirabilis	4 (11.7)
Pseudomonas aeruginosa	4 (11.7)
Staphylococcus aureus	4 (11.7)
Klebsiella pneumoniae	3 (8.7)
Enterococcus spp.	2 (5.8)
Enterobacter cloacae	1 (2.9)
Stenotrophomonas maltophilia	1 (2.9)
Candida parapsilosis	1 (2.9)
No growth	5 (14.7)

DISCUSSION

Among the hospital infections (HI) that develop after CVS, SSI is most frequently reported and studied. SVG incision site SSI, which is observed after coronary artery bypass graft surgery, is a serious complication and its outcomes have not yet been adequately evaluated.

The incidence of developing SSI in the SVG incision site after coronary artery bypass graft surgery ranges from 1 to 24% in various publications (6-8). In a retrospective study by DeLaria et al. on 2545 CABG cases

using the saphenous vein, the incidence of SVG incision site SSI was reported to be as low as 1% (15). We found a rate of 0.8%, similar to the literature. The most likely reason for our low SSI incidence (0.8%) was due to the fact that the patients were closely followed up for HI postoperatively, ensuring early diagnosis and treatment when an infection is suspected in the surgical site.

Compared to the initial years of cardiovascular surgery, complications such as SSI are more common today, which is thought to stem from the increased number of more complicated operations that can be performed on the elderly and more risky patient groups with modern techniques. The risk of SSI is higher at advanced ages. Advanced age weakens the innate defense mechanisms (16). It has been reported that complications associated with the leg where an SVG is prepared are seen particularly in women after mobilization (17). However, there is no clear information as to why it is more common in women. Coronary artery disease often occurs in women in the postmenopausal period. Some researchers think that the changes in estrogen levels in women during this period impair wound healing. The correlation between female sex and the incidence of SVG incision site SSI depends on obesity, sex-related fat distribution, and microtrauma due to shaving and removal of leg hair. In our series, age and sex were found to be significant risk factors for the development of SSI.

Wound complications most commonly appear as SSI, neuropathy, or lymphocele, rarely requiring surgical intervention. However, some studies have reported debridement or amputation of the extremity at different levels, as well as some reporting death, although very rarely (18). Wound site complications increase morbidity, prolong the length of hospital stay, and increase hospital costs (2). In our study, the clinical manifestations consisted of superficial and deep SSIs and 11 patients underwent wound debridement. All patients were successfully treated with antibiotics. None of the patients died.

Particular attention should be paid to SSI in patients undergoing cardiovascular surgery. Given the increased mortality rates, prolongation of intensive care, and increased costs in patients with surgical site infection, having the knowledge of the risk factors of SSI and taking necessary precautions to reduce its incidence have been inevitable. Considering that age and diabetes are the leading factors of SSI occurrence, the significance of diabetes and glucose control comes to the fore. Due to the negative interaction with the development of cicatrization due to microvascular changes and high blood sugar, diabetes is a risk factor for the development of infection. In diabetic patients, the immune system cannot exhibit enough resistance to infectious agents due to the existing disease. The new hypothesis regarding the increased incidence of SSI in diabetic patients suggests that it is associated with uncontrolled blood glucose levels in contrast to congenital or acquired immune deficiency (19). We found DM to be a significant risk factor for SVG incision site SSI.

For patients developing with SSI, especially advanced age, female sex, obesity, peripheral vascular disease, and the use of intraaortic balloon pumps during intensive care have been found to play a role in the development of complications (15-20). SVG incision site SSIs are an important postoperative morbidity, particularly in obese patients and those with a high body mass index. The reasons for the higher risk of infection in obese patients include insufficient doses of prophylactic antibiotics used, difficulty of proper skin cleaning, adipose tissue creating an environment for infection, and difficulties in removing vascular grafts. In this patient group, the decreased blood flow in adipose tissue has been found to be associated with a higher incidence of deep incisional SSI following CABG surgery (2). Our study showed obesity to be a risk factor for the development of SVG incision site SSI.

Studies to date have reported that S. aureus carriage poses a high risk for all superficial SSIs (21). It has been reported that preoperative nasal carriage of S. aureus is found at a significant rate of 27% in cardiac surgery patients, which makes it an independent risk factor for the development of SSI in this population, increasing mortality (22). In the CVS department of our hospital, culture screening for nasal carriage of S. aureus is routinely performed for all patients preoperatively. We observed no S. aureus growth in the nasal swab cultures of our patients who developed SSI.

The most important source for SSI is the patient's own body flora. SSI occurs more frequently in patients with longer length of preoperative hospital stay since their body flora is deteriorated. Therefore, it is extremely important to clean the body with antiseptic solutions prior to surgery. We determined that patients were made have bath with hibitanol antiseptic solution the night before the operation (for elective operations). The mean length of preoperative hospital stay was 1.41 days. The length of preoperative hospital stay was not statistically significant in terms of SSI development.

Cleaning body hair preoperatively also plays a role in the development of SSI. Bacterial colonization occurs in microscopic incisions, increasing the risk of SSI further as the time between shaving and surgery increases. So, if the surgical site is to be shaved, it should be done just before the surgery using scissors, electric shavers, or hair removal creams instead of a razor or scalpel (23). In our study, the hair in the surgical site was cleaned the night before the operation using a 3M Remington 9604 medical shaver device in all patients (for elective operations).

Operations that lead to prolonged contact with the environment intraoperatively lead to longer durations of cardiopulmonary bypass and aortic clamping, increasing the negative effect of cardiopulmonary bypass on white cells and the risk of SSI development by increasing the possibility of contamination. In CABG surgeries, the use of bilateral IMA and using more than 1 SVG prolongs the operative time. The use of left IMA (LIMA) was present in all our patients. However, more than 1 SVG was used only on 31 patients. In our study, the duration of operation and cardiopulmonary bypass and aortic clamp time were found to be significantly different in patients with SVG incision site SSI compared to those without. This was associated with the multiple SVGs used in patients with SSI, increasing the probability of microorganisms to reach the surgical site due to longer operative times.

Another risk factor that causes SSI development is emergency operations. For patients undergoing emergency surgery, failure to clean the surgical site electively and ignoring asepsis-antisepsis rules due to rapid action are among the main reasons increasing the risk of SSI. In this study, emergency surgeries were performed on 3 patients, which was statistically significant in terms of SSI development.

The technique used to remove the SVG has an important role in the development of SSI. When preparing SVG by a classical incision, the incision starts from anteriorly to the inner malleolus and is extended upwards depending on venous graft requirement. However, this region has less supportive subcutaneous tissue and wound healing is therefore impaired. Various studies have reported that the highest rates of SSI after CABG surgery occur where the vein graft is removed, with the rate exceeding 15% (20-24). The use of endoscopic techniques has been reported for the preparation of SVG in various publications in the past 15 years (25). Many randomized studies have reported the positive aspects of endoscopic SVG removal. Endoscopic SVG removal has lower rates of wound infection and lower requirement for re-hospitalization compared to conventional open removal (26). In the present study, no endoscopic technique was used on any patient for SVG removal. Since it has begun to be used recently and only in a limited number of centers, further data on number of cases and experiences can help show that SSI is encountered less frequently using this technique.

Today, blood and blood product transfusions are often used in CABG surgery (27). Blood transfusions are thought to increase susceptibility to infection, particularly in patients undergoing cardiac surgery. One study investigated the correlation between postoperative infections and blood transfusion in cardiac surgery patients and found that the frequency of postoperative infections was increased in patients receiving 4 or more units of blood or blood products (28). Again, transfusion has been shown to be the best determinant in terms of postoperative infection (28). The study by Gol et al. (29) conducted in Turkey reported the use of blood as a risk factor for the development of infection in the postoperative period in patients undergoing cardiac surgery. In our study, the rate of blood transfusion intraoperatively was found to be 76.5%, making it significant in terms of the development of SVG incision site SSI. This increased risk may be caused by the immunosuppressive effect of blood transfusion. Moreover, the high number of SVGs used on patients with SSI led to more bleeding, increasing the requirement for blood transfusions.

Studies in the literature have used the NNIS risk index to determine the risk level for SSI. This scoring includes parameters related to ASA score, wound class, and operative time (30). In this study, the NNIS risk index was calculated for each patient, with no significant correlation in terms of SSI.

Another reason that may lead to contamination is non-sterile operating room air. Cultures taken from operating room air show that organisms are mostly concentrated above the operation table (31). A laminar flow ventilation system has been available for 12 years in the CVS rooms of our hospital. This system allows for sterile air to be delivered with pressure over the operating table, providing a continuous flow of sterile air and preventing dust and microorganisms from approaching the table. In addition, the internal doors of our operating rooms are automatic and are always kept closed between

entrances and exits. The CVS intensive care unit is within the operating room and no visitors are allowed. In the CVS unit, patients stay in single rooms. In our study, the appropriate physical conditions of our hospital were thought to contribute to our low SSI incidence.

Patients may require staying in intensive care for longer times due to reasons such as prolonged mechanical ventilator support or the requirement for IABP use postoperatively. Prolonged stay in intensive care leads to cutaneous and mucosal colonization with nosocomial pathogens, causing increased SSI postoperatively (32). In this study, the mean duration of postoperative mechanical ventilation time was 5.68 hours in patients with SSI and no IABP was used on any patient. The mechanical ventilation time and the use of IABP were found to be statistically insignificant in terms of the development of SSI, while the length of stay in the ICU was significantly higher compared to those without SSI.

It is known that patients undergoing cardiopulmonary bypass during open heart surgery have a higher susceptibility to infections due to the emergence of a secondary deficiency in the immune response postoperatively and greater likelihood for the entry of pathogenic agents. Gram-negative bacteria can contaminate the skin in the perineal region and take part in the temporary flora. Assuming that intraoperative wound contaminations are the cause for most infections, the primary pathogens in the perineal flora are pathogens in the development of leg infections (20). Because in most SSI cases, the greater the intraoperative contamination of the wound in the leg, the more Enterobacteriaceae and S. aureus are isolated (20). As in previous studies, we found microorganisms to be similarly significant as the factors described previously, with Gram-negative bacteria consisting most of these (20). The microorganisms in purulent discharge cultures consisted of Gram-negative bacteria in 18 (53%), Gram-positive bacteria in 12 (35.3%), and fungi in 1 (2.9%). It was seen that CNSs constituted 17.6% of Gram-positive bacteria, 83% of which were resistant to methicillin. It is noteworthy that CNS and Escherichia coli have constituted most of the microorganisms isolated from SVG incision site SSIs after CVS in our hospital for about 12 years.

In our study, we shared the SSI findings of a single center. We found that the main risk factors for the development of SSI were age, female sex, obesity, DM, smoking, emergency surgery, use of more than 1 SVG, operation, cardiopulmonary bypass, and long aortic clamp time, intraoperative blood transfusion, length of stay in the ICU, >72 hours of stay in the ICU, use of inotrope, and total length of hospital stay. Accordingly, our results were consistent with the general results in the literature. The CVS clinic should always require effective cooperation with the committee for infection control in terms of HI surveillance and infection control practices. More specific studies on this clinic can possibly help keep HI rates at lower levels. Having knowledge of the type, frequency, and antibiotic resistance of isolated infectious agents, determining the antibiotic use policies of various centers in light of this information and performing surgery on patients with deep SSI can significantly contribute to reducing morbidity and mortality rates, allowing us to create effective infection control strategies and thus increasing treatment success.

The limitations of this study are that one is single-center investigation with a small sample size, and the second is retrospectively.

In conclusion, particular attention should be paid to SSI in patients undergoing CVS interventions. It should be noted that SSI after CABG surgery can be reduced by determining its risk factors, modifying surgical techniques, and close follow-up of patients postoperatively. Follow-up and personal care after discharge are key, and an empirical treatment approach should be determined taking into account that CNS and E. coli were the leading infectious agents in our hospital when infection occurred. It is important for each center to reveal its own data of frequency and resistance, in order to decrease infection rates with the infection control measures and determine the antibiotic using policies.

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