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ORIGINAL ARTICLE

Evaluation of the Patients Developing Severe Pleural Effusion After Isolated Coronary Artery Bypass Operation

İzole Koroner Arter Baypas Operasyonu Sonrasında Ciddi Plevral Efüzyon Gelişen Hastaların Değerlendirilmesi

[1]Hakan Akbayrak, [2]Hayrettin Tekümit

[1]Department of Cardiovascular Surgery, Selçuk University Faculty of Medicine, Konya, Turkiye
[2] Department of Cardiovascular Surgery, Bandırma Onyedi Eylül University Faculty of Medicine, Balıkesir, Turkiye

Correspondence

Hakan Akbayrak, Department of Cardiovascular Surgery, Selcuk University Faculty of Medicine, Konya

E-Mail: hakanakbayrak@gmail.com

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ABSTRACT

Objective: In this study, we aimed to determine the causal relationship between isolated coronary bypass surgery development of severe pleural effusion in the early postoperative period.
Methods: In this study, 7862 isolated coronary artery bypass surgery cases conducted in our hospital between February 2001 and July 2013 were analyzed retrospectively. 175 (2.2%) patients developed early-severe pleural effusion were included in the study. The findings of 175 cases with early severe postoperative pleural effusion (Group A) were compared with the data of 180 cases (Group B) who had similar demographic findings and did not develop early-serious pleural effusion in the postoperative period.
Results: The mean age of these pleural effusion cases was 66.3±9.5 (55-76). 149 (85.1%) of the cases were operated under elective conditions and 26 (14.9%) of them were operated under emergency conditions. The mean cardiopulmonary bypass time of the cases was 70±28 (40-100) minutes. Left internal thoracic artery (LITA) and saphenous vein graft (SVG) were used together in 161 (92%) cases. Patients discharged after operation uneventfully. However, of the cases, 126 (72%) had shortness of breath, 115 (65.7%) dry cough, 28 (16%) productive cough, 50 (28.6%) tachypnea, 22 (12.5%) chest pain. Early severe pleural effusion developed in the left hemithorax in 154 (88%) of the cases. LITA+SVG was used in 148 (96.1%) of these cases, and only SVG was used in 6 (3.9%) cases. Early severe pleural effusion developed in the right hemithorax in 14 (8%) of the cases. LITA+SVG was used in 10 (71.4%) of these cases, and only SVG was used in 4 (28.6%) cases. The cases with bilateral early severe pleural effusion were 7 (4%). LITA+SVG was used in 3 (42.9%) of these cases, and only SVG was used in 4 (57.1%) cases. When the two groups were compared, Group A had significantly higher rates of low EF and atrial fibrillation than Group B.
Conclusion: It is known that coronary artery bypass surgery causes deterioration of postoperative pulmonary function. One of the most common complications of coronary artery bypass surgery is pleural effusion. It is known that this postoperative picture is associated with increased hospital readmission, rehospitalization and high postoperative morbidity. It is important to determine preoperative risks in terms of postoperative patient management and morbidity assessment.

Keywords: cardiac surgery; coronary artery bypass graft surgery; pleural effusion.

ÖZ

Amaç: Yapmış olduğumuz bu çalışmada, izole koroner baypas operasyonu yapılan ve erken postoperatif dönemde ciddi plevral efüzyon gelişen hastalarda, preoperatif ve operatif faktörlerin postoperatif plevral efüzyon ile ilişkisinin belirlenmesi amaçlandı.
Yöntemler: Bu çalışmamızda, Şubat 2001 ile Temmuz 2013 tarihleri arasındaki çalıştığımız kliniklerdeki opere edilen 7862 izole koroner arter bypass cerrahisi olgusu retrospektif olarak incelendi. Bu hastalardan 175 (%2.2) olguda erken-ciddi plevral efüzyon gelişti. Ameliyat sonrası erken şiddetli plevral efüzyon gelişen 175 olgunun (Grup A) özellikleri benzer demografik bulguları olan ve postoperatif dönemde erken-ciddi plevral efüzyon gelişmeyen 180 olgunun (Grup B) verileriyle karşılaştırıldı.
Bulgular: Plevral efüzyon gelişen olguların yaş ortalaması 66.3±9.5 (55-76) idi. Olguların 149 (%85.1)'u elektif şartlarda, 26 (%14.9)'sı ise acil şartlarda operasyona alındı. Olguların ortalama kardiyopulmoner bypass zamanı, 70±28 (40-100) dakikaydı. Olgulardan 161 (%92)'inde sol internal torasik arter (LİTA) ve safen ven greft (SVG) birlikte kullanıldı. Ameliyat sonrası hastalar sorunsuz taburcu edildi. Ancak taburculuk sonrası hastaların 126 (%72)'sı nefes darlığı, 115 (%65.7)'si kuru öksürük, 28 (%16)'i prodüktif öksürük, 50 (%28.6)'si takipne, 22 (%12.5)'i ise göğüs ağrısı şikayetleri ile tekrar başvurdu. Olguların 154 (%88)'ünde sol hemitoraksta erken ciddi plevral efüzyon gelişti. Bu olguların 148 (%96.1)'inde LİTA+SVG, 6 (%3.9)'sında ise sadece SVG kullanıldı. Olguların 14 (%8)'ünde sağ hemitoraksta erken ciddi plevral efüzyon gelişti. Bu olguların ise 10 (%71.4)'unda LİTA+SVG, 4 (%28.6)'ünde ise sadece SVG kullanıldı. Bilateral erken ciddi plevral efüzyon gelişen olgular ise 7 (%4) idi. Bu olguların 3 (%42.9)'ünde LİTA+SVG, 4 (%57.1)'ünde ise sadece SVG kullanıldı. Grup A'da Grup B'ye kıyasla düşük EF ve atriyal fibrilasyonun istatistiki olarak anlamlı şekilde fazla olduğu görüldü.
Sonuç: Koroner arter bypass cerrahisinin postoperatif pulmoner fonksiyonun bozulmasına neden olduğu bilinmektedir. Koroner arter bypass cerrahisinin en sık görülen komplikasyonlarından biri de plevral efüzyondur. Postoperatif oluşan bu tablonun yeniden hastaneye başvuru, hastaneye yeniden yatış ve operasyon sonrası yüksek morbidite ile ilişkili olduğu bilinmektedir. Postoperatif hasta yönetimi ve morbidite değerlendirilmesi açısından preoperatif risklerin belirlenmesi önem arz etmektedir.

Anahtar Kelimeler: kardiyak cerrahi; koroner arter bypass greft cerrahisi; plevral efüzyon

Introduction

It is known that coronary artery bypass surgery causes deterioration of postoperative pulmonary function. One of the most common complications of coronary artery bypass graft (CABG) surgery is pleural effusion. The incidence of pleural changes (pleural effusion or pleural thickening) after CABG is also high. It is known that this

postoperative picture is associated with increased hospital stay and high postoperative morbidity. Pleural effusion that develops early after CABG refers to effusions that develop within the first 30 days postoperatively (1). The incidence of pleural effusion has been reported to be between 42% and 87% (2). Early pleural effusions are generally of no clinical significance, asymptomatic, left-sided, small, and spontaneously regressing (1). However, approximately 10% of early pleural effusions may be severe enough to require thoracocentesis or tube drainage (involving more than 25% of any hemothorax) (2). In this study, we aimed to investigate the preoperative and operative factors of patients who underwent isolated coronary bypass surgery and developed severe pleural effusion in the early postoperative period after discharge.

Methods

Our study included isolated CABG cases operated in our clinics between February 2001 and July 2013. Early-severe pleural effusion developed in 175 (2.2%) of these patients. Our study was conducted retrospectively. This study was conducted within the framework of the Declaration of Helsinki, after obtaining permission from the Local Ethics Committee. In this study, 7862 isolated CABG cases operated in our clinics between February 2001 and July 2013 were retrospectively analyzed. Patients who developed pleural effusion after discharge were included in this study. For the purpose of diagnosis, standard posteroanterior and lateral chest radiography, ultrasonography, and computed tomography were utilized individually or in combination. Age, gender, complaints and physical examination findings, other clinical and pathological findings were noted from the files of the patients. The preoperative, operative and postoperative findings of 175 cases with early severe postoperative pleural effusion (Group A) were compared with the data of 180 cases (Group B) who had similar operative findings and did not develop early-serious pleural effusion in the postoperative period. Among 7862 patients, the group without pleural effusion was selected based on age, gender, and comorbid characteristics comparable to those of the group with pleural effusion.

Statistical analysis

Statistical analysis was performed with the IBM Statistical Package for Social Sciences (SPSS) version 21 software program. Conformity to normal distribution was evaluated with the Kolmogrov-Smirnov test. Continuous variables were expressed as mean ± standard deviation and minimum-maximum values, while categorical variables were expressed as numbers (n) and percentage (%). Categorical variables were compared with the chi-square test, and continuous variables were compared with the Student-t test and Mann-Whitney U test. $p<0.05$ was considered statistically significant.

Results

The mean age of the patients who developed pleural effusion was 66.3±9.5 (55-76) years. Of the cases, 102 (58.2%) were male and 73 (41.8%) were female. The mean body surface area (BSA) of the subjects in the study was 28.1±5.38 (22-34) kg/m2. The mean ejection fraction (EF) of the cases was 45.2±13.6 (28-55) percent. While 165 (94.3%) of the cases were in normal sinus rhythm (NSR), 10 (5.7%) were in atrial fibrillation rhythm. At the same time, 15 (8.5%) of the cases had peripheral artery disease and 63 (36%) had diabetes mellitus. There was a history of smoking in 123 (70.3%) cases. When both groups were compared, low EF and atrial fibrillation were found significantly higher in Group A compared to Group B (Table 1). In Group A, the rate of hospital readmission was 100% (n=175), however in Group B, it was 8.9% (n=16) ($p<0.001$). The rehospitalization rate was statistically higher in Group A (n=155, 88.6%) compared to Group B (n=4, 2.2%) ($p<0.001$).

The number of cases with renal dysfunction in the preoperative period was 17 (9.7%). 149 (85.1%) of the cases were operated under elective conditions and 26 (14.9%) of them were operated under emergency conditions. 126 (72%) of the cases were using acetylsalicylic acid in the preoperative period.

The mean cardiopulmonary bypass time (CPB) of the cases was 70±28 (40-100) minutes. LITA and SVG were used together in 161 (92%) cases (Table 2).

In the postoperative period, 14 (8%) patients developed low cardiac output (LCO), 7 (4%) patients developed pulmonary problems, 11 (6.2%) patients developed renal dysfunction, and 5 (2.9%) patients developed cerebrovascular accident (CVA). (Table 3).

126 (72%) of the cases presented with shortness of breath, 115 (65.7%) with dry cough, 28 (16%) with productive cough, 50 (28.6%) with tachypnea, and 22 (12.5%) with chest pain (Table 4).

When the percentage of cases with early severe pleural effusion in the hemithorax were evaluated, we found that 25%-50% in the LITA+SVG and SVG groups were concentrated in the group with effusion (Table 5).

Early severe pleural effusion developed in the left hemithorax in 154 (88%) of the cases. LITA+SVG was used in 148 (84.6%) of these cases, and only SVG was used in 6 (3.4%) cases. Early severe pleural effusion developed in the right hemithorax in 14 (8%) of the cases. LITA+SVG was used in 10 (5.7%) of these cases, and only SVG was used in 4 (2.3%) cases. The cases with bilateral early severe pleural effusion were 7 (4%). LITA+SVG was used in 3 (1.7%) of these cases, and only SVG was used in 4 (2.3%) cases (Table 6).

While early severe pleural effusion developed in the first 2 weeks postoperatively in 50 (28.6%) of the cases in our study, it developed within the 3rd and 4th weeks in 125 (71.4%) cases. Treatment was provided with thoracentesis in 160 (91.4%) of our cases, and with thoracic tube drainage in 15 (8.6%) cases. On

average, 728 ml (610-1470 ml) of fluid was drained from the pleura. Pleural fluid from 126 (72%) cases was sent for biochemical and cytological analysis. The fluids analyzed according to Light's criteria (2) were in transudate character and 35 (20%) were hemorrhagic.

Table 1. Demographic information of the cases and rates of existing comorbidities

	Group A (n=175)	Group B (n=180)	p
Age (year)	66.3±9.5 (55-76)	65.3±7.9 (54-74)	0.28
Male	102 (%58.2)	102 (56.7%)	
Female	73 (41.7%)	78 (43.3%)	0.84
BSA	28.1±5.38 (22-34)	28±4.9 (22-32)	0.85
EF (%)	45.2±13.6 (28-55)	55±11 (35-65)	<0.05
AF	10 (5.7%)	2 (1.1%)	<0.01
NSR	165 (94.3%)	174 (96.7%)	0.41
PAH	15 (8.5%)	13 (7.2%)	0.78
Smoking	123 (70.3%)	118 (65.6%)	0.4
COPD	21 (12%)	24 (13.3%)	0.83
DM	63 (36%)	68 (37.8%)	0.81
HT	70 (40%)	74 (41.1%)	0.92
Hospital readmission	175 (100%)	16 (8.9%)	<0.001
Rehospitalization	155 (88.6%)	4 (2.2%)	<0.001

(BSA: body surface area, EF: ejection fraction, AF: atrial fibrillation, NSR: normal sinus rhythm, PAH: peripheral artery disease, COPD: chronic obstructive pulmonary disease, DM: diabetes mellitus, HT: hypertension)

Table 2. Operative data of cases

	Group A (n= 175)	Goup B (n= 180)	P value
CPB (minutes)	70±28 (40-100)	67±22 (42-96)	0.26
X-clamp time (minutes)	54±20 (30-82)	55±17 (30-75)	0.61
Number of grafts	3.5±1.3 (2-6)	3.4±1.6 (2-6)	0.52
LITA+SVG	161 (92%)	170 (94.4%)	0.48
SVG	14 (8%)	10 (5.6%)	0.48

Table 3. Complication rates in postoperative cases

Group A (n=175)	
LCO	14 (8%)
Post-op pulmonary complication	7 (4%)
Post-op renal dysfunction	11 (6.3%)
Post-op CVA	5 (2.9%)
Post-op arrhythmia	29 (16.6%)

(LCO: low cardiac output, CVA: cerebrovascular accident)

Table 4. Patients' complaints after discharge

Group A (n=175)	
Shortness of breath	126 (72%)
Dry cough	115 (65.7%)
Productive cough	28 (16%)
Tachypnea	50 (28.6%)
Chest Pain	22 (12.6%)

Table 5. Percentage of patients with early severe pleural effusion in the hemithorax according to the type of graft used

Hemithorax Effusion Amount	LITA + SVG (n=161)	SVG (n=14)	Total (n=175)
25%-50%	135 (83.8%)	10 (71.4%)	145 (82.8%)
51%-75%	17 (10.6%)	2 (14.3%)	19 (10.9)
>76%	9 (5.6%)	2 (14.3%)	11 (6.3%)

LITA: left internal thoracic artery, SVG: saphenous graft

Table 6. Rates of grafts used in the operation and hemithorax with effusion

Effusion	LITA + SVG (n=161)	SVG (n=14)	Total (n=175)
Left side	148 (91.9%)	6 (42.8%)	154 (88%)
Right side	10 (6.2%)	4 (28.6%)	14 (8%)
Bilateral	3 (1.9%)	4 (28.6%)	7 (4%)

Discussion

It is known that coronary artery bypass surgery causes deterioration of postoperative pulmonary function. One of the most common complications of coronary artery bypass surgery is pleural effusion. The incidence of pleural changes (pleural effusion or pleural thickening) after CABG is also high. It is known that this postoperative picture is associated with increased hospital stay and high postoperative morbidity. Traumas occurring during surgery and blood entering the pleural space trigger the formation of pleural effusion. Surgical intervention triggers immunological reactions and creates pleural effusion (2). The incidence of pleural effusion after CABG has been reported between 42% and 87%. The frequency of such effusions that require thoracentesis or tube drainage is reported between 1% and 10% (2, 3).

Re-hospitalization of patients after CABG surgery is associated with adverse outcomes and significant healthcare costs, and the 30-day hospital readmission rate is considered an important indicator of quality of care. In a meta-analysis, pleural effusion is among the causes of hospital readmissions with a rate of 0.4-22.5% (4).

The presence of a pleural effusion is typically confirmed by posterior and lateral chest radiographs, but if there is any uncertainty, ultrasonography or computed tomography scans are definitive for detecting minor effusions. In the study conducted by Karolyi et al. (5) evaluating the benefit of adding computed tomographic angiography (CTA) taken in the early postoperative period to routine clinical studies in patient management after bypass surgery, although its clinical value has not yet been determined, pleural effusion was detected at a rate of 27%, in addition to other additional pathological findings, in the evaluation made with the images taken on the 6th postoperative day. CTA taken in the early postoperative period reveals a high frequency of respiratory system pathologies that affect patient management in the

clinic. The incidence of symptomatic large pleural effusions (>25% of hemithorax) detected within 30 days of surgery was shown as 3.1% in a retrospective study involving 356 patients (6). We used computed tomography, ultrasonography, and posteroanterior and lateral chest radiography on our patients either separately or in combination.

Merin et al. (7) in a retrospective study in which chest radiographs up to 10 days of 893 patients who had undergone CABG surgery were examined, advanced age, female gender, and presence of congestive heart failure were found as risk factors for pleural effusion in patients. In our study, atrial fibrillation and low ejection fraction were found more common in the preoperative period compared to the group with pleural effusion.

At the same time, there are studies showing that topical hypothermia applied during the operation causes pulmonary morbidity in addition to cardioplegia protection (8).

When the graft was harvested in patients who used only internal thoracic artery graft in addition to the selected graft, the comparison of the patients with and without opening the pleural space on the postoperative 5th day, at the discharge and at the 30th day after the discharge showed that the rate of pleural effusion and other pulmonary complications was reduced because the pleural space was not opened (9).

In another study comparing coronary artery surgeries performed with and without CPB, it was shown that gas exchange was better and early extubation was observed in cases performed without CPB, but there was no change in pleural effusion rates in the postoperative period (10).

In our study, we found our frequency of early (in the first 30 days postoperatively) severe (involving more than 25% of any hemithorax) pleural effusion frequency that required drainage in the postoperative period in isolated CABG cases was 2.2%.

Our study has some limitations. This study's primary limitation was its retrospective and observational design, which prevented generalization of the results. On the other hand, logistic regression analyses should be performed to determine the risk factors of postoperative pleural effusion. However, it was not possible for us to reach some data on a large number of patients in the wide range of dates in which the study was conducted. Selecting the control group presents an additional limitation. It was recommended to use propensity score matching to construct an artificial control group. However, we did not use this statistical technique in our analyses. Further prospective and randomized studies with a larger patient group and longer follow-up period are needed to lighten the postoperative pleural effusion and its risk factors.

In a conclusion, according to our results we think that low EF and atrial fibrillation are important risk factors for the development of early severe pleural effusion after isolated coronary bypass surgery. Determination of preoperative risk factors plays a decisive role in terms of postoperative patient management and morbidity.

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