Cardiovasc Surg Int 2020;7(2):70-75
http://dx.doi.org/DOI: 10.5606/e-cvsi.2020.824
www.e-cvsi.org
©2020 Turkish Society of Cardiovascular Surgery. All rights reserved.

Cardiovascular Surgery and Interventions

Original Article Open Access

# Effect of entering cardiopulmonary bypass prior to sternotomy on outcomes in redo open heart surgery

İhsan Peker[1], Orhan Gökalp[2], Yüksel Beşir[2], Levent Yılık[2], Hasan İner[2], Nihan Yeşilkaya[2], Şahin İşcan[1], Ali Gürbüz[2]

[1]Department of Cardiovascular Surgery, Izmir Katip Çelebi University Atatürk Training and Research Hospital, Izmir, Turkey
[2]Department of Cardiovascular Surgery, Izmir Katip Çelebi University, Faculty of Medicine, Izmir, Turkey

***Received:*** May 14, 2020 ***Accepted:*** June 30, 2020 ***Published online:*** July 28, 2020

***ABSTRACT***

**Objectives:** In this study, we aimed to investigate the effect of the initiation of cardiopulmonary bypass (CPB) before sternotomy on the postoperative outcomes in patients undergoing redo open heart surgery.

**Patients and methods:** A total of 104 patients (58 males, 46 females; mean age 48.2 years; range, 13 to 77 years) who underwent CPB via femoral cannulation before and after sternotomy between January 1990 and December 2016 were retrospectively analyzed. The patients were divided into two groups as those with femoral cannulation before sternotomy (Group 1, n=34) and those with sternotomy without femoral cannulation (Group 2, n=70). Both groups were compared in terms of pre-, intra-, and postoperative data.

**Results:** There was no significant difference in the pre- and intraoperative results between the groups. The rates of 24-h drainage, extubation time, length of intensive care unit and hospital stay, surgical revision for bleeding, the amount of blood transfusion, prolonged use of inotropic agents, and postoperative acute renal failure were significantly higher in Group 1.

**Conclusion:** Due to the lack of a significant difference in the pre- and intraoperative data of the patients and the absence of a positive contribution to the outcome of CPB before sternotomy, it is more reasonable to use this method in only high-risk patients for cardiac injury.

***Keywords:*** Cardiopulmonary bypass, redo open heart surgery, resternotomy.

Due to the rising number of cardiac interventions and increased life expectancy, the number of recurrent cardiac procedures has dramatically increased.[1] Patients undergoing cardiac reoperations are older and have also more comorbid factors. In addition, operation procedures are more complicated compared to the initial surgery. When it is decided that it is difficult and risky to reach the heart in terms of surgery after preoperative evaluation in patients scheduled for cardiac reoperation, cannulation of the femoral artery and vein is one of the methods which can be preferred. Patients with mediastinal adhesion (i.e., recent operations, mediastinitis, or mediastinal radiation), patent graft available, an enlargement in the ascending aorta, and severe right ventricular dilatation should be evaluated as the risky group. This procedure allows the surgical team to make a safe dissection and it is also thought that the patient has secured with the chance of starting cardiopulmonary bypass (CPB) at the onset of a sudden injury which may occur.

In the present study, we aimed to investigate whether the initiation of CPB via femoral arterial and venous cannulation prior to sternotomy affected the operative results of the patients scheduled redo open heart surgery.

## PATIENTS AND METHODS

In this retrospective study, a total of 104 patients (58 males, 46 females; mean age 48.2 years; range, 13 to 77 years) who underwent CPB via femoral cannulation before and after sternotomy between January 1990 and December 2016 were retrospectively analyzed. The patients with a previous cardiac surgery who underwent standard unicaval, bicaval, or femoral artery cannulation were included in the study. Those with axillary artery, subclavian artery and jugular

**Corresponding author:** İhsan Peker, MD. İzmir Katip Çelebi Üniversitesi Atatürk Eğitim ve Araştırma Hastanesi Kalp ve Damar Cerrahisi Kliniği, 35360 Karabağlar, İzmir, Türkiye.
Tel: +90 553 - 574 18 16 e-mail: ihsanpeker35@hotmail.com

***Citation:***
Peker İ, Gökalp O, Beşir Y, Yılık L, İner H, Yeşilkaya N, et al. Effect of entering cardiopulmonary bypass prior to sternotomy on outcomes in redo open heart surgery. Cardiovasc Surg Int 2020;7(2):70-75.

venous cannulation, and undergoing off-pump surgery were excluded from the study. The patients were divided into two groups as those with femoral cannulation before sternotomy (Group 1, n=34) and those with sternotomy without femoral cannulation (Group 2, n=70). Patient data were obtained from the hospital registry system. Data including baseline demographic and clinical characteristics of the patients and intra- and postoperative data were recorded. A written informed consent was obtained from each patient. The study protocol was approved by the Izmir Katip Çelebi University Atatürk Training and Research Hospital Ethics Committee. The study was conducted in accordance with the principles of the Declaration of Helsinki.

### Statistical analysis

Statistical analysis was performed using the IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation, median (min-max) or number and frequency. The distribution of the variables was analyzed using the Kolmogorov-Smirnov test. Independent samples t-test and Mann-Whitney U test were used to examine quantitative independent variables. The chi-square test was used to analyze qualitative independent variables, while the Fisher's exact test was performed to analyze data not suitable for chi-square test conditions. A $p$ value of <0.05 was considered statistically significant.

## RESULTS

There was no statistically significant difference in the preoperative characteristics such as age, EuroSCORE, ejection fraction, pulmonary artery pressure, smoking habit, hypertension, diabetes mellitus, chronic obstructive pulmonary disease, or chronic renal failure between the groups (p>0.05). However, the number of male patients was significantly higher in Group 1 (p<0.05) (Table 1). There was no statistically significant difference in the operative data of the patients (p>0.05) (Table 2).

In addition, the patients were compared in terms of the data obtained from postoperative intensive care unit and ward follow-up. There was no significant difference between the groups in terms

**Table 1**
Baseline demographic and clinical characteristics of patients

| | Group 1 (n=34) | | | | Group 2 (n=70) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | n | % | Mean±SD | Median | n | % | Mean±SD | Median | $p$ |
| Age (year) | | | 49.1±12.1 | 50.5 | | | 47.9±15.4 | 47.5 | 0.680* |
| Sex | | | | | | | | | 0.034† |
| Male | 24 | 70.6 | | | 34 | 48.6 | | | |
| Female | 10 | 29.4 | | | 36 | 51.4 | | | |
| EuroSCORE | | | 5.6±2.1 | 5.0 | | | 6.1±2.2 | 6.0 | 0.277‡ |
| Ejection fraction | | | 55.1±6.9 | 57.5 | | | 55.3±7.8 | 60.0 | 0.841‡ |
| Pulmonary artery pressure | | | 32.8±13.3 | 30.0 | | | 40.9±21.0 | 35.0 | 0.072‡ |
| Smoking habit | 18 | 52.9 | | | 27 | 38.6 | | | 0.165† |
| Hypertension | 16 | 47.1 | | | 23 | 32.9 | | | 0.161† |
| Diabetes mellitus | 7 | 20.6 | | | 10 | 14.3 | | | 0.377† |
| COPD | 3 | 8.8 | | | 6 | 8.6 | | | 0.966† |
| Chronic renal failure | 0 | 0.0 | | | 1 | 1.4 | | | 1.000† |
| LIMA use in first operation | 6 | 17.6 | | | 9 | 12.9 | | | 0.514† |
| Total surgery | | | | | | | | | 0.595† |
| 2 | 32 | 94.1 | | | 68 | 97.1 | | | |
| 3 | 2 | 5.9 | | | 2 | 2.9 | | | |

SD: Standard deviation; COPD: Chronic obstructive pulmonary disease; LIMA: Left internal mammary artery; * t-test; † Chi-square test; ‡ Mann-Whitney U test.

**Table 2**
Intraoperative data

| | Group 1 (n=34) | | | | Group 2 (n=70) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | n | % | Mean±SD | Median | n | % | Mean±SD | Median | *p* |
| Duration of operation (min) | | | 301.6±71.8 | 293 | | | 276.1±62.2 | 270 | 0.097† |
| Duration of CPB (min) | | | 139.3±48.3 | 132.5 | | | 132.2±54.0 | 117.0 | 0.262† |
| Duration of aortic cross-clamping (min) | | | 92.3±40.1 | 94.5 | | | 87.1±39.2 | 76.5 | 0.425† |
| Cardiac injuring during sternotomy | 2 | 5.9 | | | 1 | 1.4 | | | 0.249‡ |

SD: Standard deviation; CPB: Cardiopulmonary bypass; † Mann-Whitney U test; ‡ Chi-square test.

of the need for intra-aortic balloon pump support, premature mortality, and development of neurological complications (p>0.05). In Group 1, 24-h drainage, extubation time, the length of intensive care unit stay and discharge time, the need for postoperative revision surgery for bleeding, the amount of blood product use, prolonged use of inotropic agents, and postoperative acute renal failure development were significantly higher (p<0.05) (Table 3).

The rate of mitral valve replacement was found to be higher in Group 2 (p<0.05). However, there was no statistically significant difference between the two groups, when the first operations were compared (p>0.05). In addition, there was no significant difference in the time interval between the first operation and the second operation between the groups (Table 4).

## DISCUSSION

At the present time, open heart surgery has dramatically evolved owing to the increased experience and technological developments. With the increase in life expectancy, the number of patients with cardiac reoperations has been increasing day by day.[1] Patients who need cardiac reoperation are older and have also more comorbid factors. In addition, mediastinal exploration is thought to be more difficult in these patients. One of the preferred methods is the initiation of CPB through femoral cannulation before sternotomy to prevent the complications which may occur due to these factors. Therefore, the operation was started by the initiation of CPB via femoral cannulation before sternotomy for patients who were at risk for cardiac injury in our center.

**Table 3**
Postoperative data

| | Group 1 (n=34) | | | | Group 2 (n=70) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | n | % | Mean±SD | Median | n | % | Mean±SD | Median | *p* |
| 24-h drainage | | | 982.9±617.8 | 1000 | | | 735.3±680.1 | 535 | 0.022† |
| Blood product use (IU) | | 3.6 | 5.5 | 5 | | 1.3 | 2.3 | 2 | 0.000† |
| IABP use | 6 | 17.6 | | | 6 | 8.6 | | | 0.174‡ |
| Extubation time (h) | | | 23.2±19.7 | 17.5 | | | 18.6±20.7 | 14.0 | 0.009† |
| ICU staying (day) | | | 8.2±7.8 | 4.0 | | | 6.9±13.3 | 3.0 | 0.011† |
| Discharging time (day) | | | 19.5±12.5 | 16.0 | | | 12.3±9.6 | 8.0 | 0.000† |
| Bleeding revision operation | 19 | 55.9 | | | 8 | 11.4 | | | 0.000‡ |
| Prolonged use of inotropic agents (24 h) | 27 | 79.4 | | | 31 | 44.3 | | | 0.001‡ |
| Premature mortality (in 30 day) | 4 | 11.8 | | | 8 | 11.4 | | | 0.960‡ |
| Neurological complications | 6 | 17.6 | | | 8 | 11.4 | | | 0.358‡ |
| Postoperative ARF development | 12 | 35.3 | | | 9 | 12.9 | | | 0.008‡ |

SD: Standard deviation; IABP: Intra-aortic balloon pump; ICU: Intensive care unit; ARF: Acute renal failure; † Mann-Whitney U test; ‡ Chi-square test.

**Table 4**
Comparison of operations

| | Group 1 (n=34) | | | | Group 2 (n=70) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | n | % | Mean±SD | Median | n | % | Mean±SD | Median | *p* |
| Previous operation | | | | | | | | | |
| Mitral valve replacement | 9 | 26.5 | | | 30 | 42.9 | | | 0.107‡ |
| Other operations | 6 | 17.6 | | | 12 | 17.1 | | | 0.949‡ |
| Aortic and mitral valve replacement | 2 | 5.9 | | | 8 | 11.4 | | | 0.329‡ |
| Aortic valve replacement | 6 | 17.6 | | | 4 | 5.7 | | | 0.054‡ |
| Open mitral commissurotomy | 3 | 8.8 | | | 5 | 7.1 | | | 0.764‡ |
| Coronary artery bypass grafting | 8 | 23.5 | | | 11 | 15.7 | | | 0.336‡ |
| Duration between operations (month) | | | 103.2±109.7 | 60.5 | | | 91.4±78.3 | 79.5 | 0.760† |
| New operation | | | | | | | | | |
| Mitral valve replacement | 9 | 26.5 | | | 37 | 52.9 | | | 0.014‡ |
| Other operations | 11 | 32.4 | | | 8 | 11.4 | | | 0.009‡ |
| Aortic and mitral valve replacement | 1 | 2.9 | | | 4 | 5.7 | | | 0.537‡ |
| Aortic valve replacement | 6 | 17.6 | | | 8 | 11.4 | | | 0.385‡ |
| Open mitral commissurotomy | 0 | 0.0 | | | 3 | 4.3 | | | 0.222‡ |
| Coronary artery bypass grafting | 7 | 20.6 | | | 10 | 14.3 | | | 0.417‡ |

SD: Standard deviation; † Mann-Whitney U test; ‡ Chi-square test; Other operations include aortic valve repair, atrial septal defect Repair, Bentall procedure, supracoronary aortic replacement, pericardiotomy, Tetralogy of Fallot, tricuspid valve replacement, ventricular septal defect patchplasty.

In the light of this information, the idea of making a serious preoperative evaluation before the onset of cardiac reoperation is in the foreground. Apart from the standard approach, we are confronted with the literature on the advantages and disadvantages of various techniques such as computed tomography (CT), magnetic resonance imaging (MRI), transesophageal electrocardiography (TEE), and nuclear MRI.[2-6] Among them, we believe that CT plays an important role in the preoperative evaluation of patients scheduled for cardiac reoperation. However, we do not recommend CT to be used routinely for the reasons of financial burden and time lost. In our clinical practice, we prefer using it in patients in whom the internal mammary artery was used as a graft in the previous operation, patients who have risk factors on their chest X-ray, and those exposed to sternotomy at least two times previously.

It is thought that the initiation of CPB via femoral cannulation prior to the sternotomy leads to a complete evacuation of the heart without compromising the hemodynamic parameters during the sternotomy, allows an easier dissection, and causes less injury to the mediastinal structures and less bleeding. Review of the literature reveals that the initiation of CPB before resternotomy may avoid heart injuries, leading to hemodynamic disturbance along with heart decompression and allows a safer and easier dissection.[7,8] However, some authors have reported that re-entry injuries which can be occurred during redo open heart surgery do not produce any significant differences, when compared to the initial sternotomy.[7-11] In our study, three patients in the total of two groups had cardiac injury which did not impair hemodynamics during resternotomy. There was no statistically significant difference between the two techniques, consistent with the literature data.

There are many studies in the literature regarding the parameters related to postoperative mortality and morbidity. In a study, Merin et al.[12] reported a mortality rate of 9%, while O'Brien et al.[10] reported a mortality rate of 2.9% and Salehi et al.[2] reported a mortality rate of 3%. In our study, the mortality rate was found to be 11.8%, indicating no statistically significant difference between the two groups. These findings are consistent with the current literature. In addition, based on these findings, we conclude that the comparison of the duration of operation and the duration of CPB is of utmost importance for redo open heart surgery patients. In the literature, the only study comparing two techniques reported that the duration of operation was statistically significantly shorter in the group in which CPB was initiated before resternotomy, while the duration of CPB

was found to be longer in the group without CPB before resternotomy.[13] In our study, we observed no statistically significant difference in this respect. Therefore, we believe that the duration of femoral cannulation preparation is short and that our clinic has sufficient surgical experience in peripheral cannulation.

On the other hand, Luciani et al.[13] found that the patients who underwent CPB prior to resternotomy were less likely to have postoperative bleeding and prolonged use of inotropic agents. Again, in the same study, the patients were found to have shorter periods of the intensive care unit stay. In our study, Group 1 was found to have higher values of postoperative 24-h drainage, prolonged inotropic support need, and surgical revision for bleeding. This can be attributed to the fact that coagulopathy can be more frequent due to prolonged systemic heparinization. However, in our study, unlike Luciani et al.,[13] the duration of extubation, length of intensive care unit stay, and discharge time were significantly higher in the patients who underwent CPB before resternotomy. We believe that this is due to the higher amount postoperative bleeding and the increased need for blood product use in our study.

In the present study, the primary objective was to investigate the effect of CPB before resternotomy on postoperative mortality and morbidity. In addition, there are many studies in the literature reporting the mortality and morbidity rates in patients requiring resternotomy.[10-12,14] Yet, in our study, the mortality rate was found to be 11.6%, indicating no statistically significant difference between the two groups. These findings are consistent with the current literature. Furthermore, postoperative mortality and morbidity were examined in the study of Luciani et al.,[13] which is the only study comparing the patients who did and did not receive CPB before resternotomy, as in our study. According to this study, the mortality, stroke, myocardial infarction, sepsis, and lung failure rates were similar in both groups. Unlike our study, in this study, acute renal failure was found to be more frequent in patients who did not receive CPB prior to resternotomy. In our study, the development of acute renal failure was found to be statistically significantly higher in the group of patients who underwent CPB before resternotomy. We believe that this difference in our study is the result of a higher amount of blood products used due to the greater amount of bleeding in the patient group who underwent CPB prior to sternotomy. Based on many studies, it was shown that increasing need for blood use increased the rate of deterioration of renal function.[15,16]

The complications which may develop after femoral cannulation have been discussed in many studies. These include vascular injury, hematoma, pseudoaneurysm, lower extremity ischemia, and wound infections.[13] In our study, no complication was encountered in the patient group in which the femoral artery cannulation was performed.

The main limitation of our study is its retrospective design with a relatively small sample size. However, we believe that our study is valuable, as it shows the differences in initiation of CPB before resternotomy compared to the conventional method.

In conclusion, patients who are scheduled for resternotomy are at a particular risk than those who are scheduled for surgery for the first time. Therefore, preoperative management of these patients is crucial. Starting of CPB prior to resternotomy may reduce the risk of cardiac injury and help surgeons feel more secure. However, it should be taken into account that there may be adverse effects on postoperative results, particularly due to the increased amount of bleeding and the use of blood. Nevertheless, the initiation of CPB should be considered as an alternative for patients who are at risk for preoperative cardiac injury.

**Declaration of conflicting interests**

The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

**Funding**

The authors received no financial support for the research and/or authorship of this article.

## REFERENCES

1. Escaned J. Secondary revascularization after CABG surgery. Nat Rev Cardiol 2012;9:540-9.
2. Salehi M, Bakhshandeh AR, Saberi K, Alemohammad M, Sobhanian K, Karamnezhad M, et al. Resternotomy, a single-center experience. Asian Cardiovasc Thorac Ann 2017;25:13-7.
3. Karthekeyan R, Selvaraju K, Ramanathan L, Rakesh M, Rao S, Vakamudi M, et al. Retrospective study of redo cardiac surgery in a single center. IJA 2006;12:1-6.
4. Elahi MM, Kirke R, Lee D, Dhannapuneni RR, Hickey MS. The complications of repeat median sternotomy in paediatrics: six-months follow-up of consecutive cases. Interact Cardiovasc Thorac Surg 2005;4:356-9.

5. Roselli EE. Reoperative cardiac surgery: challenges and outcomes. Tex Heart Inst J 2011;38:669-71.
6. Cremer J, Teebken OE, Simon A, Hutzelmann A, Heller M, Haverich A. Thoracic computed tomography prior to redo coronary surgery. Eur J Cardiothorac Surg 1998;13:650-4.
7. Sabik JF 3rd, Blackstone EH, Houghtaling PL, Walts PA, Lytle BW. Is reoperation still a risk factor in coronary artery bypass surgery? Ann Thorac Surg 2005;80:1719-27.
8. Singh AK, Stearns G, Maslow A, Feng WC, Schwartz C. Redo sternotomy for cardiac reoperations using peripheral heparin-bonded cardiopulmonary bypass circuits without systemic heparinization: technique and results. J Cardiothorac Vasc Anesth 2011;25:347-52.
9. Morales DL, Zafar F, Arrington KA, Gonzalez SM, McKenzie ED, Heinle JS, et al. Repeat sternotomy in congenital heart surgery: no longer a risk factor. Ann Thorac Surg 2008;86:897-902.
10. O'Brien MF, Harrocks S, Clarke A, Garlick B, Barnett AG. How to do safe sternal reentry and the risk factors of redo cardiac surgery: a 21-year review with zero major cardiac injury. J Card Surg 2002;17:4-13.
11. Yau TM, Borger MA, Weisel RD, Ivanov J. The changing pattern of reoperative coronary surgery: trends in 1230 consecutive reoperations. J Thorac Cardiovasc Surg 2000;120:156-63.
12. Merin O, Silberman S, Brauner R, Munk Y, Shapira N, Falkowski G, et al. Femoro-femoral bypass for repeat open-heart surgery. Perfusion 1998;13:455-9.
13. Luciani N, Anselmi A, De Geest R, Martinelli L, Perisano M, Possati G. Extracorporeal circulation by peripheral cannulation before redo sternotomy: indications and results. J Thorac Cardiovasc Surg 2008;136:572-7.
14. Rodewald G, Guntau J, Bantea C, Kalmar P, Krebber HJ, Rödiger W, et al. The risk of reoperation in acquired valvular heart disease. Thorac Cardiovasc Surg 1980;28:77-88.
15. Gokalp O, Eygi B, Besir Y, Iner H, Gokalp G, Yilik L, et al. Effects of blood transfusion on long-term survival of cardiac surgery patients. Ann Thorac Surg 2017;104:371-2.
16. Gökalp O, Kestelli M, Yürekli İ, Beşir Y, Yılık L, Yaşa H, et al. Effect of the use of fresh frozen plasma in cardiac surgery on the postoperative serum creatinine values. Turk Gogus Kalp Dama 2011;19:490-4.