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Coronary artery bypass grafting after iatrogenic coronary artery dissection: A single center eight years' experience

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SOUHRN

Kontext: Iatrogenní disekce koronární tepny během diagnostické nebo terapeutické katetrizace představuje vzácnou a smrtelnou komplikaci, která může vést k rozvoji dalšího infarktu myokardu. Cílem této studie je podělit se o výsledky léčby koronárním bypassem (coronary artery bypass grafting, CABG) u pacientů s iatrogenní disekcí koronární tepny po koronarografickém vyšetření (coronary angiography, CAG) na naší klinice.
Metody: Retrospektivně byly analyzovány údaje všech pacientů, u nichž byla v období mezi lednem 2014 a prosincem 2021 v naší nemocnici provedena CAG nebo perkutánní koronární intervence (PCI); do studie byli zahrnuti i pacienti s CABG po iatrogenní disekci koronární tepny. Disekce se hodnotila pomocí klasifikace National Heart, Lung and Blood Institute (NHLBI).
Výsledky: Během uvedených osmi let byla CAG provedena u 20 398 pacientů a PCI u 9 583 pacientů. Koronární bypass pro iatrogenní disekci koronární tepny bylo nutno provést u 17 pacientů (0,06 %). K disekci kmene levé věnčité tepny došlo u 6 (35,3 %) pacientů, přední sestupné větve u 6 (35,3 %), circumflex tepny u 2 (11,8 %) a pravé věnčité tepny u 3 (17,6 %). U 3 pacientů (17,6 %) překročila doba intubace 48 hodin. Jeden z těchto pacientů nedávno předtím prodělal onemocnění covid. U dalšího pacienta došlo k rozvoji otoku plic. Jiný pacient zemřel 4 dny po operaci v důsledku nízkého srdečního výdeje. Doba pobytu na jednotce intenzivní péče činila 2 (min.: 1 – max.: 13) dní; celkově v nemocnici 6 (min.: 4 – max.: 20) dní.
Závěr: Vývoj kritického klinického stavu před chirurgickým výkonem těsně souvisí s vyšší pravděpodobností úmrtí v časné a pozdní pooperační době. Z toho jasně vyplývá, že jakákoli léčba v každém období před operací, během ní a po ní představuje nejdůležitější determinantu konečného výsledku.

Keywords:
Cardiac surgery
Complications
Coronary angiography
Coronary artery bypass grafting
Coronary artery dissection
Iatrogenic coronary artery dissection

ABSTRACT

Background: Iatrogenic coronary artery dissection during diagnostic or therapeutic catheterization is a rare and mortal complication that may result in a newly developed myocardial infarction. In this study, we aimed to share the results of CABG treatment of patients with iatrogenic coronary artery dissection after coronary angiography (CAG) in our clinic.
Methods: All patients who underwent CAG or percutaneous coronary intervention (PCI) in our hospital between January 2014 and December 2021 were analyzed retrospectively and patients who underwent CABG after iatrogenic coronary artery dissection were included in the study. The dissection classification was achived according to the National Heart, Lung and Blood Institute (NHLBI) classification.
Results: During the eight years, CAG was applied to 20,398 patients and PCI to 9583 patients. Needed to treat CABG in iatrogenic coronary artery dissection developed in 17 of the patients (0.06%). LMCA was dissected in 6 (35.3%) patients and LAD in 6 (35.3%), CX in 2 (11.8%) and RCA dissection in 3 (17.6%). 3 patients (17.6%) had an intubation time longer than 48 hours. One of them has recently had a COVID infection. Another was suffering from pulmonary edema. The other patient died on the 4th postoperative day due to low cardiac output. The length of stay in the intensive care unit was 2 (min: 1 – max: 13) days. The hospital stay was 6 (min: 4 – max: 20) days.
Conclusion: The development of a critical clinical condition prior to surgery is strongly associated with a higher probability of early and late postoperative death. For this reason, it is clear that the treatments applied at every stage of the pre-, per-, and postoperative period are the most important determinants of the results.

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Introduction

Iatrogenic coronary artery dissection during diagnostic or therapeutic catheterization is a rare and mortal complication that may result in newly developed myocardial infarction (MI).[1] The frequency of iatrogenic left main coronary artery (LMCA) dissection during coronary angiography has been reported as <0.1%. Depending on the size of the dissection flap and luminal occlusion, the clinical presentation may vary from an asymptomatic angiographic finding to hemodynamic deterioration.[2] Therefore, after the complication, conservative treatment could be enough or a patient may require treatment with percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG). Complications following percutaneous coronary intervention are usually successfully managed in the catheterization laboratory, but some complications may require immediate surgical intervention.[3,4] In such patients, myocardial infarction (MI) develops during the procedure, and as a result, they may need high-dose inotropic agent support, intra-aortic balloon pump (IABP), and extra corporeal membrane oxygenation (ECMO) to correct hemodynamic deterioration. Although emergency CABG is the most common treatment strategy in such cases where hemodynamic stability is not achieved but the 30-day mortality rate following a successful CABG remains at a high level of 26%.[5] In this study, we aimed to share the results of CABG treatment of patients with iatrogenic coronary artery dissection after coronary angiography (CAG) in our clinic.

Methods

In our study, all patients who underwent CAG or PCI in our hospital between January 2014 and December 2021 were analyzed retrospectively and patients who underwent CABG after iatrogenic coronary artery dissection were included in the study. The dissection classification was achived according to the National Heart, Lung and Blood Institute (NHLBI) classification.[2] Patients who are followed up or underwent PCI or died without undergoing CABG after coronary dissection were excluded from the study. If the patients had previous CABG or need an additional valve surgery were also excluded from the study (Fig. 1).

The information of the patients included in the study was obtained from the hospital data system and patients files. Baseline patients characteristics (age, hypertension, diabetes mellitus, previous PCI, chronic kidney failure), preoperative and postoperative ejection fraction (EF%), preoperative CABG time, number of vessels applied, postoperative death, stroke, MI, renal failure, intensive care unit stay and hospital stay were evaluated.

Definition of NHLBI and indication of CABG

According to NHLBI coronary artery dissection classification, Type C dissections appear as contrast outside the coronary lumen ("extra luminal cap") with persistence of contrast after dye has cleared from the lumen. Type D occurs as spiral ("barbershop pole") luminal filling defects, often with excessive contrast staining of the false lumen. Type E represents as new, persistent filling defects within the coronary lumen. Type F occurs those that lead to total occlusion of the lumen without distal antegrade flow. Patients with Type C–F were treated with balloon angioplasty or PCI in the same session. When residual stenosis was less than 30% and if the thrombosis in myocardial infarction (TIMI) 3 flows maintained procedure is considered successful. The patients who did not succeed in the interventional procedure were referred to CABG.

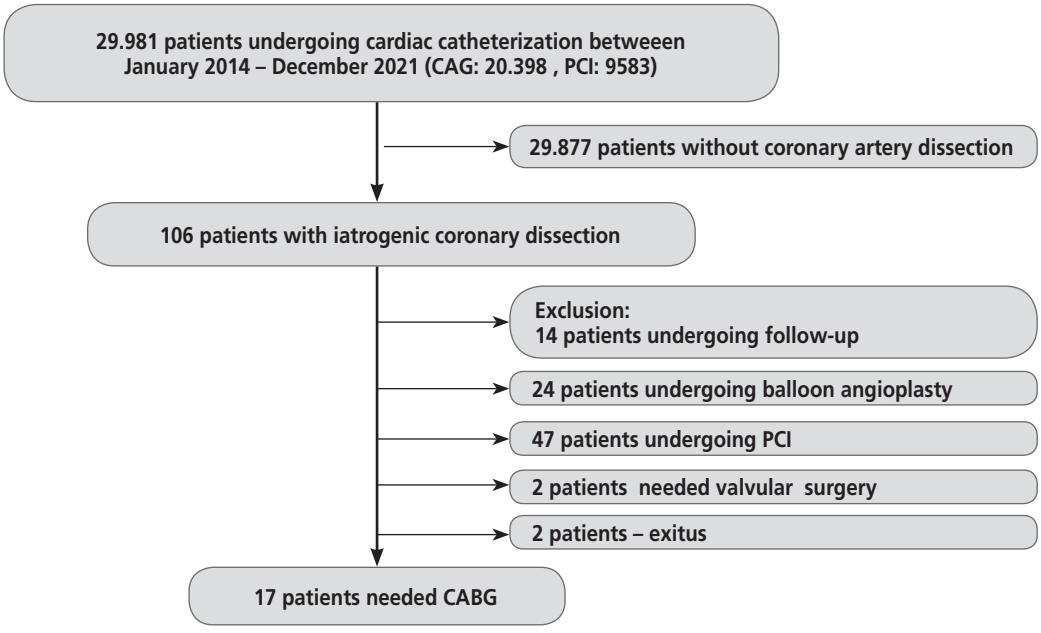

Fig. 1 – Study flow chart. CAG – coronary angiography; PCI – percutaneous coronary intervention.

In addition, if there is an indication for CABG according to the ESC Guidelines in patients who developed coronary artery dissection during diagnostic CAG, these patients were also referred to CABG.

The patients are treated with on-/off-pump CABG, depending on the patient's hemodynamic status and the surgeon's preference. Our clinical preference is off-pump CABG in hemodynamically stable patients and beating heart on pump or conventional CABG in unstable patients.

Procedure of CABG

All operations were performed with median sternotomy. Standard cannulation has been performed if it was an on--pump CABG surgery by placing arterial cannula in the ascending aorta and two-stage cannula in the right atrium. 100 IU/kg of heparin was administered intravenously to start extracorporeal circulation. A membrane oxygenator, a roller pump therefore a non pulsatile flow were used during cardiopulmonary bypass. We aim to achieve a nasopharyngeal temperature of 32 °C (mild hypothermia) and a hematocrit value of 22–24% (moderate hemodilution). During cardiopulmonary bypass, mean blood pressure of a patient was maintained over 60 mmHg and a pump flow at 2.4 l/m^2/min. Cardiac arrest was achieved with antegrade (and also with retrograde if it is needed) potassium blood cardioplegia (10 ml/kg) to preserve the myocardium after cross-clamping. If the left internal mammary artery was a suitable graft it used as the last distal anastomosis on the left anterior descending artery. After taking cross clamp off, proximal anastomoses were performed under side clamping on the beating heart in all operations.

If it is an off-pump surgery, we still harvested the left internal mammary artery and 100 IU/kg heparin to achieve adequate anticoagulation (activated coagulation time of >250 s). The pericardium was dissected widely for proper cardiac positioning. Also a deep pericardial traction suture was placed in two thirds of the posterior pericardium to be able to elevate the base of heart by avoiding any injury to the phrenic nerve, the esophagus or the pulmonary lobe. The pericardium in the right aspect was incised widely to position the heart into the pleural space. To achieve the optimal visualization of the target vessels especially in the lateral and inferior aspect, the operating table was placed in the right decubitus Trendelenburg position. We prefer a cardiac positioning system that allows lifting the heart with preserved functional geometry without pushing the apex of the heart (Maquet ACROBAT stabilizer and XPOSE positioner; Maquet GMBH & Co, Rastatt, Germany). To be able to achieve a clean surgical field we routinely use a CO_2 insufflator. After a short waiting time after heparinization we perform arteriotomy and place an intracoronary shunt into the artery (Medtronic Inc., MN, USA). We perform the anastomosis using interrupted 7-0 Prolene sutures and remove the shunt from the coronary artery just prior to the completion of anastomosis. When all distal anastomoses were completed we suture proximal anastomoses onto the aorta using 6-0 Prolene sutures under a side-biting clamp. Total operation time, target arteries, and number of anastomosis are recorded. After the surgery is completed, we transfer all patients to the intensive care unit (ICU) with intubation.

Statistical analysis

The data were analyzed with SPSS v21. Descriptive statistical categorical variables were expressed in frequency (n) and percentage (%), while numerical variables were expressed in mean standard deviation.

Results

During the period of study, CAG was applied to 20,398 patients and PCI to 9583 patients. A need to treat CABG in iatrogenic coronary artery dissection developed in 17 of the patients (0.06%). Thirteen (76.4%) of these patients were male. In 12 (70.6%), hypertension was accompanied. Eight (47%) of these patients had a previous history of PCI. Dissection has developed during diagnostic angiography in 2 (11.8%) patients and during performing PCI in 15 (88.2%) patients. The dissection classification of these patients was done according to the NHLBI. Type C dissection was seen in 1 (5.9%) patient, Type D lesion in 2 (11.8%), Type D dissection in 6 (35.3%), Type E dissection in 8 (47%) patients. LMCA was dissected in 6 (35.3%) patients and LAD in 6 (35.3%), CX in 2 (11.8%) and RCA dissection was carried out in 3 (17.6%) (Table 1).

Considering the clinical condition of the patients and the type of dissection, the timing of the operation also varied. 9 patients (52.9%) were operated on urgently, 8 patients (47) were operated as an emergency. The procedure was performed as off-pump CABG in 10 patients (58.8%), and as on-pump CABG in 7 patients (41.2%). 5 vessel CABG was applied to 1 patient (5.9%), 4 vessels to 2 patients (11.8%), and 3 vessels to 4 patients (23.5%). On-pump CABG was applied to 1 patient with 5 vessels, 2 patients with 4 vessels, 2 patients with 3 vessels, and 2 patients with 2 vessels. Intra-aortic balloon pump was needed in 7 of the patients (41.2 %). 4 (23.5%) of them were applied preoperatively and 3 (17.6%) were applied per-operatively (Table 2).

In the postoperative period, 1 patient (5.9%) was re-operated on the same day due to bleeding. There was bleeding caused by the incision of the aortic cannula and it was repaired. No complications developed afterwards. 3 patients (17.6%) had an intubation time longer than 48 hours. One of them has recently had a COVID infection. Another patient suffered from pulmonary edema. The other patient died on the 4th postoperative day due to low cardiac output. The length of stay in the intensive care unit was 2 (min: 1 – max: 13) days. The hospital stay was 6 (min: 4 – max: 20) days. Patients came to the routine postoperative controls on the 14th day and it was observed that one patient had no ventilation sounds in the left lung during auscultation. The patient was hospitalized and the left lung was drained with pleurocan. Another patient applied to the emergency room with dyspnea in the 3rd month postoperatively. It was observed that patients had low EF and non-adherence to medica-

Table 1 – Baseline demographics

Patients	Median (min–max)	Mean ± SD	n (%)
Age (years)		68.7±10.5	
Male			13 (76.4)
Hypertension			12 (70.6)
Diabetes mellitus			6 (35.3)
Insulin-treated diabetes			3 (17.6)
Smoking			11 (64.7)
Hyperlipidemia			8 (47)
Renal insufficiency			4 (23.5)
Hemodialysis			1 (5.9)
Prior MI			7 (41.2)
Prior CVE			1 (5.9)
Prior PCI			8 (47)
PVD			3 (17.6)
COPD			3 (17.6)
EF (%)	30 (20–60)		
Procedure type			
Diagnostic CAG			2 (11.8)
PCI			15 (88.2)
Vascular access			
Radial			5 (29.4)
Femoral			12 (70.6)
Dissection vessel			
LMCA			6 (35.3)
LAD			6 (35.3)
CX			2 (11.8)
RCA			3 (17.6)
Dissection type (NHLBI classification)			
C			1 (5.9)
D			2 (11.8)
E			6 (35.3)
F			8 (47)

CAG – coronary angiography; COPD – chronic obstructive pulmonary disease; CVE – cerebrovascular event; CX – circumflex artery; EF – ejection fraction; LAD – left anterior descending artery; LMCA – left main coronary artery; MI – myocardial infarction; NHLBI – National Heart, Lung and Blood Insitute; PCI – percutaneous coronary intervention; PVD – peripheral vascular disease; RCA – right coronary artery.

tion. The patient was rehospitalized and discharged on the 3rd day with adequate diuretic therapy. Acute renal failure developed in 3 patients. 1 patient required hemodialysis and another one required hemofiltration. The patient who needed hemofiltration was discharged with normal renal functions. 4 patients (23.5%) had POAF and 2 of them returned to sinus rhythm with medication and 1 with cardioversion. One patient was discharged with AF after no hemodynamic problems were found. In the 2nd

Table 2 – Peroperative data

Patients	Median (min–max)	Mean ± SD	n (%)
Urgent			9 (52.9)
Emergency			8 (47)
CPB			
On-pump			7 (41.2)
Off-pump			10 (58.8)
Need for inotropic agent			11 (64.7)
Blood transfusion (ES)	2 (0–8)	1±0.7	
IABP			7 (41.2)
Preoperative using			4 (23.5)
Peroperative using			3 (17.6)
Total CPB time	53 (24–87)	Mean ± SD	
Cross clamp time	23 (9–38)	Mean ± SD	
Number of grafts			
One vessel			4 (23.5)
Two vessels			6 (35.3)
Three vessels			4 (23.5)
Four vessels			2 (11.8)
Five vessels			1 (5.9)

CPB – cardiopulmonary bypass; ES – erythrocyte suspension; IABP – intra-aortic baloon pump.

Table 3 – Postoperative data

Patients	Median (min–max)	Mean ± SD	n (%)
Reoperation for bleeding			1 (5.9)
On ventilator ≥48 h			3 (17.6)
Postoperative EF (%)			
In-hospital	35 (20–60)		
After 90 days	42 (25–60)		
Length of ICU stay (days)	2 (1–13)		
Length of hospital stay (days)	6 (4–20)		
Re-hospitalization			2 (11.8)
Postoperative AKI			3 (17.6)
New-onset dialysis--dependent			2 (11.8)
Postoperative AF			4 (23.5)
Postoperative stroke			1 (5.9)
Postoperative MI			0
Postoperative PCI			0
Re-CABG			0
Postoperative mortality			
In-hospital mortality			2 (11.8)
In 30 days			2 (11.8)
In 180 days			2 (11.8)

AF – atrial fibrillation; AKI – acute kidney injury; CABG – coronary artery bypass grafting; EF – ejection fraction; ICU – intensive care unit; MI – myocardial infarction; PCI – percutaneous coronary intervention.

month follow-ups, it was observed that this patient was also in sinus rhythm. 1 patient (5.9%) had a transient ischemic attack. It was observed that there was also a loss of strength (4/5) in the right upper extremity. This patient was operated on urgently. It was observed that he had a carotid lesion in the postoperative carotid doppler imaging. 2 patients died postoperatively due to low cardiac output as a result of diffuse anterior myocardial infarction on postoperative day 1 and day 4 (Table 3).

Discussion

Coronary artery dissection may rarely develop during diagnostic or therapeutic interventional procedures.[6] While it may be sufficient to just follow up a patient with a coronary artery dissection without any intervention, CABG is needed in some patients.[7] Although it is the type of CADx that determines such a difference in terms of indications, the clinical conditions and hemodynamics of the patients are also the main determinants. While there are many studies about the cause of iatrogenic coronary artery dissection or the interventional treatment, there are not enough studies on the surgical treatment.[4,5,8–10] In this study, we shared the management, treatment planning, and results of patients with CABG after coronary artery dissection during coronary angiography.

There are some studies that it was thought the catheter selection and how these catheters are used is related with coronary artery dissection. Considering the results of these studies, it was stated that choosing the right catheter to be used according to the angle of the ostium of coronary artery with the aorta is important. In addition, it has been observed that the diameter of the catheter must be in accordance with the ostial diameter of the coronary artery, the catheter should not advance too far towards the ostium during imaging or intervention. It should be placed in the right axis and the catheter should not be dampened, or contrast injection must not be given with high pressure.[11] After all, we think that the patient's coronary ostium diameters should play a role in the selection of the catheter and that having enough experience in the use of catheters is also required. In addition, we believe that it would be more accurate to use automatic devices to give contrast injection instead of trying to adjust pressure manually.

In a study, it was seen that there is no difference in radial or femoral access as a risk factor.[12] The reason for the proportional difference with the access site in the studies was that the clinic performing the catheterization has an approach priority depending on their experience. In our study, the femoral artery was used in 12 (70.6%) patients and the radial artery was used in 5 patients (29.4%). We do not think that the proportional difference here is due to the access region. Since the femoral approach is mostly preferred as a catheterization site, it was concluded that there was a proportionately higher rate of femoral artery access.

In most studies, iatrogenic LMCA dissection appears to be <1%.[7] As a result of diagnostic or therapeutic catheterization, the rate of dissection in LMCA and RCA was 0.14%. In the same study, approximately 90% of dissections occurred during PCI and it was approximately 20 times more likely to occur during PCI compared to CAG.[13] In our study, 15 (88.2%) of the iatrogenic coronary artery dissection patients who needed CABG occurred during PCI and 2 (11.8%) during CAG. Overall, the risk of developing coronary artery dissection while performing PCI was 15 times higher than CAG in our study.

When planning CABG after coronary artery dissection, the clinical condition and symptoms of the patient are kept in consideration. However, there is no clear treatment algorithm determined by the guidelines. Therefore, the dissection level of the patients was defined according to NHLBI.[2,12] According to these classifications, Type A and B dissections are more stable. Type C–F coronary dissections carry the risk of acute myocardial infarction. Therefore, intervention is recommended for these patient groups.[12] CABG is a good option in unstable patients, especially in patients whose true lumen cannot be fully defined. Since emergency intervention is an important issue in these cases, it is important that the cardiac surgery team is ready beforehand. In some centers, because the team gets ready, there is a tendency to perform PCI to provide hemodynamic stability.[14] Although there is no study in the literature to determine whether there is an advantage in patients who underwent PCI and CABG, the short term results were found to be acceptable with patients who underwent PCI.[12] Coronary artery dissection developed in 106 patients, and CABG was applied in 17 of them in our study. The main reason for this low rate is that the dissection has occurred in CX and RCA in most of the patients. These patient groups were treated with interventional methods or followed up if they are asymptomatic. CABG has been a priority in LMCA and LAD dissections, especially in patients with long segment dissections.

Timing of surgery is an important factor in patients who need CABG. In general, in cases of acute MI, there is a tendency to take CABG after cardiac enzymes have normalized if hemodynamics and patient clinic allow.[15,16] However, considering the symptoms of patients, it is obvious that there is an urgent need for intervention. In other studies, prolonged ischemia time was associated with MI and mortality in patients not admitted to emergency CABG.[2] In our study, 9 patients (52.9%) were taken to urgent CABG, while 8 patients (47.1%) were taken to emergency CABG. In order to undergo CABG operation under elective conditions after coronary artery dissection, it may be considered that the type of coronary dissection may be more asymptomatic, such as C–D, but even in these cases, the need for an emergency operation may arise. During the preoperative evaluation of the patients, IABP can be used to protect the hemodynamics of the patients and to reduce the myocardial burden.[13] In our study, we used IABP in 4 (23.5%) of the patients to be taken for emergency operation. Considering the patients who were taken to the emergency operation, IABP was used in one of every two patients.

Off-pump CABG was preferred in patients with CADx if they had a suitable vascular structure, stable hemodynamics for positioning, suitable diameters with the target vessel.[17,18] CPB triggers the formation of systemic inflammatory response syndrome (SIRS) through many

pathways such as the complement system, cytokines, coagulation-fibrinolysis cascade, endothelium and cellular immune system. Surgical procedure, contact of blood elements with the inner surface of the pump system in cardiopulmonary bypass, ischemia/reperfusion injury, hypothermia, endotoxemia, surgical stress and anesthesia are the causes of SIRS.[19] This inflammatory response may occur in the postoperative period with myocardial dysfunction, respiratory failure, renal and neurological disorders. It may be associated with complications such as bleeding diathesis, liver dysfunction, and even multiple organ failure (MOF).[20,21] At the same time, a cardiac-stunned heart may have difficulty with weaning from CPB. Therefore, in our study, 7 patients (41.2%) had on-pump surgery and 10 (58.8%) had off-pump. In our preference, we mostly decided according to the number of vessels to be bypassed and also depending on the primary surgeons decision. When we look at the patients who underwent on-pump, 1 patient (5.9%) had 5-vessel CABG, 2 patients (11.8%) 4-vessel CABG, 2 patients (11.8%) 3-vessel CABG, 2 patients (11.8%) 2-vessel CABG. According to our result, we observed that Cx which is the most difficult accessible coronary in off-pump surgery is in the common cluster.

Myocardial stunning (MS) is defined as a reversible myocardial damage, however, post-ischemic mechanical dysfunction can persist despite the adequate revascularization. So no matter how quickly we intervene, the probability of encountering a stunning situation after acute MI is high enough. It may take days or even weeks for the ventricle to return to normal function.[22] Considering our patients, since iatrogenic coronary artery dissection can cause unexpected myocardial infarction, the treatment of these patients is similar to the management of myocardial stunning process in addition to surgery. Therefore, inotropic support is indicated for these patient groups.[23,24,25]

The most commonly used and recommended vasoactive drugs as first-line therapy in the treatment of circulatory shock are dopamine and norepinephrine. These drugs act on both alpha and beta adrenergic receptors to varying degrees. Therefore, the effects of these drugs on cardiac output, another organ perfusion, peripheral circulation and cardiac contractility can be different.[26,27] These important agents used in cardiac surgery sometimes adversely affect the cardiac process by triggering arrhythmia. Therefore, the use of dopamine at low cardiac output after cardiac surgery triggered arrhythmia more compared to noradrenalin, necessitating additional protocols in the cardiac process and prolonged intensive care processes.[28] All of our patients needed inotropes. In inotropic treatment, dopamine, noradrenaline, and adrenaline were used, respectively. In our patients, atrial fibrillation developed in 4 patients during the intensive care stays. Three of these 4 patients were receiving both dopamine and noradrenaline infusions.

In addition to the support of inotropic agents in these patient groups, IABP should be considered at the appropriate time to minimize myocardial damage. Both bypass and myocardial ischemic times are also associated with increased dependence on inotropic support.[28] In our study, there were 11 patients (64.7%) receiving inotropic support which is a significantly high rate. When we focus on the subgroups of these patients, we discovered that there are hemodynamically compromised patients with advanced types of dissection and acute MI. 4 (23.5%) of these patients had IABP placed preoperatively. IABP was placed in 3 patients (17.6%) because of difficulty of weaning from CPB. In 2 patients who received IABP preoperatively, they were needed taken into the operation urgently due to the continuation of angina while they were receiving IABP support and maximum medical treatment.

While most patients are treated with percutaneous interventions after iatrogenic coronary artery dissection, we observed that patients with severe mortality are often treated with CABG. In patients undergoing CABG, the management of the surgical process is of great importance. After the development of coronary artery dissection, if percutaneous treatments are evaluated or even tried, the duration of myocardial ischemia is significantly prolonged. In this process, CABG planning should be done as quickly as possible according to both the hemodynamic and clinical conditions of the patients, and even inotropic agents and IABP may be required to protect hemodynamics. In the slightest hemodynamic instability or in the presence of any clinical complaints, an inotropic agent or IABP should not be hesitated to start, and the patient should be operated on as soon as possible. Preferring off-pump CABG during the operation to avoid myocardial ischemia and systemic inflammatory response brought about by CPB will yield better results in terms of patient clinic and cardiac function. On-pump CABG can be applied in patients who cannot tolerate off-pump surgery hemodynamically. We think that the use of IABP is beneficial to reduce cardiac preload and increase coronary nutrition at any stage. To terminate inotropic medication, IABP or mechanical ventilator support, the hemodynamic status of the patient should be considered carefully and rapid decisions should be avoided. While planning the medical treatment of the patients during discharge, the necessary medical treatment of heart failure should be added. It has been observed that especially in patients with low EF, if there is non-compliance with medical treatment, patients return to the hospital with complaints of pulmonary failure and diffuse edema. These results showed us that diuretics should be included in medical treatment. In addition, in the control echocardiogram of the patients postoperatively, it was observed that there was an increase in EF after surgery, although it was not statistically significant. Therefore, in patients in the acute stage, early CABG prevented myocardial ischemia and increased cardiac function by allowing the correction of EF.

When it comes to limitations of the study, our work is retrospective in nature and therefore susceptible to all its inherent weaknesses. However, our institute policy is to treat all patients with iatrogenic lesions, regardless of age and comorbidities, thereby greatly reducing selection bias. Although the sample size was relatively small, it is probably the largest study to include the patient undergoing corrective cardiac surgery for complications occurring during PCI. It is a descriptive study without a control group.

Conclusion

Iatrogenic coronary artery injuries requiring CABG after PCI or diagnostic angiography are associated with high operative mortality and prolonged hospital stays despite urgent surgical treatment. Patients who develop acute coronary occlusion during PCI have a poor long-term prognosis. The development of a critical clinical condition prior to surgery is strongly associated with a higher probability of early and late postoperative death. For this reason, it is clear that the treatments applied at every stage of the pre-, per-, and postoperative period are the most important determinants of the results.

Conflict of interest
No conflict of interest was declared by the authors.

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Ethical statement
Ethics committee approval was received.

Informed consent
Informed consent was obtained from the participants.

Authors' contribution
All authors read and approved the final version of the manuscript. All authors contributed equally.

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