Use of multiple artery grafts to ensure long-term graft patency in coronary bypass surgeries

Arterials grafts in CABG

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Abstract

Aim: When selecting a graft for coronary artery bypass surgery (CABG), it is necessary to consider the quality of life and life expectancy of the patient besides ensuring complete revascularization. Use of multiple artery grafts confers the advantage over venous grafts because of their longer patency rates. The aim of this study is to evaluate our experiences in the use of arterial grafts and draw attention to the use of multiple artery grafts. Accordingly, coronary bypass surgeries that we have performed by using multiple arterial grafts were reviewed in our study. Material and Method: Between January 2017 and December 2017, 10 patients (8 males average age: 52.75 2 females average age: 61) had undergone CABG surgery by using multiple arterial grafts. We used the left internal mammary artery (LIMA) and radial artery (RA) in 2 patients, LIMA and right internal mammary artery (RIMA) in 6 patients and LIMA-RIMA and radial artery in 2 patients. In 2 of these patients, a T-graft was constructed by anastomosing the proximal end of the free RIMA to the side of the attached LIMA. In all cases, the radial artery was proximally anastomosed to the aorta. All patients were followed up in the intensive care unit for 2 days. Patients were discharged from the hospital in 5-6 days on average. Results: Patients were evaluated in terms of operative mortality, cross clamp time, intensive care and hospitalization period, pain in the incision area, management of post-extubation saturation levels, postoperative complications, recurrent angina, myocardial infarction (MI) and reoperation. No complications were reported during the early period of our evaluations. Although low levels of saturation were detected during this time in patients for whom bilateral IMA was used, saturation increased in the following days with no complications. No sternal dehiscence or infections were observed in patients. Non-steroidal anti-inflammatory (NSAI) and paracetamol anti-analgesics were given to all patients. For measurement of incision area pain, a pain index test was implemented. Discussion: In patients, whose venous grafts are used following CABG, early period graft thromboses lead to repetitive interventional operations and increase in re-operations. Although the superiority of CABG operation versus stent operation is accepted for multiple vein patients, many cardiologists and patients carry objections against the repetitive interventional operations that may arise due to early graft failure and the consequent increase in early period mortality and morbidity risk. We believe that we can overcome these risks by use of multiple artery grafts which allow for a higher patency rate over the long term.

Keywords

Bilateral IMA; Radial Artery; Artery Graft; Graft Occlusion

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Introduction

When selecting a graft for coronary artery bypass surgery, it is necessary to consider the quality of life and life expectancy of the patient besides ensuring complete revascularization. Use of multiple artery grafts confers the advantage over venous grafts because of their longer patency rates. It has been almost 30 years since it was first proved by Loop et al. that there is a decrease in myocardial infarction, recurrent angina, and re-operation risk when an Internal Mammary Artery (IMA) graft is used instead of the saphenous vein in CABG operations [1,2,3,19]. Still today, patients are being followed up, now in their 2nd and 3rd decades post-surgery, with functionally intact IMA anastomoses. At present, the use of bilateral IMA or full arterial revascularization operations performed by using the radial artery is more advantageous than the grafts where the saphenous vein is used since these ensure long-term graft patency. They have also been shown to result in increased effort capacity in the early period and improved overall well-being. Despite all of these, the use of Bilateral IMA in developed countries is not more than 5% - 10% [2,3].

Previous studies have demonstrated that the development of atherosclerosis following the use of the radial artery is 5.3% more than when the IMA is used. When we consider that 50% of saphenous veins are thrombosed in the first 5 - 10 years, it becomes clear that the use of the radial artery as an alternative arterial graft in CABG operations is a better option [4,5].

Yet other studies have demonstrated that the use of bilateral IMA increases perioperative mortality, morbidity and operation duration while causing sternal wound site problems [6]. However, in an ongoing Arterial Revascularization Trial (ART), 3102 patients' IMA or Bilateral IMA were evaluated in 28 centers in 7 countries. Results spanning the past 10 years will be released by the end of 2018. According to the results of the first year, using a second IMA in CABG operations extends the operation time by 23 minutes on average. However, when analyzed in terms of death, stroke and myocardial infarction within both the first 30 days and by the end of one year, a significant difference was observed compared to the patients where single IMA was displaced [7].

In this study, we evaluated our experiences in multiple artery grafts usage and wanted to draw attention to the use of multiple artery grafts.

Material and Method

Between January 2017 and December 2017 ATHISAR INTERCONTINENTAL HOSPITAL. 10 patients (8 males with average age: 52.75 and 2 females with average age: 61) had undergone CABG surgery by using multiple artery grafts (Table 1). In the operations, the left internal mammary artery (LIMA) and radial artery (RA) were used in 2 patients, LIMA and right internal mammary artery (RIMA) were used in 6 patients and LIMA-RIMA and radial artery were used in 2 patients. In 2 of these patients, a T-graft was constructed by anastomosing the proximal end of the free RIMA to the side of the attached LIMA (Table 2). The radial artery was proximally anastomosed to the aorta. While carrying out the proximal anastomosis operation, attention had to be paid to ensure that the proximal end of the radial artery was positioned in a proper manner as to avoid it from getting splayed over the aorta too broadly and would not create tension on that region. Patients were followed up in the intensive care unit for 2 days after which they were transferred to inpatient ward and discharged in 5-6 days, on average. Pain index test was applied to patients at post-op days 2 and 5 [1]. The patients were asked to rate the pain around the median sternotomy incision line from 1 to 10 based on the severity and frequency of the pain, with 1 being the least severe and least frequent, and 10 being the most severe and most frequent. Patients were evaluated in terms of operative mortality, cross clamp time, intensive care and hospitalization period, pain in the incision area, saturation follow-up after extubation, postoperative complications, recurrent angina, MI and re-operation. Both IMA grafts prepared during CABG were pedicled. To avoid spasm subsequent to radial artery preparation from the left

Table 1. Demographic and operative data

Patients	Age/ gender	operation	graft anastomose targets	Pain index	PaSO2
1	38/M	cabgx4	lıma-lad,radial –d1	40-4	94
2	55/M	cabgx2	lıma-lad,radial-Cx1	48-8	92
3	52/M	cabgx3	lıma-lad,radial-d1,rıma-pda	40-6	80
4	55/M	cabgx3	lıma-lad,rıma-pda	35-6	88
5	49/M	cabgx3	lıma-lad,radial-d1,rıma-rca	42-4	82
6	67/M	cabgx3	lıma-lad,rıma-pda	30-4	82
7	49/M	cabgx4	lıma-lad,rıma-rca	48-6	80
8	57/M	cabgx3	lıma-lad,rıma-rca	42-6	76
9	60/F	cabgx3	lıma-lad, lıma-rıma-om1	50-10	70
10	62/F	cabgx3	lıma-lad,lıma-rıma-om1	48-12	74
Mean	59.4				

LIMA: Left internal mammary artery, RIMA: Right internal mammary artery, D:Diagonal Artery, Cx: Circumflex artery, RCA: Right coronary artery, PDA: Posterior descending artery, OM: Optus Marginal

Table 2. Target veins where arterial grafts are used

Graft name	LIMA	RIMA	Radial artery
LAD	10		
Diagonal			3
Circumflex		2	1
Right coronary artery (RCA)		6	

LIMA: Left internal mammary artery, RIMA: Right internal mammary artery

Table 3. Operative and postoperative data

Operation Implemented	CCD (min.)	ICU (day)	Hospitalization period (day)	Drainage (ml)
1-cabgx4	43	2	5	800
2-cabgx2	24	2	6	600
3-cabgx3	49	2	5	750
4-cabgx3	60	2	5	700
5- cabgx3	40	2	5	750
6- cabgx3	39	2	5	700
7- cabgx4	60	2	6	800
8- cabgx3	37	2	5	750
9- cabgx3	38	2	7	900
10-cabgx3	40	2	7	800
Mean	43	2	5.6	755

CABG: Coronary artery bypass grafting, CCD: Cross Clamp duration, ICU: Intensive Care Unit,

upper extremity, a combination of nitroglycerin, heparin, and diltiazem was delivered routinely. Upon extubation, diltiazem infusion was stopped. Diltiazem tablets were administered and planned to be used for the post-operative first 3 months.

Results

The extended time required during graft preparation and technical difficulties associated with arterial anastomoses during cross-clamp, as compared to venous grafts, resulted in extended operation duration and longer cross-clamp (43 minutes in average) time. However, we believe that such prolonged preparation time can be shortened in the future as more experience is gained through each additional case.

Postoperative drainage amounts were 755 ml on average. Although this amount is slightly more than what is collected during operations using venous grafts and LIMA, none of the patients had to undergo a re-operation because of hemorrhage. It was observed that the drainage was more in patients in which bilateral IMA was used when compared with the patients in whom the radial artery and LIMA were used (Table 3).

The patients were extubated on the post-operative first day. During the post-operative period, all patients were followed up in the intensive care unit for 2 days. They were then taken to the inpatient service. Patients were discharged from hospital after 5-6 days on average.

During the post-extubation early period, low levels of saturation were detected in patients in whom bilateral IMA grafts were used. Saturation levels increased during the following days and no subsequent complications were experienced. None of the patients required re-intubation or mechanic ventilation support.

Operative and early period mortality was not observed in any patient. Pain in the area of incision was evaluated for each patient, based on the severity and frequency of the pain reported. Pain index test was applied to the patients on the first day following extubation and at the time of discharge. Mean value was calculated as 42.3 – 6.6. Results of pain indexes were found to be higher when compared with the patients who had undergone a CABG operation where the single arterial graft was used [1]. All patients were administered NSAIDs and paracetamol until they were discharged from the hospital. Recurrent angina or MI that may occur due to the artery graft spasm was not observed during the post-operative early period.

Discussion

The primary purpose of coronary bypass surgery is the complete revascularization of the myocardium. At this point, selection of grafts comes to the forefront. Graft selection is one of the most important factors determining graft patency. When compared with other grafts, IMA graft is resistant to the development of atherosclerosis and its patency rate is maintained by 80% - 90% after 10 years. In the saphenous vein, this rate decreases to 50% - 60%. The patency rate of the radial artery is more when compared with the saphenous vein. Compliance of IMA graft with the dimensions of the coronary artery, functionality of graft endothelium, and the ability to regulate the flow capacity according to the requirements of the myocardium are the well-known advantages of IMA grafts. In IMA grafts, the most important factors that ensure resistance against atherosclerosis are the presence of a developed lamina elastica interna layer and fewer numbers of smooth muscles in the media layer [8-9].

Graft spasm occurring in the postoperative period is the most alarming complication of artery grafts. Proposed mechanisms as to what causes these spasms occurring in artery grafts include denervation [12] or neurohumoral system activation caused by endothelin or norepinephrine occurring in circulation following CABG operation [8-9]. Additionally, there is a risk of vasospasm occurring by means of alpha-receptors and by the influence of the radial artery on circulating catecholamines due to the thickness of its muscular layer [8,10]. There are studies suggesting the use of diltiazem in order to avoid radial artery spasm since it inhibits atrial arrhythmias during the postoperative period and since there are reliable studies regarding its long-term effects [11]. In our clinical application, following its preparation, the radial artery graft was kept in a solution containing nitroglycerin, diltiazem and heparin in order to avoid spasm development. In the post-operative period, diltiazem infusion was administered to the patients in whom the radial artery was used. Following their discharge from the hospital, diltiazem tablet was given for the first 3 months.

Pick et al. found that the major sternal infection rate in bilateral IMA patients is 4% and reported diabetes in females and low cardiac output as risk factors [13,14,17,18,19]. Therefore, some surgeons suggested to apply bilateral IMA graft in young non-diabetic male patients [14,17,18,19]. However, in this study, no opening, separation, infection or mediastinitis was observed in the sternal incision areas of patients where bilateral IMA was used. In 13% - 14% of venous grafts, occlusions begin to develop due to thrombosis in the post-operative first month. In the first year following operation, proliferation begins in smooth muscle cells in the intima of the vein wall [15,18]. Angiographically, such cases appear as a 25% - 30% constriction in graft diameter. While in each succeeding year progressive intimal hyperplasia develops, a further 2% graft occlusion occurs during each consecutive year [16,17].

Conclusion

Another advantage of arterial graft usage is the increase in effort capacity and overall wellbeing of patients in the early period. Among the artery grafts used for coronary bypass operations, our data indicated that the first choice should be LIMA. The second choice should be RIMA since it is more resistant to atherosclerosis than the other arterial grafts. The radial artery may also be used as a good alternative. Results from long-term studies show the benefit and improvement in patient's quality of life provided by arterial grafts. Arterial grafts should therefore be considered as the first choice in coronary bypass surgery. Especially in young patients, usage of bilateral IMA and the radial artery should be the most beneficial approach.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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