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Bilateral Semi-Skeletonized IMA; Less Thermal Injury, Easier to Harvest, Early Post Operative Comparison with Single IMA Patients After CABG

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Abstract: The use of BITA is prominent in coronary bypass surgery due to its positive effects on long-term mortality and morbidity. However, its use is not widespread enough among heart surgeons due to its technical difficulty and the longer period of time it requires. There are still many articles being published on the subject. In patients who receive BITA, harvesting is usually performed in a skeletonized fashion. This protects the patient from sternal complications because it disturbs the vascularity of the chest wall less compared to the pedicled technique. However, the risk for injury on IMA is high. This is where harvesting in semi-skeletonized fashion distinguishes itself. Not only does it disturb the vascularity of the chest wall less but it also has a lower risk for thermal injury. Furthermore, it provides some advantages in terms of time over skeletonized fashion. The study enrolled 24 patients who underwent an isolated CABG operation using cardiopulmonary bypass (CPB) by a single surgeon between March 2017 - December 2017. 12 patients (10 males, 2 females; mean age: 55.083) underwent CABG operation using semi-skeletonized BITA (Table 1). Another 12 patients (8 males, 4 females; mean age: 56.25) underwent CABG using LIMA and venous graft. Post-operative sternal wound complications and post-operative pain of patients were compared. In the patients of the BITA group, cross clamp time, operation time and mammary harvesting time caused a slight prolongation. None of patients had deep sternal infection or mediastinitis or mechanical sternal dehiscence. BITA harvesting patients had more postoperative pain. As a result using semi-skeletonized ITA is more beneficial for sternal wound recovery compared to IMA harvested with the pedicled technique because the former causes less trauma in the thorax and disturbs the bleeding of the chest wall less. Furthermore, we think that it has advantages in terms of time and less traumatic effects on ITA compared to ITA harvested in a skeletonized fashion.

Keywords: Semi-Sklerotonized IMA, Bilateral Mammaria, VAS Score, Sternal Wound Infection, IMA Harvesitng

1. Introduction

Coronary artery bypass grafting (CABG) is the golden standard in multi-vessel coronary artery disease or if there is concomitant diabetes [1]. The success of a CABG is highly attributable to excellent longterm survival outcomes related to the use of the left internal thoracic artery—left anterior descending artery [2]. Spurred by this success, surgeons introduced the use of the right internal thoracic artery for bilateral internal thoracic artery (BITA) revascularization [3]. BITA usage was shown to prolong survival when compared to patients who underwent single LIMA [4, 5]. However,

BITA usage is not becoming more widespread among heart surgeons. In the studies conducted, BITA use in patients who undergo CABG in North America is less than <5% [6]. The reasons heart surgeons avoid BITA harvesting include the technical difficulty of preparing it, the high risk of thermal injury in skeletonize fashioned harvesting and lack of confidence in its potential benefits. In addition, one of the much-debated outcomes of BITA usage is the risk of sternal wound infection (SWI) [10, 11, 14].

This is likely due to the belief that BITA harvesting

compromises blood flow to the sternum and might increase the risk of sternal wound complications.

For ITA harvesting, conventional pedicled technique, skeletonized technique and semi-skeletonized techniques are defined. When BITA is harvested with the conventional pedicled technique, sternal infection rates range between 1.7% to 6.9% [7–11]. A full skeletonized technique has been used in some institutions with reported sternal infection rates of 1.5% to 1.9% [12–15]. To capitalize on the advantages of both the conventional and the full skeletonized technique, a semi-skeletonized technique has been developed [16]. With this technique, ITA is harvested at the maximum length and less traumatic damage occurs in parasternal tissues compared to the pedicled technique.

Our study group included 12 patients who underwent coronary bypass surgery where BITA was harvested with the semi-skeletonized technique and 12 patients where the single left mammarian artery was harvested with the conventional pedicled technique. The incision site pain, superficial and deep wound site infections of these patients were compared. Patients were routinely followed-up 5 weeks postoperatively.

2. Methods

2.1. Clinical Outcomes

The primary outcomes were postoperative morbidity, and mortality in BIMA compared to SIMA cases. Postoperative morbidity included cardiac arrest, cerebrovascular accident, SWCs, DSWI, readmission with a pleural effusion, reoperation for bleeding or graft occlusion, and shortterm complication composite. Short-term composite included a patient experiencing any of the following events: death, reoperation, DSWI, cardiac arrest, stroke, and renal failure requiring dialysis. Secondary outcomes were comparing mammary harvest time and Cross Clamp time between single IMA and BITA useage.

Because SWCs are the main concern when using BIMA grafts, we evaluate the incidence of these complications with this technique.

SWCs included the following types. Sternal infection (suppurative sternitis) was diagnosed when there was purulent fluid associated with the sternal halves and all the sternal wires and when a second surgical procedure was performed, involving removal of the wires with debridement and closure. This category was further divided into 2 groups: sternal infection with mediastinitis, and sternal infection alone. In patients without mediastinitis, there was minimal sternal dehiscence. Mechanical dehiscence was considered present when sternal instability developed without evidence of infection. Superficial sternal wound infection was defined as the presence of subcutaneous inflammation that prompted antibiotic use, with or without superficial wound dehiscence. Early mechanical dehiscence and late sternal non-union were treated with direct rewiring. Superficial sternal wound infection was treated conservatively with antibiotics.

2.2. Study Plan

24 patients underwent an isolated CABG operation using cardiopulmonary bypass (CPB) by a single surgeon between March 2017 - December 2017 at the Hisar Intercontinental Hospital. 12 patients (10 males, 2 females; mean age: 55.083) underwent CABG operation using BITA graft (Table-1, Table-2). Another 12 patients (8 males, 4 females; mean age: 56.25) underwent CABG using LIMA and venous graft.

Surgery was performed through a median sternotomy with cardiopulmonary bypass established through right atrial and ascending aortic cannulation. Intermittent cold cardioplegia was used in the initial 24 patients and blood cardioplegia thereafter. An intravenous second-generation cephalosporin antibiotic was administered intraoperatively and for 48 hours postoperatively for prophylaxis against infection.

Following sternotomy, the IMAs were exposed using a sternal retractor, and the left IMA was harvested first. When a single LIMA was used, it was harvested in pedicled fashion. When BIMA were used, they were both harvested in semi-skeletonized fashion.

For harvesting BITA, parietal pleura was opened, endothoracic fascia was cauterized, and IMAs were harvested with the semi-skeletonized technique. Endothoracic facia and accompanying veins were left in the chest wall in some amount. Following full mobilization, the IMAs were divided distally, and also proximally in the case of the right IMA for Cırcumflex system. This technique has been described in detail by Horii and Suma. [16]

The LIMA group received a single pedicled mammary artery to the left anterior descending artery and saphenous vein grafts to all other coronary arteries. The BIMA group received LIMA to the left anterior descending artery and RIMA to RCA, or RIMA to another left-sided coronary artery of Circumflex system and Proksimally to LIMA as a "Y" Graft.

Patients in the BITA group were followed up for a mean of 2 days in intensive care. They were then taken into the general ward and discharged after a mean of 5.83 days. Patients in the LIMA group were followed up for a mean of 2.25 days in intensive care. They were then taken into the general ward and discharged after a mean of 7.83 days. A pain index test was applied to patients on post-operarative Day 2 and Day 5 [17]. The patients were asked questions where the severity and the frequency of the pain around the median sternotomy incision line would be scored from 1 to 10. The patients were assessed in terms of operative mortality, cross clamp time, drainage amounts, intensive care and hospitalization length, incision site pain, post-extubation saturation follow-up, post-operative complications and recurrent angina, MI and reoperation.

Table 1. measured pre-operative and per-operative variables.

Hypertension	16
Peripheral vascular disease	4
Diabetes mellitus	12
IABP insertion	1
Emergent surgery	1
Hyperlipidemia	14
history of cigarette use	18
Respiratory failure	0
Reexploration for bleeding	0

Table 2. Demographic and operative data for BITA.

Patients	Age/Gender	Operation performed	Grafts	Pain Index	PaSO2
1	38/M	Cabgx4	lıma-lad, lıma-rıma –OM1	50-8	86
2	55/M	cabgx2	lıma-lad, lıam-rıma-OM1	48-8	82
3	52/M	cabgx3	lıma-lad, rıma-rca	40-6	80
4	55/M	cabgx3	lıma-lad, rıma-rca	35-6	88
5	49/M	cabgx3	lıma-lad, rıma-rca	42-4	82
6	67/M	cabgx3	lıma-lad, rıma-pda	30-4	82
7	48/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
11	58/M	Cabgx3	Lıma-lad, lıma-rıma-OM1	56-8	80
12	60/M	Cabgx3	Lıma-lad, lıma-rıma-OM1	42-6	78
Mean	55.083			44,25-7	79,83

LIMA: Left internal mammarian arter, RIMA: Right internal mammarian arter, D:Diagonal Arter, Cx: Sirkumflex arter, RCA: Sağ koroner arter, PDA: Posterior descending artery, OM: Optus Marginal

3. Results

In the BITA harvesting group, the length of graft preparation and the technical difficulty of anastomosis on venous grafts during cross clamp caused a slight prolongation in operation and cross clamp (LIMA: 39 min, BITA: (42.3 min) times.

The mean post-operative drainage amount in patients was 775 mL for the LIMA group and 816 mL for the BITA group. Although this amount was higher in patients undergoing BITA compared to the operations with venous grafts and preparation of single LIMA, no patients were reoperated due to bleeding. Drainage was seen to be higher in patients undergoing bilateral IMA compared to patients undergoing LIMA (Table-3, Table-4).

Patients were extubated on post-operative Day 1. Patients in the LIMA group were followed up for 2.2 days in intensive care during the post-operative period.. Patients in the BITA group were followed up for 2 days in intensive care during the post-operative period. They were then taken into the general ward. LIMA patients were discharged after a mean of 7.8 days. Meanwhile, BITA patients were discharged after a mean of 5.8 days.

Saturation lowness was observed in patients undergoing both IMA grafts in the post-extubation early phase. Saturation increased in the following days, and there were no other complications. No patients required re-entubation or mechanical ventilation support.

While the harvesting time in patients undergoing single LIMA was mean 17.8 min, the harvesting time in patients undergoing BITA was 47.3 min.

Operative and early phase mortality were not observed. Incision site pain was evaluated with questions about the severity and frequency of the pain. Pain index test was applied to patients on post-extubation Day 1 and at discharge. The mean pain index value was detected to be 44.2-7 in the BITA group. The mean pain index was found to be 24.6-5.3 in the single LIMA group. Pain index results were found higher in the BIMA group compared to the patients undergoing CABG operation with single IMA. All patients were given NSAID and paracetamol until discharge. Recurrent angina and MI that could occur due to arterial graft spasm in the post-surgery early phase were not observed.

Superficial or deep sternal infection or mechanical sternal dehiscence were not observed in any of the patients. Dehiscence was seen in the sternal sub zone in a female, obese and diabetic patient with BITA harvested. Wound site infection or opening was not observed. She was followed up with sternal corset. She was followed up without requiring for a second surgical attempt. She recovered to a large extent at the end of the 1st month.

***Table 3.** Operative and postoperative data of BITA patients.*

Procedure	CCT(Min)	ICU (Day)	Hospital (Day)	Drainage(ml)	BITA harvesting time(min)
1-cabgx4	43	2	5	800	48
2-cabgx2	24	2	6	800	40
3-cabgx3	49	2	5	800	56
4-cabgx3	60	2	5	700	50
5- cabgx3	40	2	5	800	50
6- cabgx3	39	2	5	700	46
7- cabgx4	60	2	6	900	48
8- cabgx3	37	2	5	800	40
9- cabgx3	38	2	7	900	42
10-cabgx3	40	2	7	800	50
11-cabgx3	36	2	7	900	48
12-cabgx3	42	2	7	900	50
Mean	42,33	2	5,83	816	47,33

***Table 4.** Operative and postoperative data of LIMA patients.*

Procedure	CCT(Min)	ICU (Day)	Hospital (Day)	Drainage(ml)	Age/Gender	LIMA harvesting time(min)	Pain Index
1-cabgx3	36	2	7	800	74/M	18	30-4
2-cabgx3+CE	28	3	8	900	63/M	15	24-4
3-cabgx3	33	2	7	700	54/M	20	28-2
4-cabgx4	34	2	5	800	64/M	18	20-6
5- cabgx3	40	2	5	750	42/M	14	30-6
6- cabgx3	51	2	8	650	61/F	20	30-8
7- cabgx4	38	2	7	800	55/M	22	20-4
8- cabgx3	45	3	8	900	55/F	17	30-8
9- cabgx3	BH	2	8	700	66/F	24	20-2
10-cabgx3	43	2	7	700	62/M	16	24-6
11-cabgx3	45	3	8	800	70/M	14	20-2
12-cabgx3	36	2	7	700	64/F	16	20-2
mean	39	2,25	7,83	775	56,25	17,83	24,6-5,3

CE: Carotis Endarterectomy Aortic valve replacement, BH: Beating Heart, CABG: Coronary artery bypass grafting, CCT: Cross-clamp time, ICU: Intensive Care Unit.

4. Discussion

Heart surgeons are still reluctant about BITA harvesting. They generally prefer LIMA and accompanying saphenous vein grafts or radial artery. Present, the rate of BITA grafting strategy use is approximately only 4% [6].

However, occlusion begins to develop due to thrombosis in the first month post-operation in 13-14% of venous grafts. One year after the operation, proliferation starts in smooth muscle cells in the intima of the vein wall [18, 21]. This is angiographically seen as a 25-30% shrinking of the graft diameter. Intimal hyperplasia develops each subsequent year and 2% graft occlusion occurs per year [19, 20].

There are several reasons underlying this phenomenon. A reason is that BITA grating is technically more demanding. A second reason is that BITA grafting is time-consuming because of its technical challenge and because the 2 conduits are harvested sequentially by a single surgeon, whereas simultaneous conduit harvesting can be performed with SITA. Another reason is that BITA grafting is associated with increased risk of sternal wound complications. [4, 9, 11]. And a final reason is a lack of financial reimbursement for a technically more demanding and longer procedure.

Technically, skeletonization is often criticized for its longer harvesting time [22] and potential risk of damaging the ITA with elektrokoteterizasition [23, 24]. Some publications have reported longer harvesting times for skeletonized versus conventional, non-skeletonized conduits, but it can be completed in 25–30 minutes in most cases [25, 26]. This time was 47.33 min in patients who underwent semi-skeletonized BIMA harvest in our study. It is demonstrated that the mean effective length of the ITA obtained was approximately 4 cm longer than that obtained using the conventional thick pedicle harvesting technique [26]. We did not experience any problems due to shortness in any semi-skeletonized RIMAs we used in RCA or PDA.

Another concern regarding use of ITA grafts as composite Y-grafts is whether there is enough blood flow in different limbs of this configuration. Glineur et al. [27] studied the hemodynamic characteristics of 17 composite Y-grafts made with the left ITA anastomosed to the LAD and with either the free right ITA or a SV graft implanted proximally to the left ITA and distally to the circumflex territory. They found that the Y-configuration allows an adequate revascularization of the whole left coronary system with an even distribution of perfusion pressure in both distal branches and a minimal resistance to maximal blood flow.

However, if we have highly stenotic vessels we can have

excellent patency with these arterial grafts as well. Evidence suggests that radial artery patency can equal that of an ITA when it is grafted to a left sided vessel with high grade stenosis [28].

More definitive clinical trials are warranted to justify the utilization of BITA skeletonization in patients with high risks of SWI, particularly those with COPD and diabetes. We should not prematurely exclude these patients from the potential benefits of BITA grafting [29].

If positive wound culture occurs in the superficial sternal wound infection, systemic antibiotic treatment is also used. Sternal wound site infection is handled on a broad spectrum from wound separation to mediastinitis. In prevention, many treatment options exist, including cleaning the whole wound, surgical debridement, closed drainage systems and vacuum-assisted closure (VAC). All increase the hospitalization time. It both causes a psychological discomfort for the patient and increases the costs at a considerable amount. Products such as nitinol clip or sternal bands are sometimes used for a full stabilization of the sternum, which may further increase the costs. It causes a long hospitalization period and increased costs. Treatment methods including VAC and antibiotic choice are also important.

Deep sternal wound infection (DSWI) is a rare but serious complication after cardiac surgery and is associated with the need for subsequent surgical procedures, a prolonged hospital stay, and increased mortality and morbidity. The incidence of this complication ranges between 0.5% and 2.7% in recent series [30, 31].

DSWI has been defined as bone-related infections with the need for surgical intervention, [33, 34] but a number of studies also included superficial wound infections, consequently reporting a higher incidence of this complication. [32, 35].

The main outcome variable of this study was SWI. This complication was defined as drainage of purulent material from the sternotomy wound and instability of the sternum.

Apart from the surgical technique, other factors such as diabetes mellitus, obesity, COPD (chronic obstructive pulmonary disease, emergency procedure, prolonged operative time, aortic crossclamp time, prolonged mechanical ventilation, and the use of SIMA or BIMA grafts have been reported as independent risk factors for SWCs [7-14].

5. Conclusion

As a conclusion using semi-skeletonized ITA is more beneficial for sternal wound recovery compared to IMA harvested with the pedicled technique because the former causes less trauma in the thorax and disturbs the vascularity of the chest wall less. However after operation with semi-skeletonized harvesting technique patients have more sternal pain according to pedicled LIMA harvesting patients, none of them have sternal wound heeling problems. Furthermore, using semi-skeletonized ITA has advantages in terms of time and makes less traumatic effects on ITA compared to ITA harvested in a skeletonized fashion.

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