



# Should We Hesitate to Use Skeletonized Bilateral Internal Mammary Artery?

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## ABSTRACT

**Introduction:** This study aimed to examine the mortality and morbidity associated with skeletonized BIMA use as well as the long-term outcomes of the technique.

**Patients and Methods:** Patients who underwent CABG with or without additional intervention by using skeletonized BIMA in our clinic between the years 2017 and 2021 were included in this study (n= 193).

**Results:** During the six-month postoperative follow-up, none of the patients in whom BIMA was used developed deep sternal wound infection. Only ten patients developed skin closure defects at the sternal incision line during the first postoperative week, and one of them required revision of the skin incision site. Bacterial growth was not present on the sternal incision site cultures of any patients.

**Conclusion:** When considering the long-term outcomes of skeletonized BIMA use, we believe that surgeons should not be reluctant to use BIMA due to concerns about deep sternal wound infection.

**Key Words:** Coronary artery bypass graft; bilateral internal mammary artery

## Skeletonize Bilateral İnternal Mammarian Arter Kullanmakta Tereddüte Gerek Var Mı?

### ÖZET

**Giriş:** Bu çalışmanın amacı; skletonize BİMA kullanımının mortalite, morbidite ve uzun dönem sonuçlarını irdelemektir.

**Hastalar ve Yöntem:** Kliniğimizde 2017-2021 tarihleri arasında skletonize BİMA kullanılan 193 CABG ve ek girişim yapılan vakaları çalışmaya dahil ettik.

**Bulgular:** Postoperatif altı aylık takiplerde derin sternal enfeksiyon BİMA kullanılan hiçbir hastada görülmedi. Sadece 10 vakada postoperatif taburcu sonrası ilk bir haftada sternal insizyon hattında ciltte kapanma defekti görüldü ve bunlardan bir tanesine cilt revizyonu yapıldı. Hastaların hiçbirisinde sternal insizyon yeri kültürlerinde üreme olmadı.

**Sonuç:** Skletonize BİMA kullanımının uzun dönem sonuçlarına bakıldığında, sternal derin yara yeri enfeksiyonu tereddütü ile cerrahların BİMA kullanımından kaçınmaması gerektiğini savunmaktayız.

**Anahtar Kelimeler:** Koroner arter bypass cerrahisi; bilateral internal mammarian arter

## INTRODUCTION

Owing to its advantage of obviating the need for recurrent interventions, coronary artery bypass grafting (CABG) still represents a superior option when compared to percutaneous coronary intervention (PCI)<sup>(1)</sup>. Selection of a suitable graft for CABG is important to minimize mortality and the need for recurrent intervention. The left internal mammary artery (LIMA) is currently the gold standard graft for the left anterior descending artery (LAD)<sup>(2)</sup>. Although the patency rates of arterial grafts are known to be better than venous grafts, bilateral internal mammary artery (BIMA) graft use is only around 4% worldwide<sup>(3)</sup>. The main reason for surgeons to avoid using BIMA is deep sternal wound infection and its potential complications<sup>(4)</sup>.

Skeletonized or pedunculated preparation of BIMA has always stimulated interest in terms of surgical technique.

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This study aimed to examine the mortality and morbidity associated with skeletonized BIMA use as well as the long-term outcomes of the technique.

**PATIENTS and METHODS**

Patients who underwent CABG with or without additional intervention by using skeletonized BIMA in our clinic between the years 2017 and 2021 were included in this study (n= 193). Among them, 126 were in the 50-60 years age group, and male to female ratio was 176/17. Fifty-six patients had a preoperative HbA1c level higher than 6.0%. Oral antidiabetic agents were discontinued preoperatively, and blood glucose levels were controlled with insulin administration. A total of 112 patients had a body mass index (BMI) of greater than 30 kg/m<sup>2</sup>. Preoperative creatinine levels of the patients were within normal range. None had a history of radiotherapy or immunosuppressive treatment.

Skeletonized BIMA was not used in patients with clinically suspected or radiologically established peripheral artery disease (PAD) (Table 1).

Troponin levels of the patients were within normal range. Only eight patients had acute coronary syndrome and were eligible for skeletonized BIMA preparation due to their stable hemodynamics.

**Surgical Technique**

Whole body skin disinfection with 10% povidone-iodine solution (iso-Betadine Dermique 10%) was done prior to the operation. All procedures were performed through median sternotomy. BIMA was harvested using a skeletonized approach and papaverine was used while harvesting. IMA bifurcation was protected during the distal clamping of BIMA. The operation was done under cardiopulmonary bypass using right atrial cannulation.

Saphenous vein grafts (SVG) were used in 27 patients with multi-vessel coronary artery disease where BIMA was not sufficient. The radial artery was not used in any of the cases. In 118 cases, the right internal mammary artery (RIMA) graft was used sequentially as a free graft to vascularize the left coronary system, and proximally it was anastomosed over LIMA. In 48 cases, BIMA was used in situ to vascularize both left and right coronary systems. Twenty-one cases underwent additional procedures: aortic valve replacement (AVR), mitral valve replacement (MVR), Yacoub procedure, and septal myectomy in a patient diagnosed with idiopathic subaortic stenosis (IHSS) (Table 2).

During the six-month postoperative follow-up, none of the patients in whom BIMA was used developed deep sternal wound infection. Only ten patients developed skin closure defects at the sternal incision line during the first postoperative

**Table 1. Preoperative characteristics of the patients**

<b>Sex</b>	
Female	17
Male	176
<b>Age</b>	
<50 years	38
50-60 years	126
>60 years	29
<b>HBA1C</b>	
<5.5	42
5.5-6	95
>6	56
<b>BMI</b>	
<30	81
>30	112
<b>Creatinine</b>	
0.4-1.3	193
<b>COPD</b>	
Present	3
Absent	190
<b>PAD</b>	
Present	0
Absent	193

HBA1C: Hemoglobin A1c, BMI: Body mass index, COPD: Chronic obstructive pulmonary disease, PAD: Peripheral artery disease.

**Table 2. Perioperative characteristics of the patients**

<b>Surgical procedure</b>	
CABG	172
CABG plus additional procedure	21
<b>Graft use</b>	
In Situ BIMA	48
BIMA plus SVG	27
Free RIMA	118
<b>CBP</b>	
On pump	189
Off-pump	4
<b>Cross clamp duration</b>	63 ± 37
<b>Total bypass duration</b>	113 ± 37

CABG: Coronary artery bypass grafting, BIMA: Bilateral internal mammary artery, RIMA: Right internal mammary artery, SVG: Saphenous vein graft, CPB: Cardiopulmonary bypass.

**Table 3. Postoperative characteristics of the patients**

<b>Revision for bleeding</b>	
Present	0
Absent	193
<b>Duration of ICU stay</b>	
24 hours	190
48 hours	3
<b>Duration of hospital stay</b>	
5 days	172
6 days	17
7 days	4
<b>Deep sternal infection</b>	
Present	0
Absent	193
<b>Sternal detachment</b>	
Present	0
Absent	193

ICU: Intensive care unit.

week, and one of them required revision of the skin incision site. Bacterial growth was not present on sternal incision site cultures of any patients (Table 3).

## DISCUSSION

The use of SVG for CABG is associated with an increase in recurrent invasive procedures due to SVG atherosclerosis resulting in high occlusion rates: 12.5%, 25%, and 50% at one, five, and 12 years, respectively<sup>(5,6)</sup>. SVGs are 2.6 times more prone to dysfunction when compared to arterial grafts<sup>(7)</sup>. Therefore, grafts with higher patency rates should be used. The patency rate of IMA grafts in the third decade following CABG was shown to be 80%<sup>(4)</sup>. RIMA patency rate was 96% and 81% at five and 10 years, respectively. Corresponding figures for LIMA are 98% and 95%, respectively<sup>(8)</sup>. Several angiography studies demonstrated similar patency rates for RIMA and LIMA at 6.7 and 12 years after the operation, ranging between 86% and 97%<sup>(9,10)</sup>.

Saso et al. reported an excellent 95% patency rate for skeletonized IMA at postoperative three years<sup>(11)</sup>.

Despite its long-term advantages, BIMA use is associated with increased deep sternal infection, postoperative bleeding, and revision risks. To minimize these risks, a skeletonized approach is recommended for BIMA harvesting. The skeletonized approach means the mobilization of IMA while preserving

the integrity of the accompanying vein and surrounding tissues, which was first described by Keeley in 1987<sup>(12,13)</sup>. In that approach, IMA branches are ligated close to the artery, thus providing collateral circulation for the sternum. Although some cardiac surgeons believe that the skeletonized approach harms the endothelium, no difference was found between pedicled IMAs and skeletonized IMAs in terms of patency rate and endothelial injury in the study by Athanasiou et al<sup>(14)</sup>.

The use of BIMA in diabetic patients is still controversial among surgeons. In the studies by Momin et al.<sup>(15)</sup> and Svensson et al.<sup>(16)</sup>, BIMA use in insulin-dependent diabetes mellitus patients was not associated with an increased risk for sternal wound infection. When compared to pedicled IMA, skeletonized IMA was shown to minimize sternal infection risk in diabetic patients<sup>(17,18)</sup>. In addition, studies demonstrated that skeletonized BIMA can be used without affecting the deep sternal infection rate in patients with insulin-dependent diabetes mellitus when strict glycemic control and proper hygienic conditions are provided in the perioperative period<sup>(19)</sup>.

The other associated condition in coronary patients who underwent surgical intervention is peripheral artery disease (PAD), which is present in 10-30% of the cases<sup>(20,21)</sup>. The complication rate is higher in CABG patients with a history of PAD<sup>(22)</sup>; therefore, the selection of the appropriate surgical technique is of utmost importance<sup>(23)</sup>. Particularly, the selection of the graft and revascularization strategy are key factors for the success of these procedures. Large studies demonstrated a survival advantage for BIMA use over LIMA use in CABG patients with PAD<sup>(24,25)</sup>. No guidelines exist for coronary vascularization strategy in PAD patients; thus, the use of one or two thoracic arteries is at the discretion of the surgeon.

PAD is clinically defined as the presence of one more of the following criteria: claudication at rest or with effort, confirmed aorta-iliac occlusive disease and confirmed abdominal aortic aneurism. Winslow pathway<sup>(26,27)</sup> is a systemic-systemic communication connecting the internal thoracic artery, superior epigastric artery, inferior epigastric artery, and external iliac artery, which is prominent in aorta-iliac obstructive disease. The Winslow pathway is the most important flow source for the lower extremities; lower extremity ischemia has been reported when IMA was removed in patients with aorta-iliac occlusive disease<sup>(28,29)</sup>. BIMA use in a patient with PAD is associated with the impairment of right and left collateral Winslow pathways, thereby a significant increase in severe postoperative extremity ischemia risk. BIMA use should be avoided in patients with clinical evidence of PAD or radiologically confirmed PAD. Therefore, we did not use BIMA in CABG patients with PAD in our clinic.

## CONCLUSION

We suggest that skeletonized BIMA use in CABG patients has an important role in arterial revascularization due to its good long-term patency rate. Emphasis should be given to preoperative and postoperative glycemic control in diabetic coronary patients. We do not recommend BIMA use in cases with confirmed PAD. In our series, we harvested BIMA grafts using the skeletonized approach to provide collateral sternal circulation and prevent deep sternal infection. When considering the long-term outcomes of skeletonized BIMA use, we believe that surgeons should not be reluctant to use BIMA due to concerns about deep sternal wound infection.

**Ethics Committee Approval:** The approval for this study was obtained from Istanbul Kent University Health Sciences Scientific Research and Publication Ethics Committee (Decision no: E-10420511-050-14514, Date: 05.08.2022).

**Informed Consent:** This is retrospective study, we could not obtain written informed consent from the participants.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept/Design - AÖ, HT; Analysis/Interpretation - AÖ, HT; Data Collection - AÖ, HT; Writing - AÖ, HT; Critical Revision - AÖ, HT; Final Approval - AÖ, HT; Statistical Analysis - AÖ, HT; Overall Responsibility - AÖ, HT.

**Conflict of Interest:** The authors have no conflicts of interest to declare.

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### Reviewer Comment

Thanks for your effort about this study. I see that you were very careful about the selection criteria to use BIMA. Your study population consist of young aged patients, glycemic control is good, there are no chronic kidney disease and peripheral artery disease diagnosed patient, COPD diagnosed patient is only three. This means that you can of course use BIMA if necessary. Your patients are very suitable yo use BIMA, every surgeon want to meet patients like this. These criterias are the important points to make a good determination. The point is that a good assessment should be done preoperatively to use BIMA. I think you can add some words about this to direct the readers. Because surgeons don't hesitate to use BIMA, but as you know that our patient population is consisted of diabetic, PAD, COPD, CKD diagnosed elderly patients. All surgeons pay attention to these criterias. Yes you have 193 patient in your study, but what about the percentage of these patients in your operated patient population for these five years period. If the criterias are suitable, all surgeons don't hesitate to use BIMA. And I think that you don't want to use BIMA in a COPD, non-glycemic controlled, PAD diagnosed elderly patient. You have to describe your aim about this point.

You haven't got a control group, this is important and this is a limitation of your study. For example to compare the post-operative drainage amount, or to compare the sternal skin closure defects etc.

### Dr. Özgen's Reply

In our clinic, the total number of coronary artery bypass grafting (CABG) cases in five years is 558, the total number of cases in which BIMA is used is 193 and the rate of using BIMA is 34.5%. The total number of distal anastomoses is 1635, the number of distal anastomoses using internal mammary artery (IMA) is 835, and the rate of IMA usage in distal anastomoses is 51%. In 118 cases, right internal mammary artery (RIMA)

graft was used sequentially as a free graft to vascularize the left coronary system and proximally it was anastomosed over left internal mammary artery (LIMA). In 48 cases, BIMA was used in situ to vascularize both left and right coronary system. Our aim is to increase the number of arterial anastomosis by reducing the number of anastomosis with saphenous vein graft and to provide patency rate with long-term arterial graft. In addition, the rate of deep sternal infection among a total of 558 CABG cases performed in our clinic is 0.01%. During six-month postoperative follow-up, none of the patients developed deep sternal wound infection in whom BIMA was used.

The most important criterion we consider when choosing patients to use BIMA is the degree of stenosis of the coronary artery lesion. Our aim is to preserve the postoperative long-term patency rate of arterial grafts. Fifty-six patients had a preoperative HbA1c level higher than 6.0% and ninety-five patients with HbA1C between 5.5-6. Diabetes mellitus (DM) was not a contraindication for us when choosing our patients.

When compared to pedicled IMA, skeletonized IMA was shown to minimize sternal infection risk in diabetic patients. In addition, studies demonstrated that skeletonized BIMA can be used without effecting deep sternal infection rate in patients with insulin dependent diabetes mellitus when tight glycemic control and proper hygienic conditions are provided in the perioperative period. A total of 112 patients had a body mass index (BMI) higher than 30 kg/m<sup>2</sup>. Obesity was not a contraindication for us.

In 558 cases who underwent CABG in our clinic, the rate of severe chronic obstructive pulmonary disease (COPD) was 0.019% and the rate of chronic renal failure (CRF) was 0.012%. The rate of COPD in patients using BIMA is 0.015%, and the rate of CRF is 0%.

In our clinic, the rate of bleeding revision in 558 CABG cases is 0.04%. Bleeding revision was not observed in patients using BIMA.