

# We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,900

Open access books available

186,000

International authors and editors

200M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index  
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?  
Contact [book.department@intechopen.com](mailto:book.department@intechopen.com)

Numbers displayed above are based on latest data collected.  
For more information visit [www.intechopen.com](http://www.intechopen.com)



# Should We Do Bilateral Internal Mammary Artery Grafting in Diabetic Patients?

*Hassane Abdallah, Ahmed Ibrahim and Khalid Al Khamees*

## Abstract

Nowadays, potential advantages of BIMA grafting are recognized overall in terms of long-term survival<sup>1</sup> and by not increasing operative morbidity. One of the major restrictions for extending the use of BIMA grafting is the current impossibility of generalizing the procedure to higher risk patients. These results tend to confirm recent results that promote the use of BIMA grafting in every kind of patients and consequently to confirm the generalization of the procedure, without being afraid of sternal complications. The absence of deep sternal wound infection in our study shows that there is no contraindication of BIMA grafting among diabetic patients.

**Keywords:** coronary, diabetes, deep sternal wound infection

## 1. Background

Coronary artery disease (CAD) is the most common pathology which prepos- sesses cardiologists and cardiac surgeons in the past century. Ischemic heart disease was also the most common reason of mortality in the world as reported by the World Health Organization in 2018 [1].

While Coronary artery bypass grafting (CABG) is the preferred therapeutic option for ischemic heart disease in diabetic patients, surgical modalities of the pro- cedure are still debated. One of these is the choice of grafts. Single internal-thoracic- artery graft has resulted in a 10-year rate of angiographic patency exceeding 90%, as compared with 50% for vein grafts. These excellent long-term outcomes have stimulated the use of a bilateral internal-thoracic-artery approach. Nevertheless, the technique is associated to a major drawback. By compromising severely the sternal vascularization, the BIMA may expose patients higher rates of sternal wound infec- tion and this risk seems to be particularly increased in diabetic patients.

The purpose of this chapter is to assess, according to our experience and litera- ture review, the feasibility and the safety of BIMA in patients with diabetes under- going CABG. Furthermore, the paper highlighted the importance of some cautions and adjunct measures that should be adopted systematically.

## 2. Patients and methods

A retrospective analysis of the patients who underwent coronary artery bypass surgery in our institution from January 2017 to January 2019 was performed.

All the data were retrieved from computer based medical records. All patients were followed-up in our hospital after the discharge.

The incidence of postoperative sternal wound infections in diabetic patients who received bilateral internal thoracic artery grafting was compared with the incidence

Variable	Total	Diabetic (n = 116)	Non –diabetic (n = 94)	P value
Age	52.1 ± 9	52.9 ± 7.9	51.04 ± 10.2	0.2
≤50 year	98(47%)	50(24%)	48(23%)	0.3
>50 year	112(53%)	66(31%)	46(22%)	
Sex				
Female	10 (5%)	4(2%)	6(3%)	0.3
Male	200(95%)	112(53%)	88(42%)	
HbA1c(mean ± SD)	7.8 ± 1.8	8.8 ± 1.6	6.1 ± 0.7	0.0001
≤7	95(45%)	27(13%)	65(31%)	0.0001
>7	78(37%)	71(34%)	8(4%)	
≥10	37(18%)	39(18%)	0(0%)	
HbA1c > 7 and BMI > 30	69(33%)	63(54%)	6(6%)	0.0001
BMI(mean ± SD)	29.1 ± 4.6	29.2 ± 4.7	28.7 ± 4.5	0.5
<25	59(28%)	29(14%)	29(14%)	0.3
25–30	76(36%)	46(22%)	29(14%)	
>30–35	52(25%)	32(15%)	21(10%)	
>35–40	23(11%)	13(6%)	11(5%)	
EF				
<30	34(16%)	21(10%)	13(6%)	0.7
30–50	69(33%)	40(19%)	29(14%)	
>50	107(51%)	59(28%)	48(23%)	

**Table 1.**  
Preoperative characteristics (n = 210).

Variable	Diabetic	Non-diabetic	P value
Number of coronary by anastomosis (mean)	2.7	2.6	0.4
Y fashion			
No	99(47%)	73(35%)	0.6
Yes	23(11%)	15(7%)	
Pump			
Off	72(35%)	60(29%)	0.7
On	44(21%)	34(16%)	
Cross clamp time in minutes (Mean ± SD)	37 ± 6	41 ± 7	0.002
Bypass surgery time in minutes (Mean ± SD)	52 ± 8	57 ± 9	0.001
Duration of surgery in minutes (Mean ± SD)	227 ± 12	233 ± 13	0.005

**Table 2.**  
Postoperative characteristics.

Variable	Diabetic (n = 116)	Non-diabetic (n = 94)	Difference	95% CI
Post-operative IABP	2 (1.7%)	1(1.1%)	0.6	-4.3 – 5.0
Atrial fibrillation	12 (10.4%)	8(8.8%)	1.6	-7.0 – 9.7
Post-operative stroke	0	0		
Diaphragmatic paralysis	0	1(1.1%)	1.1	-2.2 – 5.8
Pleural effusion	1(0.9%)	2(2.1%)	1.2	-2.9 – 6.5
Hospital acquired pneumonia	2(1.7%)	1(1.1%)	0.6	-4.3 – 5.0
Low cardiac output	2(1.7%)	1(1.1%)	0.6	-4.3 – 5.0
Bleeding re-operation	0	0		
ICU stay in day (mean)	4	3	1.0	0.6 – 1.4

**Table 3.**  
*Postoperative morbidity.*

Variable	Diabetic (n = 116)	Non-diabetic (n = 94)	Difference	95% CI
Superficial Wound Infection	2(1.7%)	1(1.1%)	0.6	-4.3 – 5.0
Deep sternal wound infection	0	0	NA	
Mortality	2(1.7%)	1(1.1%)	0.6	-4.3 – 5.0

**Table 4.**  
*Postoperative infection and the mortality rate.*

in non-diabetic patients. Two-hundred and ten patients who underwent CABG using bilateral internal thoracic arteries were enrolled in the study and were divided into two groups: group I diabetic patients (DM) (n = 116) and group II non-diabetic patients (non-DM) patients (n = 94) (**Tables 1–4**).

### 3. Surgical procedures

All patients were disinfected with dermic isobetadine (iso-Betadine Dermique, 10% solution, povidone iodine) on their whole body. A lateral drape with plastic protector was used. All procedures were performed via median sternotomy. IMAs were harvested in a skeletonized fashion since only the artery is carefully dissected off the chest wall. Once upon completion of harvesting, IMAs were prepared with papaverine.

Extracorporeal circulation (ECC) was used in 78 patients whereas off-pump CABG was performed in 132 patients.

Combinations and numbers of arterial bypasses were selected according to the angiographic findings. When the bilateral internal mammary artery (BIMA) was grafted in situ, the left internal mammary artery (LIMA) was generally used for the left descending artery (LAD) and the RIMA for the lateral wall, usually going In Situ. In 38 patients having a Y-graft, the left coronary system was chosen as the target site of revascularization and a saphenous graft was used if necessary. The mean number of distal anastomosis was 2.6.

Before sternal closure, mediastinum was irrigated with warm saline and topical Vancomycin was routinely applied. Interlocking Multi-twisted closure sternal technique was used (**Table 2**).

## 4. Data analysis

Statistical Package for Social and Sciences (SPSS) version was used for data management. Descriptive data analysis was performed and data were presented in number (n) and percentages (%). Mean  $\pm$  SD was reported for continuous variables. Statistical significance difference was assessed by using T-test for continuous variables and Chi squared for categorical variables and proportion, *P* value of ( $<0.05$ ) was considered significant [2, 3].

## 5. Results

We included 210 patients, men (n = 200) and women (n = 10). The median age was 52.1  $\pm$  9 years, 116 patients were DM and 100 patients of them in insulin, the median BMI was 29.1  $\pm$  4.6 kg/m<sup>2</sup> and the mean Euro SCORE was 4.8.

Overall operative mortality was 2.8% and was recorded in three high risk patients with severe LV systolic dysfunction (ejection fraction  $< 30\%$ ).

No statistical difference between the two groups was observed. There were no stroke or transient neurologic accident happened among our patients even no reoperation for bleeding (**Table 3**).

Deep sternal wound infection occurred in none of our patients. Only three cases showed signs of superficial wound infection that healed promptly following daily dressing, antibiotics and strict glycemic control (**Table 4**).

## 6. Discussion

Since 1980s, internal mammary artery (IMA) has become the graft of choice, thanks to clinical and angiographic data showing its long term patency rates and its superiority over the saphenous vein graft. Subsequently, the use of more arterial grafts especially bilateral mammary arteries was studied to achieve better long-term results when compared to single IMA and SVG. Interestingly, many analyses have demonstrated that patients undergoing CABG with bilateral internal mammary artery (BIMA) grafting have significantly improved survival and freedom from repeat revascularization when compared with patients receiving a single internal mammary artery (SIMA) [4].

Accordingly, the use of BIMA in diabetics was studied as long as CABG has emerged as the best option of myocardial revascularization in this group [5]. However, in spite of Histological superiority of IMA and the improved outcomes, the use of BIMA in patients with diabetes mellitus is still debated mainly due to the higher risk of sternal infection which remains a life-threatening complication after cardiac surgery associated with increased morbidity and mortality.

The ART trial is the first randomized study that compares outcome of single and bilateral internal thoracic artery grafting for CABG. Survival after BIMA versus SIMA grafting is being assessed by the randomized controlled Arterial Revascularization Trial (ART) [6]. Analysis of early data from this trial demonstrated similar surgical mortality and major morbidity for both the SIMA and the BIMA groups at 30 days and 1 year but with a small increase in the need for sternal wound reconstruction using BIMA. In our study BIMA used in selected diabetic patients do not lead to a significant higher incidence of deep sternal wound infection. We did not get the late survival advantage of using both internal thoracic arteries in this cohort. These results support the feasibility of CABG using BIMA



grafts in patients undergoing CABG however Special cautions should to use BIMA in diabetics have been highlighted [7, 8].

Recently, it has been suggested that the skeletonization technique of internal thoracic artery reduces the risk of deep sternal wound complications by preserving sternal vascularization. Furthermore, a recent meta-analysis compared the incidence of sternal wound infection in diabetic patients undergoing skeletonized and pedicled IMA harvest. While pedicled BIMA harvest clearly increases the risk of DSWI, skeletonized BIMA harvest can be safely performed in diabetic patients [6].

Similarly, other measures should be applied in order to reduce the risk of sternal wound infection especially in diabetic patients. A recent prospective study showed the importance of a tight glycemic control with continuous intravenous insulin infusion- in comparison with fractional subcutaneous insulin injections, reduces significantly serum glucose levels and leads to a significant reduction in deep sternal wound infection rates [9]. Other studies highlighted that patients receiving topical vancomycin before closure of the incision had less superficial sternal infections (0% vs. 1.6%;  $P < 0.0001$ ), deep sternal infections (0% vs. 0.7%;  $P = 0.005$ ), any type of sternal infection (0% vs. 2.2%;  $P < .0001$ ) and more interestingly a significant decrease in sternal infections of any type in patients with diabetes mellitus (0% vs. 3.3%;  $P = 0.0004$ ). As a conclusion they mentioned that topical vancomycin applied to the sternal edges, in conjunction with perioperative antibiotics and controlled glycemic level, helps to eliminate wound infections in cardiac surgical patients [10].

Contraindications to bilateral IMAs, according to the ART Trial, would be insulin-dependent diabetes mellitus, specifically in obese individuals, and chronic obstructive airways disease with some early shoots of higher complications in women and the elderly, which were thus relative contraindications [11]. Nevertheless, our protocol reveals that the feasibility of the double mammary in insulin -dependent diabetic patients without affecting the incidence of deep sternal wound infection, in condition with tight glycemic control and strict hygiene during perioperative period.

## **7. Conclusions**

Excellent outcomes following BIMA grafting can be expected in diabetic patients with a similar morbimortality compared to non-diabetic patients. Thus, use of BIMA grafting is an acceptable surgical procedure technique for diabetic patients. It provides multiple grafting with the best arterial conduits (IMAs) and is associated with an acceptable risk of deep sternal infections provided that preventive measures are taken. Indeed, adherence to a policy of strict perioperative glycemic control, good surgical technique, skeletonization, as well as effective post-operative management of surgical wounds would maximize the adoption of BIMA grafting as a default revascularization strategy even for diabetic patients. Further randomized controlled trials with longer follow-up are needed to confirm the safety and efficiency of BIMA grafting in diabetics.

IntechOpen

## Author details

Hassane Abdallah<sup>1\*</sup>, Ahmed Ibrahim<sup>2</sup> and Khalid Al Khamees<sup>3</sup>

1 Consultant Cardiac Surgeon, Cardiac Surgery Department, Prince Sultan Cardiac Center, AlHassa, Saudi Arabia

2 Consultant Epidemiologist, Research and Biostatistics Department, Prince Sultan Cardiac Center, AlHassa, Saudi Arabia

3 Consultant Cardiac Surgeon, Chairman Cardiac Surgery, Director of VAD Program, CEO- Prince Sultan Cardiac Center, AlHassa, Saudi Arabia

\*Address all correspondence to: abdallahhassane@hotmail.com

## IntechOpen

© 2020 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

## References

- [1] Global Health Estimates 2016: Deaths by Cause, Age, Sex, by Country and by Region. 2000- 2016. Geneva, Switzerland: World Health Organization; 2018. Available from [http://www.who.int/healthinfo/global\\_burden\\_disease/estimates/en/](http://www.who.int/healthinfo/global_burden_disease/estimates/en/). [Accessed from: 28 October 2019]
- [2] Ltman DG. Statistics with Confidence. In: Hopkins W, Batterham AM, editors. Bristol: BMJ Books; 2000;49:6
- [3] Campbell I. Chi-squared and Fisher-Irwin tests of two-by-two tables with small sample recommendations. *Statistics in Medicine*. 2007;26:3661-3675
- [4] Yi G, Shine B, Rehman SM, Altman DG, Taggart DP. Effect of bilateral internal mammary artery grafts on long-term Survival: A meta-analysis approach. *Circulation*. 2014;130:539-545
- [5] Edwin L. Alderman, Katharine Andrews, James Bost, Martial Bourassa et al. Comparison of coronary artery bypass surgery with angioplasty in patients with multivessel disease. The bypass angioplasty revascularization Investi- gation (BARI) investigators. *The New England Journal of Medicine*. 1996;335:217-225
- [6] Taggart D, Altman D, Gray A, Lees B, Nugara F, Yu L, et al. ART investigators. Randomized trial to compare bilateral vs. single internal mammary in coronary artery bypass grafting: 1-year results of the arterial revascularisation trial (ART). *European Heart Journal*. 2010;31:2470-2481
- [7] Taggart DP et al. Randomized trial of bilateral versus single internal-thoracic-artery grafts. *The New England Journal of Medicine*. 2016;375(26):2540-2549. DOI: 10.1056/NEJMoa1610021
- [8] Kelly R, Buth K, Legare JF. Bilateral internal thoracic artery grafting is superior to other forms of multiple arterial grafting in providing survival after coronary bypass surgery. *The Journal of Thoracic and Cardiovascular Surgery*. 2012;144:1408e15
- [9] Furnary AP, Zerr KJ, Grunkemeier GL, Starr A. Continuous intravenous insulin infusion reduces the incidence of deep sternal wound infection in diabetic patients after cardiac surgical procedures. *The Annals of Thoracic Surgery*. 1999;67(2):352-362
- [10] Lazar HL, Ketchedjian A, Haime M, Karlson K, Cabral H. Topical vancomycin in combination with perioperative antibiotics and tight glycemic control helps to eliminate sternal wound infections. *The Journal of Thoracic and Cardiovascular Surgery*. 2014 Sep;148(3):1035-1038. 1038-1040. DOI: 10.1016/j.jtcvs.2014.06.045
- [11] Taggart DP, Benedetto U, Gerry S, Altman DG, Gray AM, Lees B, et al. Bilateral versus single internal thoracic artery grafts at 10 years. *The New England Journal of Medicine* 2019;380:437-446