ORIGINAL ARTICLE

MYOCARDIAL REVASCULARIZATION SURGERY WITH BILATERAL INTERNAL MAMMARY ARTERY

ABSTRACT

Introduction: The internal mammary artery is the only graft with a long-term impact on mortality in patients with coronary artery disease. Some questions limit the use of both arteries simultaneously, such as prolonged surgical time, risk of sternal infections, especially in diabetic and obese patients. This study sought to describe the 5-year experience in patients revascularized with bilateral internal mammary artery (BIMA). **Methods:** Descriptive cohort follow-up study. 42 patients underwent myocardial revascularization with BIMA between 2015-2020, Manuel-Uribe-Ángel Hospital, Envigado-Colombia. Secondary and primary information sources. Univariate analysis was developed for the description of variables. **Results:** Mean age of 55.2 years, 19% were diabetic, mean body mass index (BMI) 24.5 kg/sq.mt; severe coronary artery disease 90.5%, 95.2% with complete revascularization. No patient presented surgical site infection. Median follow-up of 5.1 years during which 5.4% suffered an acute myocardial infarction, 13.5% required percutaneous coronary intervention, 16.2% died, 33.3% of which were attributed to a cardiac cause. **Discussion:** The participants had a normal average BMI, 19% were diabetic; they had adequate metabolic control, presenting mean glycosylated hemoglobin of 7.09%. In the studied population there were no cases of surgical site infection and 16.2% of the cohort presented angina, which is lower than that described in other studies. Incidence of acute myocardial infarction and percutaneous coronary intervention was similar to the ones reported in other studies. **Conclusion:** In the studied population, patients with BMI in the normal range and glycemia with adequate metabolic control, myocardial revascularization with BIMA was a safe technique with acceptable medium-term cardiovascular outcomes.

Key words: *myocardial revascularization, coronary artery bypass, internal mammary-coronary artery anastomosis, treatment outcome*

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INTRODUCTION

The internal mammary artery has anatomic and physiological properties that create resistance to coronary disease[1]. Protection against intimal hyperplasia, vasospasm and atherosclerosis is reflected in a superior performance of grafts, showing up to 90% patency at ten years as compared to a risk of occlusion of almost 50% with venous grafts[2,3]. The use of the left internal mammary artery (LIMA) was established as the gold standard in myocardial revascularization surgery, having proven a significant advantage in post-op results in the long term, even impacting mortality[1,4]. Eventually, based on the promising results of the use of LIMA, the associated use of the right mammary artery was proposed as it showed identical anatomic properties as the contralateral artery; this is how both arteries have come to be used simultaneously for revascularization (BIMA, *bilateral internal mammary artery*).

However, there have been some concerns about this intervention, for which reason it has not gained universal acceptance. Such concerns include longer surgical time, the complexity involved in the technique to harvest the graft and the potential increased risk of sternal infection in high-risk populations, such as diabetic and obese patients[5]. Thus, saphenous vein and radial artery grafts remain as the alternative of choice for many surgeons, and the use of the BIMA technique has been estimated to reach 5 to 20% of all revascularization procedures[6].

Based on recent results of studies on coronary revascularization with the BIMA technique, new information was obtained on the advantages and limitations of the technique, reopening the risk versus benefit arguments[7]. The disadvantages mentioned by some authors are the increased risk of sternal infection[8]; prolonged surgical time[7] and the complexity and rigor involved in the procedure[9].

Recent studies have reported that revascularization with BIMA has a similar performance as other techniques, like LIMA, in the short term; however, it shows higher arterial patency at ten years of follow-up[10]. The trend has been to use this technique in young adults, although European guidelines do not provide a specific cut-off age[11]. However, the double mammary technique is being used more and more frequently in elderly patients[12]. There are safety and effectivity reports, even in populations older than 70, diabetics and obese patients, traditionally classified as high-risk for BIMA[13].

Given the level of controversy this surgical intervention has arisen, this study sought to describe the results obtained in a cohort of patients revascularized with BIMA so as to characterize the population and show the results of the technique, as well as its outcome at 5 years of follow-up.

MATERIALS AND METHODS

A descriptive study involving follow-up of a cohort, using secondary information sources and obtaining clinical records data and primary source data with telephone tracking. The study included all patients that underwent CABG with BIMA during the period 2015-2020 at the Hospital Manuel Uribe Ángel, Envigado, Colombia, recruiting a sample of 42 participants. Having undergone the surgical procedure was the only inclusion criterium and no exclusion criteria applied. The instrument used was a telephone survey conducted by the investigation group with the purpose of allowing follow-up and exploring the outcomes: acute myocardial infarction, angina, percutaneous coronary intervention and death.

IT tools like Excel, Word and Jamovi were used for analysis of the information with a CES University license. A univariate analysis was performed with the aim of describing variables included in the research.

The study was run in compliance with CIOMS International Ethical Guidelines for Health-related Research Involving Humans)[14] and the guidelines provided by 1993 Resolution 008430, where the Ministry of Health provides the scientific, technical and administrative regulations for health-related investigation, according to which this study was rated as "no risk". The Project received approval of the Bioethics Committee of Hospital Manuel Uribe Angel.

RESULTS

Clinical characteristics

The study included 42 patients that underwent myocardial revascularization surgery with BIMA from 2015 to 2020. The study population was mostly males (88.1%), with an average age of 55.2 years. Most of the patients had preserved LVEF, with an average LVEF estimated at 51.2%. At the time of surgery almost one fifth of the patients reported to be active smokers (19%). As for baseline diseases, a prevalence of 11.9% chronic renal disease and 19% diabetes mellitus was found. Of the patients with the latter pathology, 11.9% received medical treatment, whereas 7.1% received insulin. Among diabetics, the mean glycosylated hemoglobin was calculated at 7.09%. A median BMI of 24.5 kg/sq.mt was estimated. Most of the patients had 3 vessels coronary disease, accounting for 52.4%, and 38.1% with more than 3 vessels involved (see *Table 1*).

Perioperative characteristics

Ninety-five point two (95.2%) % of the patients underwent complete revascularization. The average extracorporeal circulation time was 72.3 minutes, with a median aortic clamp time of 63 minutes. The median ICU stay was 2 days. As for postoperative complications, 14.3% of patients presented acute renal lesion, of which only 2.4% required renal replacement therapy. Atrial fibrillation was identified in 7.1% of patients and no cases of operative site infection by mediastinitis or sternal dehiscence were reported. One hundred percent (100%) of the arteries were harvested using the skeletonization technique (see *Table 2*).

Follow-up characteristics

Five patients were lost to the follow-up. It was possible to follow-up 37 patients with a median age of 5.1 years and an interquartile range of 3 years. During this period none of the studied patients required reoperation. Five-point four percent (5.4%) presented acute myocardial infarction. Percutaneous coronary intervention was performed in 13.5% of patients and 16.2% of patients reported angina at some point during the follow up. Six deaths were recorded, 33.3% of which were due to cardiac causes. Of all deaths reported none occurred during the first postoperative month and the average survival was 2.7 years (see *Table 3*).

DISCUSSION

In the studied population, patients with BMI within a normal range and adequate glycemic control, myocardial revascularization with BIMA is a safe technique with acceptable cardiovascular outcomes in the medium term.

TABLE 1. Clinical characteristics of patients that underwent myocardial revascularization with BIMA, 2015-2020

Age (years) X (SD)	Age (years) X (SD)
Sex n (%) • Male • Female	 37 (88.1) 5 (11.9)
LVEF (%) X (SD)	51.2 (9.74)
Smoking n (%)	8 (19)
Chronic renal disease n (%)	5 (11.9)
Diabetes n (%) • Medical management • Management with insulin	 5 (11.9) 3 (7.1)
HbA1c (%) X (SD)	7.09 (1.71)
BMI (kg/m2) Me (IQR)	24.5 (4.02)
Coronary disease n (%) • 2 vessels • 3 vessels • >3 vessels	 4 (9,5) 22 (52,4) 16 (38,1)

TABLE 2. Perioperative characteristics of patients that underwent myocardial revascularization with BIMA, 2015-2020

Complete revascularization n (%)	40 (95.2)
Extracorporeal circulation time (minutes) X (SD)	72.3 (18.2)
Aortic clamp time (minutes) X (SD)	63 (15.8)
ICU Stay (days) Me (IQR)	2 (2)
Mechanical ventilation n (%) • <48 hours • >=48 hours	 37 (88.1) 5 (11.9)
Post-op renal lesion n (%)	6 (14.3)
Post-op dialysis n (%)	1 (2.4)
Post-op atrial fibrillation n (%)	3 (7.1)
Surgical site infection n (%)	0

TABLE 3. Follow-up data of patients that underwent myocardial revascularization with BIMA, 2015-2020

Reintervention n (%)	0
Acute myocardial infarction n (%)	2 (5.4)
Percutaneous coronary intervention (%)	5 (13.5)
Angina n (%)	6 (16.2)
Death n (%)	6 (16.2)
Cause of death n (%) • Cardiac • Non-cardiac	 2 (33.3) 4 (66.7)
Average survival (years)	2.7

Myocardial revascularization surgery with a double mammary artery technique has proven to be safe in the short and medium term and showed better performance in the long term [10,15]. However, the use of BIMA has been controversial as it increases the risk of operative site infection and requires longer surgical time due to the technical difficulty involved[1].

Recent studies have shown that the rate of operative site infections may be reduced using the skeletonized technique of harvesting the mammary artery[8]. It is for this reason that the literature recommends this method[11,16]. In this research work the internal mammary artery was harvested using the skeletonized technique in all cases.

The studied population was characterized by comprising young adults with an average age of 55.2 years, mostly males (88.1%) with preserved ejection fraction (median of 51.2%). Although the trend in the literature has been recommending the use of BIMA in young patients, as is the case of the studied population, the literature also reports that the use of multiple arterial grafts is safe and effective in patients even after 70 years of age[12,13,17].

Patients revascularized with BIMA presented a normal BMI, with a median of 24.4 kg/sq.mt. However, Vitulli et al. concluded that patients with obesity can also benefit from BIMA without increase in mortality[2,18]. Nineteen percent (19%) of them were diabetic and 7.1% insulin dependent. In these patients an adequate control of their metabolic condition was observed, recording a glycosylated hemoglobin value of 7.09%. Diabetes mellitus is considered a risk factor for unfavorable outcomes post-myocardial revascularization at large[19]. Saran et al. have proven that the use of BIMA is safe in high risk patients, including diabetics[7]. Safety in the use of BIMA in higher risk populations, defined in the literature as elderly or obese individuals, women, diabetics, patients with chronic pulmonary disease and reduced ejection fraction[7] has been reassessed; however, high risk patients are not prevalent in the studied population.

No operative site infections were observed in this study; this finding is below the incidence reported in the literature, according to which up to 10% of patients may present this type of infection, 2% mediastinitis and 1% may require sternal reconstruction[8].

During the follow-up it was found that 16.2% of patients reported some episode of angina. Davierwala et a. mention a post-op angina incidence of 28%, a rate that is higher than the one reported in this study[1]. Five point four (5.4%) of patients presented acute myocardial infarction and 95.2% of patients underwent complete revascularization. Taggart et al. reported a myocardial infarction incidence of 4.5%[20], whereas Kurlansky et al. report an incidence of 5,2%[17]. The studied population had a similar evolution as that reported in the literature; the same happens with percutaneous coronary intervention, where the incidence reported was 15.2 to 30.4%, whereas in this study the incidence was 13.5%[21].

Mortality for any cause reported in multiple studies amounts to about 20%[20,21]. In this study it was found that 16.2% of patients died during the follow-up and 33.3% of deaths were secondary to a cardiac cause.

Navarro Garcia found that 26.9% of patients had died at 10 years of revascularization surgery[22]; this study found that mortality increases as from the fourth postoperative year, which, in a long-term follow-up could be compatible with the rate presented by this author.

This investigation has a limited scope as follow-up was by telephone interviews. There may be a bias in the information by not recording events like angina or acute myocardial infarction; however, mortality data does not show this bias and is the primary outcome in this study.

It has been found that the use of the double mammary artery technique has an impact on the long-term survival and a superiority trend has been found in the BIMA vs. single mammary artery grafting[17,23,24]. For this reason, authors like Buttar, suggest that the long-term benefit, added to the short-term benefit of the procedure, make double

mammary revascularization a safe technique in different risk populations[10]. This study presents limitations in its scope as it is descriptive, new investigations with greater methodological rigor are required to compare the use of BIMA vs. LIMA in this population.

In the studied population myocardial revascularization with double mammary artery was a safe technique, with acceptable cardiovascular outcomes in the medium term; however, given its methodological scope, the results of this study do not allow to draw conclusions for the general population. Studies with greater statistical power are required to be able to assess the outcomes of this procedure in the long term.

Conflicts of interest

The authors have no conflicts of interest to disclose.

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