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Original Research Article

Comparative Analysis of Right Internal Mammary Artery and Great Saphenous Vein as Secondary Conduits in Myocardial Revascularization: Mohamed VI University Hospital Experience

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Abstract: ***Background:*** In myocardial revascularisation procedures, the underutilisation of the right internal mammary artery remains a concern. This study aimed to compare outcomes between using the right internal mammary artery (RIMA) and the great saphenous vein (GSV) as secondary conduits in Coronary Artery Bypass Grafting (CABG), focusing on early and mid-term postoperative results. ***Methods:*** A retrospective analysis of 270 patients who underwent CABG between November 2015 and January 2023 at Mohamed VI University Hospital was conducted. Patients were divided into RIMA and GSV groups for comparative analysis. ***Results:*** There were no significant differences in the preoperative characteristics of the study population. Patients in the RIMA group had lower cardiopulmonary bypass time and aortic cross-clamping time (110.70±34.08 vs 127.45±31.17: p<0.00 and 77.67±26.31 vs 82.93±23.66: p<0.00, respectively). The use of GSV was associated with more significant bleeding compared to RIMA (570.46±403.66 vs 761.40±647: p<0.00). However, there were no significant differences in the occurrence of deep sternal wound infection (3.24% vs 4.31%: p=0.8945) between the two groups. Regarding early mortality rates, there was no significant difference observed (5.19% vs 2.58%: p=0.4458). Mid-term results showed no difference in the recurrence of angina and dyspnea between the groups. ***Conclusion:*** The study indicated that RIMA used as a secondary graft in CABG wasn't linked to sternal wound infection or bleeding, suggesting its superiority as a graft choice. The findings aligned with prior research, advocating for the benefits of employing RIMA in myocardial revascularization.

Keywords: Myocardial revascularization, internal mammary artery, great saphenous vein bleeding, deep sternal wound infection.

INTRODUCTION

The debate around the most effective graft strategy for multi-vessel myocardial revascularization continues. While there are evident benefits in utilizing arterial conduits alongside the left internal mammary artery (LIMA) for the left descending coronary artery [1-4], a substantial number of CABG performed worldwide heavily rely

on saphenous venous conduits for the circumflex or right coronary artery [1, 5]. However, studies have highlighted improved long-term outcomes in CABG procedures through the use of internal mammary arteries (IMA) [6, 7]. Recently, more authors have indicated that total arterial revascularization could potentially offer better clinical outcomes for patients compared to traditional CABG [8]. In light of this, our study aimed to share our insights into myocardial revascularization, examining the use of the GSV or the RIMA as secondary grafts, with a specific focus on early and mid-term postoperative results.

PATIENTS AND METHODS

Every patient who underwent CABG from November 2015 to January 2023 (n=270) was retrospectively enrolled in the study. Two distinct groups were established: one comprised individuals treated with VSI, while the other consisted of those treated with RIMA. For the initial assessment of postoperative outcomes, early echocardiography was conducted, and patients were continuously monitored in the Intensive Care Unit (ICU). A deep sternal wound infection was identified as one necessitating reoperation. Bleeding was assessed based on the average blood loss through sternal drains within the initial 12 hours post-surgery. Postoperative acute renal failure was defined as a greater than 50% increase in serum creatinine level from the preoperative value, accompanied by the need for dialysis. Stroke criteria encompassed the sudden onset of neurological deficits persisting for over 24 hours without an apparent nonvascular cause.

Medium-term clinical assessment involved telephone interviews with participating patients, who were subsequently included in the study. Statistical analyses were performed using IBM-SPSS Statistics 21, a versatile software, and DOSBox 0.74-2. Early outcome composite criteria included sternal wound infection, bleeding, stroke, acute ischemia, and clinical evaluation (recurrence of angina and dyspnea) for medium-term outcomes. Group comparisons were conducted with reference to the p-value.

SURGICAL TECHNIQUES AND OUTCOMES

1. Surgical Techniques

Following a median sternotomy, the internal mammary arteries were harvested as skeletonized grafts. The primary technique involved in-situ anastomoses of the LIMA to the left anterior descending artery. The RIMA was utilized as a free graft and anastomosed proximally in a Y-shape on the LIMA, enabling sequential revascularization of the circumflex and the Right Coronary Artery if required. The GSV was obtained and anastomosed on the circumflex and/or Right Coronary Artery, with its proximal end anastomosed to the aorta using the lateral aortic clamping technique.

During cardiopulmonary bypass, intermittent blood cardioplegia was employed for myocardial protection. The selection of arterial bypasses type and number was guided by angiographic findings. Before concluding the sternotomy, mediastinal drains and temporary epicardial wires were placed. The sternotomy closure consistently involved the use of steel wires. Closure of the subcutaneous tissue employed vicryl 1, while the intradermal plane was sutured using rapid vicryl.

2. Preoperative data

The research involved 270 patients, with a median age of 61.68±9.00 years, of whom 71.11% were male. Common preexisting conditions among these patients included diabetes (55.18%), hypertension (32.22%), smoking (22.59%), dyslipidemia (18.88%), and obesity (7.03%). Among the total patients, 154 (57.03%) underwent treatment involving the RIMA, while 116 (42.97%) received treatment involving the GSV. Baseline preoperative characteristics (see Table 1) were largely similar between the two groups, except for age, where individuals treated with RIMA were younger (59.66±7.83 years) compared to those treated with GSV (63.94±9.81 years)

Table 1: Preoperative Characteristics

Variables	Total N=270	RIMA N=154	GSV N=116	P-value
Age	61.68±9.00	59.66.±7.83	63.94±9.81	0.000
Male	192(71.11%)	111(72.07%)	81(69.82%)	0.6863
Smoking	61(22.59%)	36(23.37%)	25(21.55%)	0.7226
Diabetes	149(55.18%)	88(57.14%)	61(52.58%)	0.4560
Hypertension	87(32.22%)	48(31.16%)	39(33.62%)	0.6695
Dyslipidemia	51(18.88%)	28(18.18%)	23(19.82%)	0.7323
Obesity	19(7.03%)	11(7.14%)	8(6.89%)	0.9375
Coronary artery revascularization history	13(4.81%)	8(5.19%)	5(4.31%)	0.7368
Acute coronary syndrome	72(26.66%)	48(31.16%)	24(20.68%)	0.0539
Stroke	4 (1.48%)	4 (2.3%)	0	
Segmental hypokinesia	151 (55.92%)	90 (58.44%)	61(52.58%)	0.3373

Variables	Total N=270	RIMA N=154	GSV N=116	P-value
Global hypokinesia	31(11.48%)	23(14.93%)	8(6.89%)	0.0402
Akinesia	34(12.5%)	19(12.5%)	15(12.93%)	0.8843
Chest pain (angina)	260 (96.29%)	150(97.40%)	110(94.82%)	0.4332
Dyspnea	106 (39,28%)	49 (31.81%)	57(45.13%)	0.0287

3. Intra and post operative outcomes (Table 2)

The average number of grafts utilised for revascularization in both groups was comparable (3.09±0.88 vs 3.08±0.78, p=0.9292). Patients treated with RIMA exhibited significantly shorter cardiopulmonary bypass and aortic cross-clamping times compared to the GSV group (110.70±34.08 vs 127.45±31.17, and 77.67±26.31 vs 82.93±23.66, respectively).

Regarding mortality, there were 11 hospital deaths, equating to an overall mortality rate of 4.07%. However, there was no noteworthy disparity in mortality between the RIMA and GSV groups (5.19% vs 2.58%, p=0.4458). The use of GSV was linked to a higher risk of postoperative bleeding compared to RIMA (570.46±403.66 vs 761.40±647, p=0.0000), although there was no significant difference in reoperation for bleeding.

Other complications, such as deep sternal wound infection, stroke, and renal failure, occurred at comparable rates in both groups. There were no instances of acute ischemia during the study period. Immediately after surgery, a notable decrease in clinical signs was observed in all patients, and they continued lifelong anti-ischemic treatment.

Throughout a follow-up period averaging 3.2 ± 1.3 years, 4.21% of patients experienced recurring angina and dyspnea, with similar incidences observed in both the RIMA and GSV groups (2.33% vs 5.71%, p=0.97). There were no significant differences in the occurrence of deep sternal wound infection and death between the two groups during medium-term follow-up (1.66% vs 0, respectively) (see Table 3).

Table 2: Intraoperative and postoperative outcomes

VARABLES	Total N=270	RIMA N=154	GSV N=116	P- value
Mitral valve replacement	4(1.48%)	2(1.60%)	2(1.72%)	0.8240
Aortic valve replacement	8(2.96%)	1(0.64%)	7(6.03%)	0.0263
Cardiopulmonary bypass time	117.83±33.61	110.70±34.08	127.45±31.17	0.0000
Aortic cross clamping time	80.24±25.27	77.67±26.31	82.93±23.66	0.0000
Graft number	3.09±0.84	3.09±0.88	3.08±0.78	0.9292
Vasoactive drugs	152 (56.29%)	87 (56.49%)	65 (56.03%)	0.9399
Segmental hypokinesia	102(37.77%)	59(38.31%)	43(37.06%)	0.3348
Global hypokinesia	35(12.96%)	22(14.28%)	13(11.20%)	0.4559
Akinesia	14(5.89%)	11(7.14%)	3(2.58%)	0.0946
Overage bleeding	668.47±572.78	570.46±403.66	761.40±647.90	0.0000
Reoperation for bleeding	1(0.37%)	0	1(0.81%)	
Deep sternal wound infection	10(3.57%)	5(3.24%)	5(4.31%)	0.8945
Pericardial effusion	6(2.22%)	4(2.59%)	2(1.72%)	0.9482
Stroke	4(1.48%)	1(0.65%)	3(2.58%)	0.4264
Pleural effusion	4(1.48%)	1(0.65%)	3(2.58%)	0.4264
Renal failure	1(0.37%)	1(0.65%)	0	
Acute ischemia	0	0	0	
Mortality rate	11(4.07%)	8(5.19%)	3(2.58%)	0.4458
Angina	4(1.48%)	4(2.59%)	0	
Dyspnea	5(1.78%)	4(2.59%)	1(0.86%)	0.5544

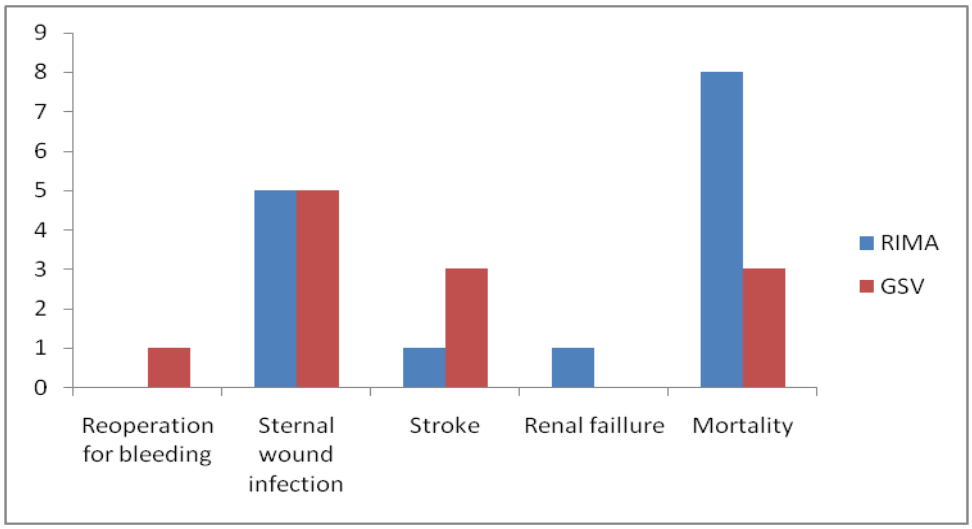

Fig. 1: Bar chart showed number of the complications

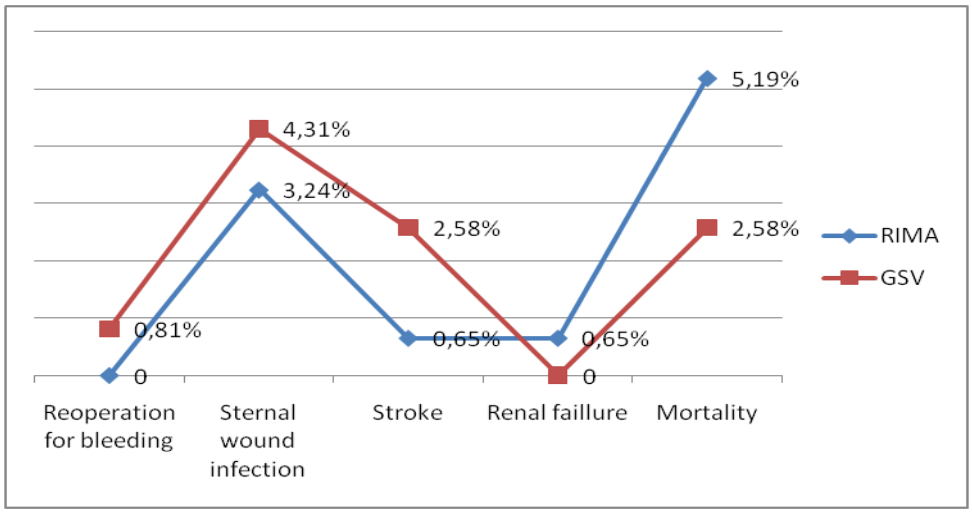

Fig. 2: Line chart showed the proportion of patients in the 2 groups relating to complications

Table 3: Long-term follow up

	TOTAL N=95	RIMA N=60	GVS N=35	P-value
Recurrence angina	4(4.21%)	2(3.33%)	2(5.71%)	0.97
Dyspnea	4(4.21%)	2(3.33%)	2(5.71%)	0.97
Sternal wound infection	1(1.05%)	1(1.66%)	0	N/A

DISCUSSION

The findings of this study indicated that both the RIMA and the GSV can serve as effective conduits for myocardial revascularization. The two groups of patients, one treated with RIMA and the other with GSV, exhibited similar baseline characteristics, barring age differences that might have influenced the choice of conduit. The study revealed that employing RIMA was linked to shorter cardiopulmonary bypass and aortic cross-clamping times, hinting at potentially swifter and less invasive procedures compared to GSV. Nonetheless, there was no significant difference in the overall number of grafts used for revascularization between the two groups.

The use of the GSV as a secondary conduit in elderly patients resonated with findings from other studies: Claudio *et al.,* [6], Calafione *et al.,* [9], and Royse *et al.,* [10] reported that many surgeons are cautious about using mammary arteries in elderly patients to mitigate invasiveness and surgical risks, instead opting for saphenous vein grafts, even for bridging the descending anterior artery. Conversely, recent studies have emphasized the adoption of multiple arterial grafts, demonstrating that arterial revascularization enhances outcomes in patients undergoing CABG surgery, irrespective of the arterial conduit type used [9,10].

Notably, the use of the GSV in this study was linked to an extension in the duration of aortic clamping and cardiopulmonary bypass, unlike the employment of RIMA, where establishing connections between the internal mammary artery (IMA) and coronary arteries poses more challenge and demand [11]. The notable increase in arterial graft usage contributed to an enhancement in the technical proficiency of our surgical team, resulting in swifter execution of internal mammary artery/coronary artery anastomoses. Conversely, the proximal anastomoses of vein grafts, conducted under extracorporeal circulation in the GSV group, led to a delayed cardiopulmonary bypass time.

Chaudray *et al.,* Jegaden *et al.,* and Mehsood *et al.,* noted significantly higher mean blood loss in patients where the RIMA was harvested and used as a conduit [12-15]. Similar results were also observed by Sethi *et al.,* and Werner *et al.,* in their respective studies [16, 17]. In our department, all patients who underwent CABG had their LIMA harvested. For patients in the RIMA group, bilateral internal mammary artery (IMA) dissection was performed, potentially contributing to more substantial bleeding. Surprisingly, bleeding was higher in the great saphenous vein (GSV) group, which contrasts with findings from other studies. Justyna Bartoszko *et al.,* [18] discovered in their research that a longer duration of cardiopulmonary bypass (CPB) was linked to indicators of increased intraoperative bleeding severity. Hence, the bleeding in the GSV group might be potentially attributed to the extended CPB duration. Conversely, the use of a skeletonizing technique during internal mammary artery harvesting played a role in managing post-operative bleeding in the RIMA group. Mehmet Özülk also highlighted the role of the skeletonization technique in controlling postoperative bleeding during internal mammary artery harvesting [19].

Researchers have noted a correlation between the use of bilateral mammary arteries and sternal wound infections [20, 21]. In a comprehensive study involving 12,267 consecutive cardiac surgical patients, Borger and colleagues reported a 3.2 times increased risk of sternal wound infections associated with the use of bilateral internal mammary arteries. Similarly, Stahle *et al.,* in a study with 13,285 cardiac surgery patients, also discovered a link between bilateral internal mammary arteries and sternal wound infections [21]. However, in our study, we found no significant difference in the incidence of deep sternal wound infections between the two groups (3.24% vs. 4.31%, p-value=0.8945).

The majority of CABG procedures are performed under cardiopulmonary bypass (CPB). When employing the GSV as a conduit, manipulation of the aorta is often necessary to create the proximal anastomosis [22]. Conversely, the use of bilateral internal mammary arteries (BIMA) eliminates the need for proximal anastomosis and side-clamping of the aorta, and has been associated with a reduced stroke rate [23]. In our practice, the surgical technique involving partial lateral clamping of the aorta may have been associated with neurological events and acute limb ischemia. However, our study revealed a low incidence of stroke in both the GSV and BIMA groups, with no reported cases of acute limb ischemia as a complication. In-hospital mortality was recorded in 5.2% of patients in the RIMA group and 2.8% in the GSV group, but the disparity in mortality rates between the two groups did not reach statistical significance. Similar outcomes were also reported by Rocha *et al.,* [24].

The average follow-up duration was 3.2±1.3 years. Medium-term follow-up was conducted on 95 patients, with 60 in the first group (RIMA) and 35 in the second group (GSV). The established positive impact of myocardial revascularization in alleviating angina is well-acknowledged [22, 26-28]. Our study indicated no significant difference in the occurrence of angina or dyspnea between the two groups during the follow-up period. However, it's important to note that conducting follow-up interviews via telephone might have limitations in drawing definitive conclusions, representing a limitation of our study. It's crucial to acknowledge other limitations of this study, including its retrospective nature, potential selection biases, and the relatively modest sample size.

CONCLUSION

As per our study, incorporating the RIMA as a secondary graft in CABG doesn't correlate with sternal wound infection or bleeding. Our findings underline the superiority of RIMA as a graft choice in coronary artery bypass procedures. Furthermore, the use of lateral aortic clamping for aorto-venous anastomosis doesn't appear to impact the occurrence of neurological events. These results echo previous research findings, further solidifying the case for surgeons to consider the advantages of utilizing the RIMA as a secondary conduit in myocardial revascularisation.

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Ethical approval: The study was approved by the Institutional Ethics Committee.

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