IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 23, Issue 7 Ser. 1 (July. 2024), PP 14-22
www.iosrjournals.org

Association of sternal dehiscence in pedicled versus skeletonised LIMA/BIMA harvest: Comparative retrospective study

Ashish S. Tyagi • Subrata Pramanik • Madhur Kumar • Anubhav Gupta (corresponding author) • Rimy Prasahd • Deepak Sridhar • Shrenuj Marvania

Abstract

Introduction

The gold standard conduits for coronary revascularisation are the internal thoracic arteries (ITAs) owing to their anti-atherosclerotic properties and long-term patency. The two established core techniques remain pedicled and skeletonised harvests. The skeletonised approach is considered superior for sternal wound preservation because it reduces tissue mobilisation and maintains collateral flow to the sternum by preserving some intercostal and sternal branches; however, there is still no consensus on this. This retrospective study compared the association between sternal wounds in pedicled vs. skeletonised LIMA and BIMA harvested from patients.

Patients and Methods

Between January 2023 and February 2024, 60 patients who underwent coronary artery bypass grafting (CABG) at our institute with LIMA or BIMA harvests as grafts were divided into two equal groups. Group 1 consisted of patients with pedicled ITA harvests and Group 2, included patients with skeletonised ITA harvests. Patients who needed emergency or redo CABG, had a low ejection fraction with or without IABP insertion, were on dialysis, or had associated valvular heart disease requiring valve replacement along with CABG were excluded from the study. The study used the departmental database and intraoperative records, with any incidence of sternal wounds or dehiscence noted in subsequent OPD follow-up records. The study was approved by the ethics committees of the Vardhaman Mahavir Medical College and Safdurjung Hospital.

Discussion

The internal thoracic artery originates from the first part of the subclavian artery. The collateral parietal branches of the ITA are the anteriorintercostal, sternal, and perforating branches.

The use of the ITA as a graft for coronary revascularisation has been a significant discovery since the advent of CABG. It is now well established over multiple studies and long-term follow-up that the ITA has the highest patency rate among the options available for coronary grafting.

ITA exhibits a unique characteristic of resistance to atherosclerosis, a quality that the native coronary artery does not possess. This resistance is attributed to the abundance of nitric oxide synthase in the endothelium leading to accentuated nitric oxide release, along with vascular smooth muscle cells that exhibit reduced tissue factor expression, high tissue-type plasminogen activator production, and reduced proliferation and migration.

RESULTS

Our study revealed that the distribution of Age, Sex, Body mass index, Number of grafts used, and comorbidities did not significantly differ between groups, suggesting a balanced patient population. The incidence of deep sternal wound infection revealed a notable discrepancy. Patients who underwent pedicled ITA harvest exhibited a significantly higher rate (13.33%) of sternal wound infection than those in the skeletonised group.

Conclusions

Our results emphasise the superiority of skeletonised ITA harvest over the pedicled technique in coronary revascularisation. Skeletonisation reduces sternal wound complications by preserving collateral blood supply to the sternum and minimising tissue trauma. Although further research is warranted to corroborate these findings and elucidate the underlying mechanisms, the evidence presented herein supports the preferential use of skeletonised ITA harvest in coronary revascularisation to optimise patient outcomes and enhance surgical success.

Date of Submission: 24-06-2024 Date of Acceptance: 03-07-2024

I. Introduction

The gold standard conduits for coronary revascularisation are the internal thoracic arteries (ITAs) because of their anti-atherosclerotic characteristics and long-term patency[1-2].

Techniques introduced by various researchers include harvesting ITAs in a pedicled or skeletonised fashion, using electrocautery or harmonic scalpels with open or intact pleura, clipping the end or maintaining perfusion, and papaverine delivery via intraluminal injection, perivascular injection, injection into the endothoracic fascia, and papaverine topical spray. However, the two established core techniques are pedicled versus skeletonised harvests. Theoretically, it is observed that technically less challenging and faster, the pedicled technique leads to significant sternal devascularisation[3] more so if bilateral ITA are harvested.

Skeletonisation was first described by Keele in 1987[4] and is considered a superior option for sternal wound preservation because it reduces tissue mobilisation and maintains collateral flow to the sternum by preserving some intercostal and sternal branches[5-6].

This study retrospectively compared the association between sternal wounds in pedicled and skeletonised left internal mammary artery (LIMA) and bilateral internal mammary artery (BIMA) harvested from patients at our institute, VMMC & SJH, New Delhi.

Patients and Methods

This study aimed to investigate the association between the ITA harvesting techniques (pedicled versus skeletonised) and sternal wound complications in patients undergoing coronary artery bypass grafting (CABG).

Patient Selection Criteria (N= 60):

- Patients included in the study underwent CABG at VMMC and SJH, New Delhi, between January 2023 and February 2024.
- This study focused on patients who received a single or bilateral ITA graft (SITA or BITA).

The patients were divided into two study groups based on the technique employed for ITA harvest (pedicled vs. skeletonised).

 Group 1: Patients who underwent pedicle ITA harvest.
 Group 2: Patients who underwent skeletonised ITA harvest.

This study utilised the departmental databases and intraoperative records to collect retrospective data on the incidence of sternal wound complications, including dehiscence, which were documented in the subsequent outpatient department (OPD) follow-up records.

Exclusion Criteria:

- Patients requiring emergency or redo CABG
- Patients with a low ejection fraction with or without intra-aortic balloon pump (IABP) insertion
- Patients on dialysis
- Patients with associated valvular heart disease requiring valve replacement along with CABG

Ethical Approval: The study was approved by the Ethics Committee of Vardhaman Mahavir Medical College and Safdarjung Hospital, ensuring adherence to ethical standards and patient confidentiality.

Methodology:

1. **Retrospective Study Design:**
   - This study adopted a retrospective design that involved the analysis of pre-existing data to investigate relationships or outcomes.
   - This design is suitable for assessing associations between variables and outcomes based on historical data.
2. **Database Review:**
   - Patient data, including demographics, operative details, and postoperative outcomes, were extracted from institutional databases.
   - The intraoperative records provided information on the surgical technique used (pedicled or skeletonised) and any intraoperative findings relevant to the study.
3. **Follow-Up Records Analysis:**
   - Subsequent OPD follow-up records were reviewed to determine the incidence of sternal wound complications, particularly dehiscence.
   - This allowed the assessment of postoperative outcomes and complications related to the ITA harvest technique.
4. **Statistical Analysis:**
   - Descriptive statistics were used to summarise patient demographics and characteristics in both study groups.

- A comparative analysis, possibly using statistical tests, such as chi-square tests or t-tests, was conducted to assess the differences between the pedicled and skeletonised groups, particularly regarding the incidence of sternal wound complications.

5. **Ethical Considerations:**

- Ethical approval was obtained to ensure that the study complied with ethical standards and to protect patient rights and privacy.
- The requirement for informed consent from the patients has been waived because of the retrospective nature of the study and the use of anonymised data.

II. Discussion

Anatomy

The ITA originates from the first part of the subclavian artery, either directly (70%) or from a common trunk (30%). The right ITA is generally more consistent and originates separately in 95% of cases[7]. It continues inferomedially into the thoracic cavity, deep to the clavicle and the first rib. It is most commonly crossed by the phrenic nerve anteriorly (54%) around 2 cm from the origin and continues till the 6^{th}-7^{th} intercoastal space before dividing into two terminal branches, the superior epigastric artery and the musculophrenic artery.

Branches

Anterior collaterals	**Posterior collaterals**	**Terminal branches**
Anterior intercostal branches	Mediastinal branches	Superior epigastric artery
Perforating branches	Thymic branches	Musculophrenic artery
Medial mammary arteries	Pericardiacophrenic artery	
	Sternal branches	
	Bronchial branches	

The collateral parietal branches of the ITA are the anterior intercostal, sternal, and perforating branches which may originate either individually or from the common trunk. The anterior intercostal are generally 4-10 in number, and the sternal are 3-6 in number.

An attempt to preserve these specific branches during ITA dissection leads to better maintenance of sternal perfusion[8].

Advantages of Internal thoracic artery graft

The use of the ITA as a graft for coronary revascularisation has been a significant discovery since the advent of CABG. Multiple studies and long-term follow-ups have established that the ITA carries the highest patency rates among the options available for coronary grafting. It has been observed that using the ITA as a graft results in an increase of up to 10%-30% in the major adverse cardiovascular events (MACE)-free interval compared to venous graft alone[9].

Cameron et al. observed that the use of the ITA as a graft to the left anterior descending artery was the single most important predictor of survival after CABG[10]. ITA exhibits a unique resistance to atherosclerosis a quality that the native coronary artery does not possess. This is attributed to the abundance of nitric oxide synthase in the endothelium with accentuated NO release, along with vascular smooth muscle cells which exhibit reduced tissue factor expression, high tissue-type plasminogen activator production, and reduced proliferation and migration[10].

Skeletonisation increases the conduit length of the ITA compared to the pedicled approach by up to 4 cm, making it suitable for distal and tension-free implantation over the left anterior descending artery[11]

Skeletonised ITA harvest.

Vineberg in 1946 was the first to pioneer ITA harvest and implant it into a tunnel in the myocardium. He was also the first to harvest the ITA in a skeletonised fashion[12-13]. However, the detailed technique of skeletonisation was described in 1962 in a paper titled "Vinberg's Operation" by Effler et al.[14-15].

The technique of skeletonisation: The parietal pleura is separated from the internal thoracic wall, and the LIMA along with the two accompanying veins (the medial and lateral internal thoracic veins) are visualised under the endothoracic fascia[16]. The endothoracic fascia is incised using diathermy and pulled down to expose the ITA. ITA

dissection is performed away from the chest wall using low-energy diathermy and a flat diathermy blade for cold dissection. The branches are identified and dissected towards the chest wall. After completely dissecting the branches, a vascular clip is placed towards the ITA. The ITA is dissected as close to the subclavian artery as possible to avoid stealing towards the intercostal branches, ensuring a free flow distally, and dissected until the terminal branches are at the level of the 6^{th}-7^{th} intercostal spaces.

III. RESULTS

Patients were divided into two equal groups based on the technique used to harvest the ITA (pedicled vs. skeletonised): Group 1 (skeletonised) and Group 2 (pedicled). Both groups had a balanced patient distribution based on

1) Age: Mean age with a standard deviation of Group 1 - 56.37 (9.8) and Group 2 - 54.07 (8.6).
2) Sex: Group 1 Males (86.66%) and Females (13.33%) compared to Group 2 Males (70%) and Females (30%).
3) Body mass index (BMI): The mean BMI in kg/sqm (SD) was as follows Group 1 -23.24 (3.24); and Group 2 – 23.45 (3.69).
4) Type II Diabetes mellitus: Present in Group 1 (63.33%) and Group 2 (73.33%).

This indicates an equally distributed and balanced dataset between the two comparative groups. This data was also considered among the factors affecting the sternal wound in the postoperative period.

Technique of graft harvesting	Number of cases
Group Skeletonised	30 (50%)
Group Pedicled	30 (50%)

Table 1: Distribution of cases according to technique of graft harvesting done. (N = 60)

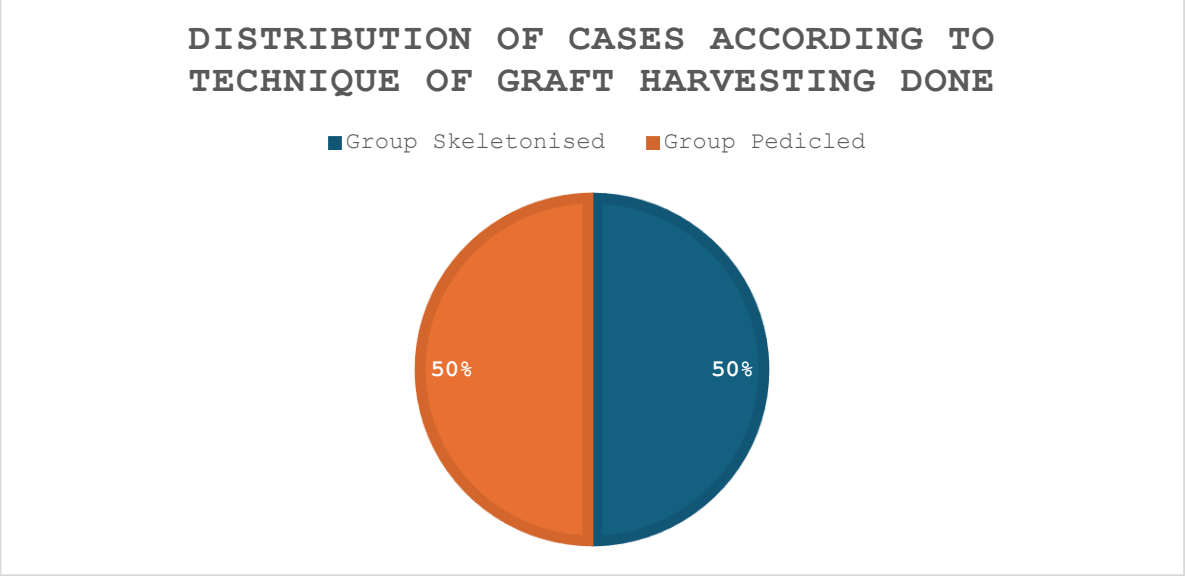


Table 2: Comparison of age between the two groups. (N = 60)

Age of the patient	Group Skeletonised	Group Pedicled	All cases	p-value
Below 50 years	7 (23.33%)	7 (23.33%)	14 (23.33%)	0.838
50 – 60 years	12 (40%)	14 (46.66%)	26 (43.33%)	
Above 60 years	11 (36.66%)	9 (30%)	20 (33.33%)	
Mean age in years (SD)	56.37 (9.83)	54.07 (8.59)	55.22 (9.23)	0.339

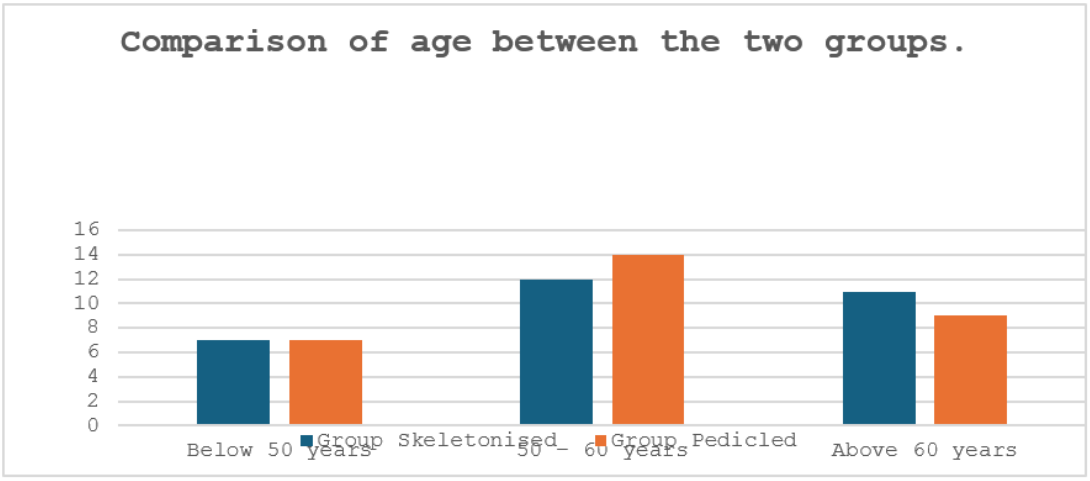


Table 3: Distribution of cases according to sex between the two groups. (N = 60)

Sex of the patient	Group Skeletonised	Group Pedicled	All cases	p-value
Male	26 (86.66%)	21 (70%)	47 (78.33%)	0.117
Female	4 (13.33%)	9 (30%)	13 (21.66%)	

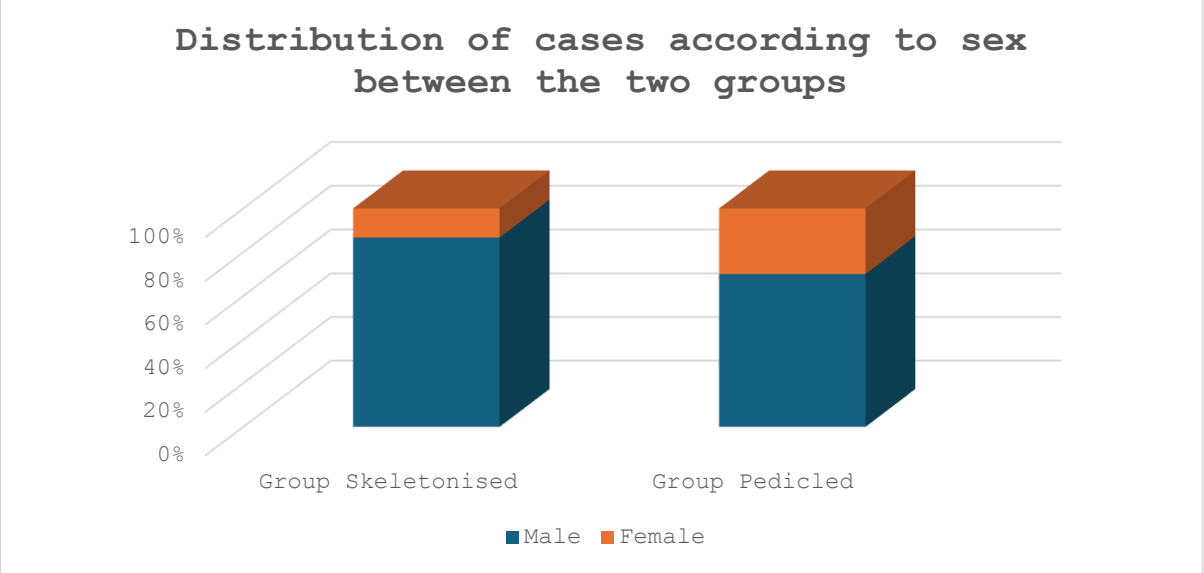


Table 4: Comparison of body mass index (BMI) between the two groups. (N = 60)

Body mass index	Group Skeletonised	Group Pedicled	All cases	p-value
Underweight	2 (6.66%)	0 (0%)	2 (3.33%)	0.360
Normal	20 (66.66%)	20 (66.66%)	40 (66.66%)	
Overweight	8 (26.66%)	9 (30%)	17 (28.33%)	
Mean BMI in Kg/sqm (SD)	23.24 (3.24)	23.45 (3.69)	23.34 (3.44)	0.815

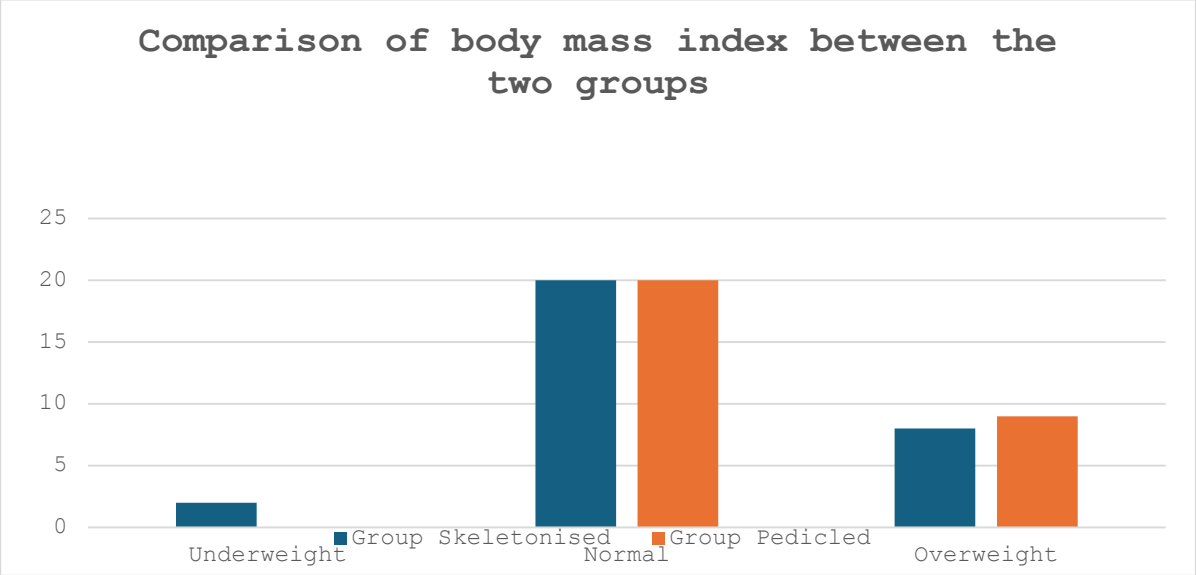


Table 5: Distribution of cases according to type of CABG in the two groups. (N = 60)

Type of CABG	Group Skeletonised	Group Pedicled	p-value
Off-pump	14 (46.66%)	22 (73.33%)	0.037
On-pump	12 (40%)	8 (26.66%)	
Op-CABG	4 (13.33%)	0 (0%)	

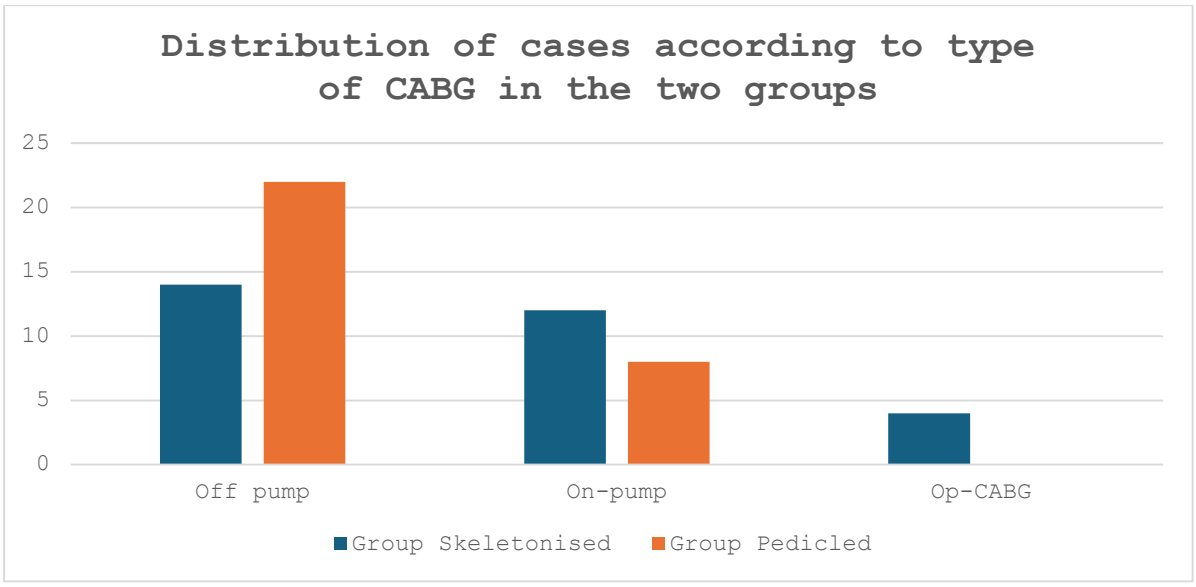


Table 6: Distribution of cases according to the number of bypasses in the two groups. (N = 60)

Bypass	Group Skeletonised	Group Pedicled	p-value
Single	0 (0%)	1 (3.33%)	0.291
Double	9 (30%)	10 (33.33%)	
Triple	14 (46.66%)	16 (53.33%)	
Quadrupled	7 (23.33%)	2 (6.66%)	
Quintuple	0 (0%)	1 (3.33%)	

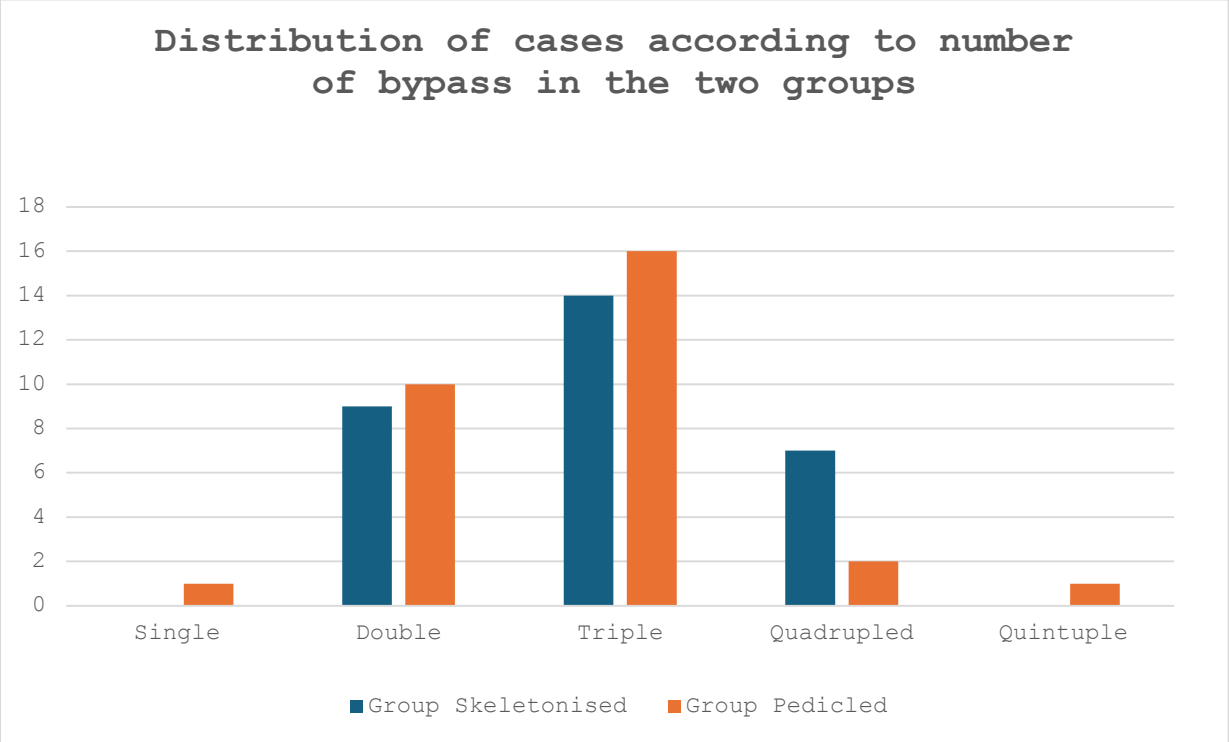
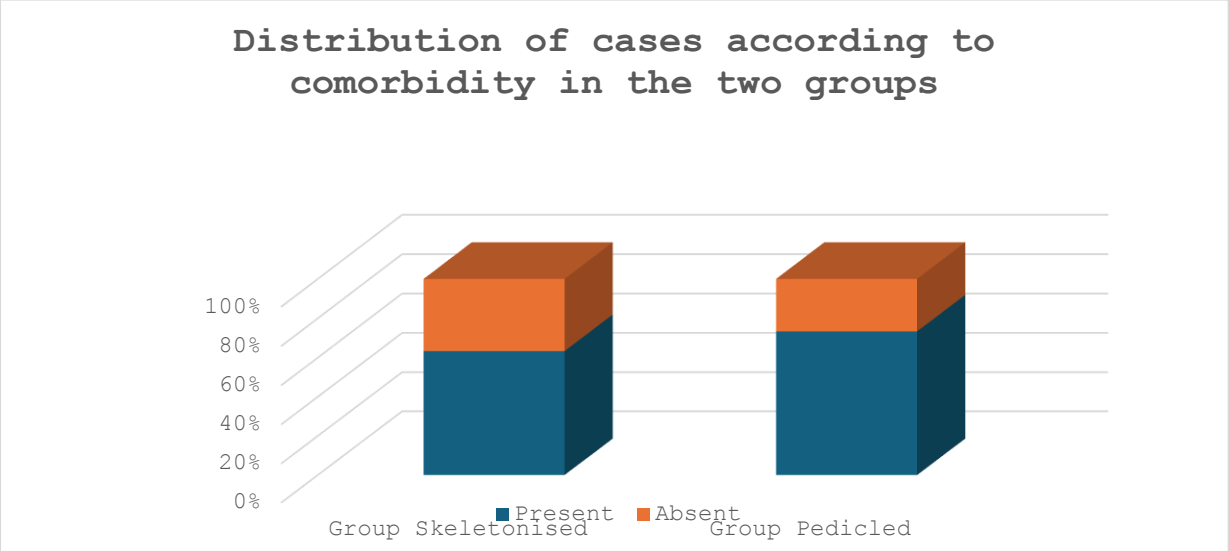


Table 7: Distribution of cases according to comorbidity in the two groups. (N = 60)

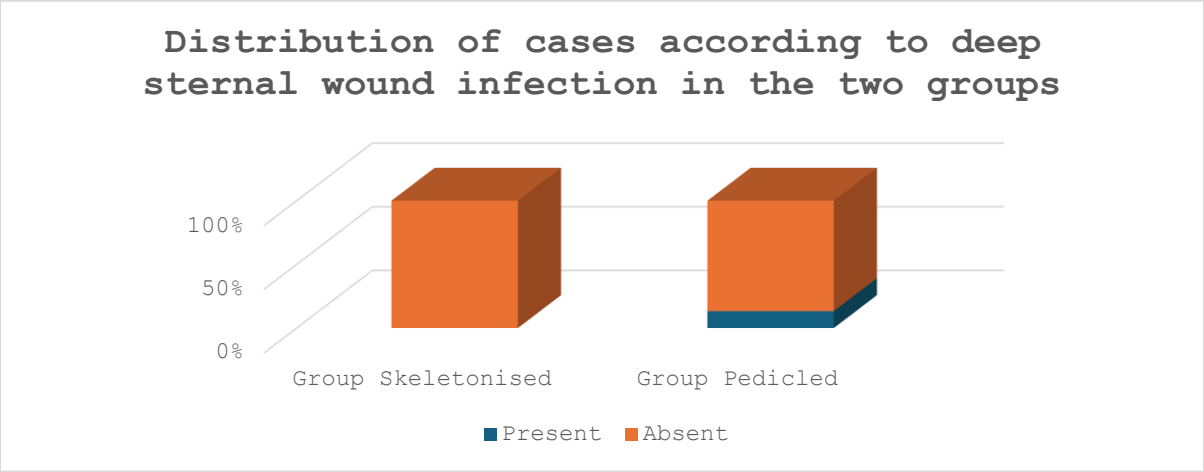
Type II DM	Group Skeletonised	Group Pedicled	p-value
Present	19 (63.33%)	22 (73.33%)	0.405
Absent	11 (36.66%)	8 (26.66%)	



In our study after comparing the patients divided into two groups who underwent CABG with a LIMA/BIMA harvest graft using two techniques under study (skeletonised vs pedicled), it was observed that although age, sex, BMI, off-pump versus on-pump approach, numbers of grafts used and comorbidities did not significantly differ, the incidence of sternal wound infection postoperatively was significantly lower in patients where LIMA/BIMA were harvested in a skeletonised fashion. The results are summarised in Table 8.

Table 8: Distribution of cases according to deep sternal wound infection in the two groups. (N = 60)

Deep sternal wound infection	Group Skeletonised	Group Pedicled	p-value
Present	0 (0%)	4 (13.33%)	0.038
Absent	30 (100%)	26 (86.66%)	



IV. Conclusion

Our study revealed that the distribution of age, sex, BMI, type of CABG (off-pump and on-pump), number of grafts used, and comorbidities did not differ significantly between the pedicled and skeletonised groups, suggesting a balanced patient population. The incidence of deep sternal wound infection revealed a notable discrepancy between the two groups. Patients who underwent pedicled ITA harvest exhibited a significantly higher rate (13.33%) of sternal wound infection compared to those in the skeletonised group.

This finding underscores the potential advantage of skeletonisation in reducing the risk of postoperative complications, particularly deep sternal wound infections, which can significantly affect patient morbidity and mortality.

Reference:

[1]. Loop FD, Lytle BW, Cosgrove DM, Stewart RW, Goormastic M, Williams GW, et al. Influence of the internal-mammary-artery graft on 10-year survival and other cardiac events. N Engl J Med [Internet]. 1986;314(1):1–6. Available from: http://dx.doi.org/10.1056/NEJM198601023140101

[2]. Yi, G., Shine, B., Rehman, S. M., Altman, D. G., & Taggart, D. P. (2014). Effect of Bilateral Internal Mammary Artery Grafts on Long-Term Survival. *Circulation*, *130*(7), 539–545. https://doi.org/10.1161/circulationaha.113.004255

[3]. Kamiya H, Akhyari P, Martens A, Karck M, Haverich A, Lichtenberg A. Sternal microcirculation after skeletonized versus pedicled harvesting of the internal thoracic artery: a randomized study. J Thorac Cardiovasc Surg [Internet]. 2008;135(1):32–7. Available from: http://dx.doi.org/10.1016/j.jtcvs.2007.09.004

[4]. Keeley SB. The skeletonized internal mammary artery. **Ann Thorac Surg**. 1987; 44: 324–325. DOI : 10.1016/s0003-4975(10)62088-7

[5]. Benedetto U, Altman DG, Gerry S, Gray A, Lees B, Pawlaczyk R, et al. Pedicled and skeletonized single and bilateral internal thoracic artery grafts and the incidence of sternal wound complications: Insights from the Arterial Revascularization Trial. J Thorac Cardiovasc Surg [Internet]. 2016;152(1):270–6. Available from: http://dx.doi.org/10.1016/j.jtcvs.2016.03.056

[6]. M. Boodhwani, B.K. Lam, H.J. Nathan, T.G.Mesana, M. Ruel, W. Zeng, editor. Skeletonized internal thoracic artery harvest reduces pain and dysesthesia and improves sternal perfusion after coronary artery bypass surgery: a randomized, double blind, within-patient comparisonCirculation. 2006. https://doi.org/10.1016/j.jtcvs.2009.03.066

[7]. Chavanon O, Romary B, Martin C, Chaffanjon P. Anatomical study of the internal thoracic arteries; implications for use in coronary artery bypass graft surgery. Surg Radiol Anat [Internet]. 2016;38(10):1135–42.

[8]. http://dx.doi.org/10.1007/s00276-016-1678-x

[9]. Coronary bypass surgery with internal-thoracic-artery grafts—effects on survival over a 15-year period. ACC Curr J Rev [Internet]. 1996;5(3):61–2. http://dx.doi.org/10.1016/1062-1458(96)86750-x

[10]. Carrier M, Grégoire J, Cartier R, Leclerc Y, Pelletier L-C. Effect of internal mammary artery dissection on sternal vascularization. Ann Thorac Surg [Internet]. 1993;55(3):803–4. Available from: http://dx.doi.org/10.1016/0003-4975(93)90306-3

[11]. Shahian DM. 50th Anniversary Landmark Commentary on Edwards FH, Clark RE, Schwartz M. Coronary artery bypass grafting: The Society of Thoracic Surgeons National Database experience. Ann Thorac Surg 1994;57:12-9. Ann Thorac Surg [Internet]. 2015;100(6):1990–1. Available from: http://dx.doi.org/10.1016/j.athoracsur.2015.10.057

[12]. Cameron A, Davis KB, Green G, Schaff HV. Coronary bypass surgery with internal-thoracic-artery grafts--effects on survival over a 15-year period. N Engl J Med [Internet]. 1996;334(4):216–9. Available from: http://dx.doi.org/10.1056/NEJM199601253340402

[13]. Kraler S, Libby P, Evans PC, Akhmedov A, Schmiady MO, Reinehr M, et al. Resilience of the internal mammary artery to atherogenesis: Shifting from risk to resistance to address unmet needs. Arterioscler Thromb Vasc Biol [Internet]. 2021;41(8):2237–51. Available from: http://dx.doi.org/10.1161/ATVBAHA.121.316256

[14]. Higami T, Kozawa S, Asada T, Shida T, Ogawa K. Skeletonization and harvest of the internal thoracic artery with an ultrasonic scalpel. Ann Thorac Surg [Internet]. 2000;70(1):307–8. Available from: http://dx.doi.org/10.1016/s0003-4975(00)01436-3

[15]. Vineberg AM. Development of anastomosis between the coronary vessels and a transplanted internal mammary artery. J Thorac Surg [Internet]. 1949;18(6):839–50, illust. Available from: http://dx.doi.org/10.1016/s0096-5588(20)31305-2
[16]. Effler DB, Groves LK, Sones FM Jr, Shirey EK. Increased myocardial perfusion by internal mammary artery implant: Vineberg's operation. Ann Surg [Internet]. 1963;158:526–36. Available from: http://dx.doi.org/10.1097/00000658-196310000-00002
[17]. Masroor M, Zhou K, Chen C, Fu X, Zhao Y. All we need to know about internal thoracic artery harvesting and preparation for myocardial revascularization: a systematic review. J Cardiothorac Surg [Internet]. 2021;16(1):354. http://dx.doi.org/10.1186/s13019-021-01733-2