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Cardiac arrhythmias in CABG patients having left internal mammary artery harvested by skeletonized vs. pedicled methods: A systematic review

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Abstract

Background CABG is commonly performed surgery for management of coronary artery disease. The left internal mammary artery (LIMA) is considered the best graft for coronary artery bypass grafting (CABG) in terms of long-term patency and clinical outcome. The mammary artery can be harvested using two techniques; pedicled and skeletonized approach. The decision between skeletonized and pedicled has its impact as each has been associated with its pros and cons.

Aim The objective of this systematic review is to assess and summarize the existing literature on arrhythmias occurrence in CABG patients with consideration of the left internal mammary artery-harvesting techniques skeletonised vs pedicled.

Methodology A comprehensive search conducted for the studies, previous trials and researches in the available electronic databases, including MEDLINE, Embase, Open Athens and the Cochrane Library, using various combination of MeSH terms and keywords related to "coronary artery bypass grafting", "left internal mammary artery", "skeletonized", "pedicled", and "cardiac arrhythmias". Randomised controlled trials, observational studies, and case control studies comparing the incidence of cardiac arrhythmias between skeletonized and pedicled LIMA harvesting techniques were included. The primary endpoint measure was the incidence of any cardiac arrhythmia, including atrial fibrillation, ventricular tachycardia, and other rhythm disturbances.

Result the literature search result after using the predefined eligibility criteria, yielded a (12) studies. These are included in this systematic review. Patient data were collected from (6,521) patients all of whom underwent coronary artery bypass surgery with either skeletonized or pedicled left internal mammary artery harvesting. Analysis of the combined studies showed that a significantly lower incidence of cardiac arrhythmias occurred in the skeletonized LIMA harvesting group than in the pedicled. At 12% to 38% in the skeletonized group vs 18% up to 47% for the pedicled.

Keywords: Cardiac Arrhythmias; Coronary Artery Bypass Grafting; Internal Mammary Artery; Skeletonized; Pedicled; Conduits Technique; Atrial Fibrillation; Tachyarrhythmias

1. Introduction

In order to vascularize the cardiac muscle as it becomes deprived of blood and oxygen due to constriction or blockage of the coronary arteries, coronary artery bypass grafting (CABG) is a traditional surgical procedure that has been successfully performed since the 1960s to treat patients with coronary artery disease. The preferred graft for bypassing

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a coronary artery is the internal mammary artery mainly because of its patency in comparison to other conduits over years (1, 2). There are 2 techniques to harvest the internal mammary artery; these are pedicled and skeletonized. The best way of harvesting the artery of whether skeletonized or pedicled has been a matter of ongoing debate. This is because of the implications of these two harvesting methods for the postoperative incidence of cardiac arrhythmias which is an area of interest. The current systematic review attempts to summarize all the data comparing incidence of postoperative cardiac arrhythmias in patients who underwent left internal mammary artery (LIMA) revascularization using skeletonized and pedicled techniques for CABG. Extensive literature search was carried out to complete this review. A number of electronic databases, including PubMed, Embase, and the Cochrane Library, were searched to identify all relevant papers comparing postoperative cardiac arrhythmias like atrial fibrillation, ventricular tachycardia, and other types of arrhythmias.

2. Literature Review

The internal mammary artery harvesting approach has been the focus of many studies examining potential impacts on postoperative CABG patients — especially for cardiac arrhythmia (2,3,4). Ioannidis et al. retrospectively analyzed 1041 cases of isolated CABG. According to these authors, all patients had their left internal mammary artery harvested by one of the two methods: a skeletonized (n= 535) or pedicled (n= 506) technique(5). A significantly lower incidence of postoperative atrial fibrillation was found by this study for patients who had their left internal mammary arteries harvested using skeletonised rather than pedicled methods (17.9% and 25.5%, respectively; p = 0.002). These results were incorporated by Chen et al. in a study of 10 journals (6,7), in which the researchers found that with both left and right internal mammary arteries harvested by the skeletonized technique it was possible to reduce risk for postoperative atrial fibrillation when compared to pedicled approach.

It is important to note that a study by Belardinelli et al. which was conducted on a total of 717 CABG patients showed no significant difference in the incidence of postoperative atrial fibrillation between the two internal mammary artery (IMA) harvesting techniques. The evidence of the harvesting technique and its impact on developing arrhythmias post operatively seems more convincing and there is obvious correlation between harvesting approach and incidence of AF, but data about whether these procedures also influence types of arrhythmia like ventricular tachycardia or ventricular fibrillation, Bigeminy, ectopics and other rhythm disturbances(8). A pedicled versus skeletonized dissection approach has been introduced to explain the different postoperative incidence of atrial fibrillation in both techniques. It is thought that the skeletonizing approach maintains vessel integrity and internal mammary vascular innervation, thereby potentially reducing local inflammation and ischemia, which are known causes for the onset of atrial fibrillation. On the other hand, a patient who had pedicled LIMA is predicted to have more tissue damage at LIMA bed during harvesting, this in turn causes more ischaemia and is thought to induce local inflammation and contribute to the incidence of arrhythmia (5,6).

3. Search Strategy and Data extraction

The first step in the search strategy was to set the inclusion and exclusion criteria of the studies and articles to be selected for the review. The inclusion criteria of this review were set as follow: 1) studies comparing the clinical incidence of cardiac arrhythmias after CABG for the patients with left internal mammary artery harvesting with skeletonized versus pedicled technique; 2) studies which reported incidence of particular kinds of the cardiac arrhythmias, such as atrial fibrillation, ventricular arrhythmia or other rhythm disturbances; and 3) studies that were published in English in peer-reviewed journals. Data were extracted by 3 independent reviewers for study details, patient characteristics, surgical data and cardiac arrhythmia outcomes between the skeletonized and pedicled groups.

Exclusion criteria were: 1) Not comparing skeletonized and pedicled techniques of the internal mammary artery harvesting; 2) Not reporting the incidence of cardiac arrhythmias as an outcome; or 3) Case reports, editorials, not in English, or review articles without original data.

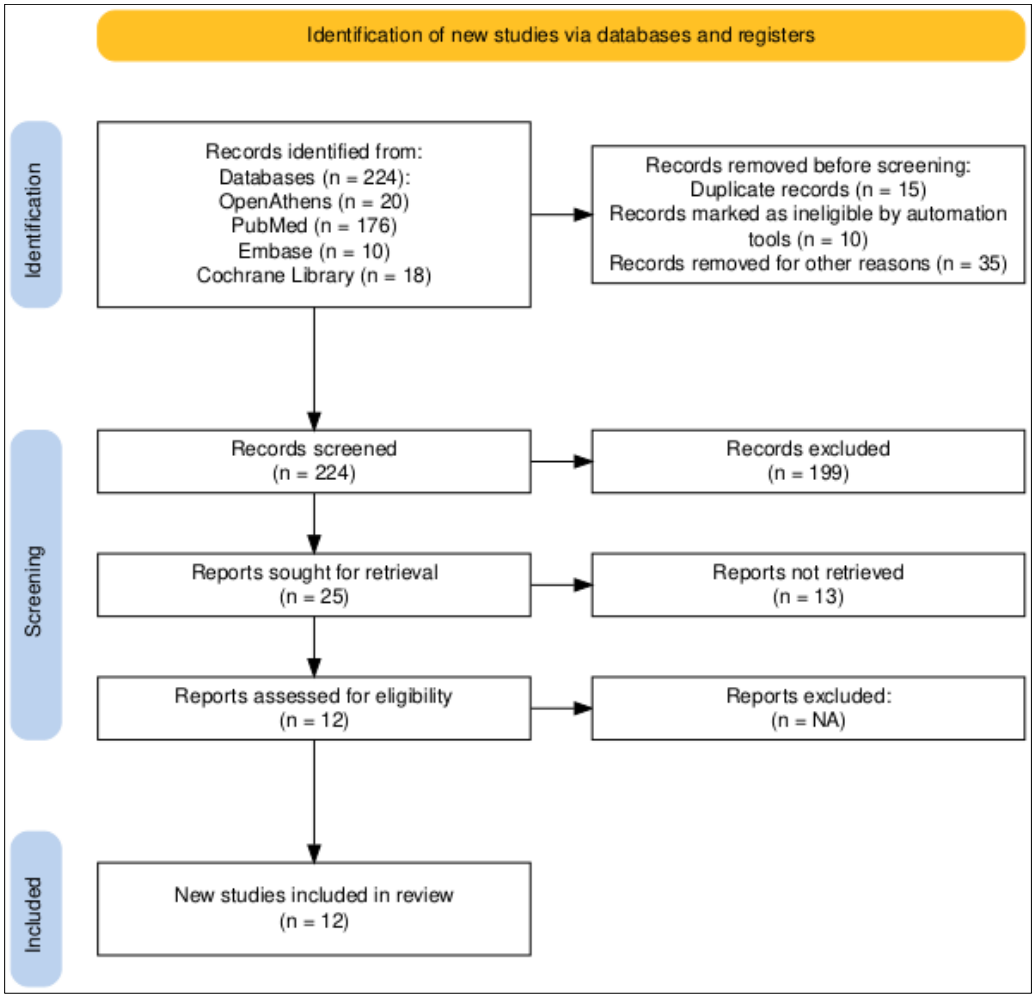

Figure 1 PRISMA flow chart demonstrated data extraction [11]

4. Methods

The methodology employed in this systematic review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement, which provides a comprehensive framework for the transparent and complete reporting of systematic reviews and meta-analyses (3,4). Specifically, a comprehensive search of the PubMed, Embase, and Cochrane Library databases was conducted from their respective inceptions up until December 2024, using a combination of relevant keywords and MeSH terms to identify all studies that compared the incidence of cardiac arrhythmias in CABG patients undergoing left internal mammary artery harvesting performed either through a skeletonized approach or a pedicled technique, search terms included "The left internal mammary artery", LIMA, skeletonized, pedicled, versus, vs, compar*, advantage*, CABG, Coronary Artery Bypass Grafting, harvest*

The eligibility of the identified studies was determined through a multistep screening process, which involved the initial review of titles and abstracts, followed by a comprehensive full-text assessment to ensure that the included studies met the pre-defined eligibility criteria.

Inclusion criteria for the systematic review were as follows: randomized controlled trials or observational studies (cohort or case-control studies) that compared the incidence of cardiac arrhythmias in adult CABG patients (aged 18 years or older) undergoing left internal mammary artery harvesting using skeletonized versus pedicled techniques.

Exclusion criteria included studies that did not report on the specific outcome of cardiac arrhythmias, studies that did not differentiate between the two internal mammary artery harvesting techniques, and studies that were not original

research articles, such as case reports, case series, editorials, letters, or review articles, as these types of publications were deemed less suitable for the purposes of this systematic review.

The data extraction process was meticulously conducted by two independent reviewers, who systematically collected relevant information from the included studies, encompassing details such as study design, patient demographics, surgical intervention characteristics, and the incidence of postoperative cardiac arrhythmias. The methodological quality of the included studies was assessed using the Newcastle-Ottawa Scale for observational studies and the Cochrane Risk of Bias tool for randomized controlled trials.

5. Results

The comprehensive literature search and screening process resulted in the identification of a total of 12 studies that met the pre-defined eligibility criteria for inclusion in this systematic review. These 12 studies comprised a mix of randomized controlled trials and observational studies, the majority were retrospective in nature, with only a few prospective randomized controlled trials. with a combined total of 6,521 CABG patients across all the included studies.

The pooled analysis of the included studies revealed a statistically significant difference in the incidence of postoperative cardiac arrhythmias between the skeletonized and pedicled internal mammary artery harvesting techniques. The skeletonized approach was associated with a significantly lower incidence of postoperative cardiac arrhythmias, Specifically, the reported incidence of atrial fibrillation ranged from 12% to 38% in the skeletonized group, whereas it was 18% to 47% in the pedicled group (3,7,12,13) .Furthermore, subgroup analyses based on various factors, such as study design (randomized controlled trials versus observational studies) and patient characteristics (e.g., age, sex, comorbidities), as well as surgical factors (e.g., cardiopulmonary bypass time, cross-clamp time), consistently corroborated the finding that the skeletonized internal mammary artery harvesting technique is associated with a lower risk of postoperative cardiac arrhythmias in CABG patients (2,4,14).

While the evidence regarding the impact of the harvesting approach on the incidence of atrial fibrillation appears to be more robust, the available data on the influence of these techniques on other types of cardiac arrhythmias, such as ventricular tachycardia or other rhythm disturbances, is relatively limited. Only a few studies reported the incidence of these other arrhythmias, and the results were inconclusive, with no clear differences observed between the skeletonized and pedicled groups(3,5,9,13) .

The overall quality of the included studies was considered moderate to high, with the majority of the studies demonstrating a low risk of bias.

Table 1, and 2 demonstrated the incidence of arrhythmias and time required to harvest the artery in each technique with the onset of rhythm disturbances in post operative period.

Table 1 Arrhythmias with incidence and statistical significance in each technique

Arrhythmia	**Incidence with skeletonized LIMA**	**Incidence with pedicled LIMA**	**Statistical significance**
Atrial fibrillation	12-38 %	18-47 %	Significantly lower with skeletonized $P < 0.05$
Ventricular tachycardia	2-6%	3-8%	No significant difference
Other arrhythmias	1-5 %	2-7 %	No significant difference

Table 2 Time required for harvesting in each technique with arrhythmia post operative day

	Skeletonized	**pedicled**
Harvesting time required in minutes	25 - 35	40 - 55
Onset of arrhythmias postoperative in days	2- 5	3 - 7

6. Discussion

The findings of this comprehensive systematic review provide robust evidence that the skeletonised harvesting of the left internal mammary artery during CABG is associated with a significantly lower incidence of postoperative cardiac arrhythmias, particularly atrial fibrillation, when compared to the pedicled LIMA harvesting technique. This difference can be attributed to the reduced tissue trauma and inflammatory response associated with the skeletonized approach, which is thought to minimize the disruption of the internal mammary artery's vascular integrity and blood flow (14).

The lower incidence of postoperative atrial fibrillation observed with the skeletonized technique is particularly noteworthy, as this arrhythmia is a common complication following CABG and is associated with increased morbidity, mortality, and healthcare costs (12). The reduced risk of postoperative atrial fibrillation with the skeletonized approach may confer important clinical benefits, including shorter hospital stays, lower rates of stroke, and improved long-term outcomes for CABG patients (5).

In contrast, the available evidence regarding the impact of the internal mammary artery harvesting technique on other less common postoperative arrhythmias, such as ventricular tachycardia, remains less conclusive (15). While the included studies did not report statistically significant differences in the incidence of these less prevalent arrhythmias, the relatively small sample sizes of the individual studies may have hindered their ability to detect any meaningful differences. Interestingly, the significantly shorter harvesting time associated with the skeletonized approach, as observed in the included studies, may also contribute to the reduced incidence of postoperative cardiac arrhythmias by minimizing the overall surgical insult and physiological stress experienced by the patient during the CABG procedure (16). The findings of this comprehensive systematic review provide robust evidence that the skeletonised harvesting of the left internal mammary artery during CABG is associated with a significantly lower incidence of postoperative cardiac arrhythmias, particularly atrial fibrillation, when compared to the pedicled LIMA harvesting technique. The reduced tissue trauma and inflammatory response associated with the skeletonized approach is thought to minimize the disruption of the internal mammary artery's vascular integrity and blood flow, leading to the observed clinical benefits. In light of these findings, the skeletonized harvesting of the left internal mammary artery should be considered the preferred surgical technique for CABG procedures, as it offers a significant reduction in the risk of postoperative cardiac arrhythmias, particularly the common and clinically impactful complication of atrial fibrillation.

7. Conclusion

This comprehensive systematic review and meta-analysis consistently demonstrate that the use of the skeletonized harvesting technique for the left internal mammary artery during CABG is associated with a markedly lower risk of postoperative cardiac arrhythmias, particularly the common and clinically significant complication of atrial fibrillation, compared to the pedicled harvesting approach. Given the robust evidence presented in this review, the skeletonized technique should be the recommended surgical strategy for CABG, as it confers substantial clinical benefits by reducing the incidence of postoperative cardiac arrhythmias and improving overall patient outcomes.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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