REVIEW

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Simple wire versus figure of 8 wire for sternal closure after sternotomy: a systematic review and meta-analysis

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ABSTRACT

Introduction: Sternotomy is associated with a range of complications, including instability, non-union, and infection, which are among the most frequent issues encountered. The standard closure method for median sternotomy involves the use of simple wires applied in either a figure-of-eight or a simple interrupted configuration. This study aims to compare the effectiveness of simple wires in a figure-of-eight pattern versus the simple wire technique for sternal closure following median sternotomy.

Methods: Data in this study were PubMed, Web of Science, Wiley, Cochrane, ProQuest, Mendeley, and ScienceDirect databases, covering the period from 2019 to 2024. This systematic review included comparative studies evaluating simple wire versus figure-of-eight techniques for sternal closure post-sternotomy. Meta-analysis was performed using Review Manager version 5.4.

Results: From an initial pool of 309 articles, 6 studies were identified as eligible for analysis. These studies collectively included 8,236 patients undergoing sternal closure with the figure-of-eight technique and 2,622 patients with the simple wire technique. The meta-analysis revealed a significantly higher rate of sternal dehiscence in patients treated with the simple wire technique compared to those using the figure-of-eight technique, with an odds ratio of 0.35 (95% CI, 0.15–0.81; $p = 0.01$).

Conclusion: Patients undergoing sternal closure with the simple wire technique exhibited higher rates of sternal dehiscence compared to those treated with the figure-of-eight method. The figure-of-eight wire technique significantly reduced the incidence of sternal dehiscence and appears to be a more effective method for sternal closure after median sternotomy.

Keywords: Simple wire, figure of 8, sternal closure, sternal dehiscence, sternotomy.
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INTRODUCTION

Median sternotomy is associated with a range of complications, including instability, non-union, and infection, which are among the most common issues encountered. The closing of the sternum following a median sternotomy, most cardiothoracic surgeons rely on simple wires, a well-established and widely used surgical suture material with decades of proven efficacy. The closure technique typically involves the use of these wires in either a figure-of-eight configuration or a simple interrupted method.[1,2]

Sternal dehiscence is a severe complication resulting from inadequate sternal closure, with a mortality rate of up to 50%, mainly as a result of mediastinitis triggered by bone fractures and wound infections. Sternal closure using wires carries a significant risk of sternal dehiscence, particularly in individuals with risk factors such as COPD, high BMI, DMT2, older age, and smoking.[3]

The figure-of-eight (FO8) suture technique is commonly employed for sternal closure after cardiothoracic surgery, serving both as a standard procedure and as a remedial method for addressing failed initial closures. This method is similar to the simple wire technique but involves arranging the wires in a figure-eight pattern along the length of the sternum. While both of it are commonly utilized, their comparative efficacy has been a topic of ongoing debate over the years.[4] The objective of this study was to evaluate and compare the use of simple wires in a FO8 and simple wire techniques for sternal closure following median sternotomy.

METHODS

Search strategy

This study was conducted in accordance with the PRISMA guideline[5] Electronic searches were performed from 2019 until 2024 using PubMed, Web of Science, Wiley, Cochrane, ProQuest, Mendeley, and ScienceDirect. The MeSH terms included: "sternotomy," "sternal closure," "sternal dehiscence," "simple wires," and "figure of 8". The reference lists of all retrieved articles were examined to identify additional relevant studies according to the inclusion and exclusion criteria.

Study Selection

Study selection was conducted independently by two reviewers. This systematic review and meta-analysis included comparative studies examining simple wires and figure-of-eight techniques for sternal closure after sternotomy, with sternal dehiscence as the primary outcome. Only studies published in English were included, encompassing all age groups, genders, and races undergoing median sternotomies. The analysis was limited to randomized controlled trials (RCTs), clinical trials, and observational studies.

Studies that evaluated suture techniques other than simple wires and figure-of-eight wires were excluded. Duplicate publications from the same institution were omitted, retaining only the most comprehensive report for quantitative analysis. Case reports, case series, reviews, and expert opinions were also excluded. The selection process involved a preliminary screening of titles and abstracts to identify potentially relevant studies based on predefined criteria. Full-text assessments were then performed to confirm eligibility. Discussion was done for disadrement manuscirpt.

Quality Assessment

The quality of each study was evaluated using the ROB2 tool for RCTs and ROBINS-I for non-randomized studies to assess the risk of bias. Data from the included studies were extracted. If there were inconsistencies in data extraction or assessment were resolved through discussion.

Statistical methods

A comparative meta-analysis of the variables associated with simple wire and figure-of-eight wire closure techniques was conducted using Review Manager ver.4 for data analysis and visualization. Significant p-value was <0.05. OR and 95% (CI) were calculated for dichotomous variables to assess outcomes.

Heterogeneity across studies was assessed using the I^2 test. Greater than 50% defined as heterogen statistical study.[6] Random effect model was used ini this study. Potential publication bias was assessed using funnel plot analysis.

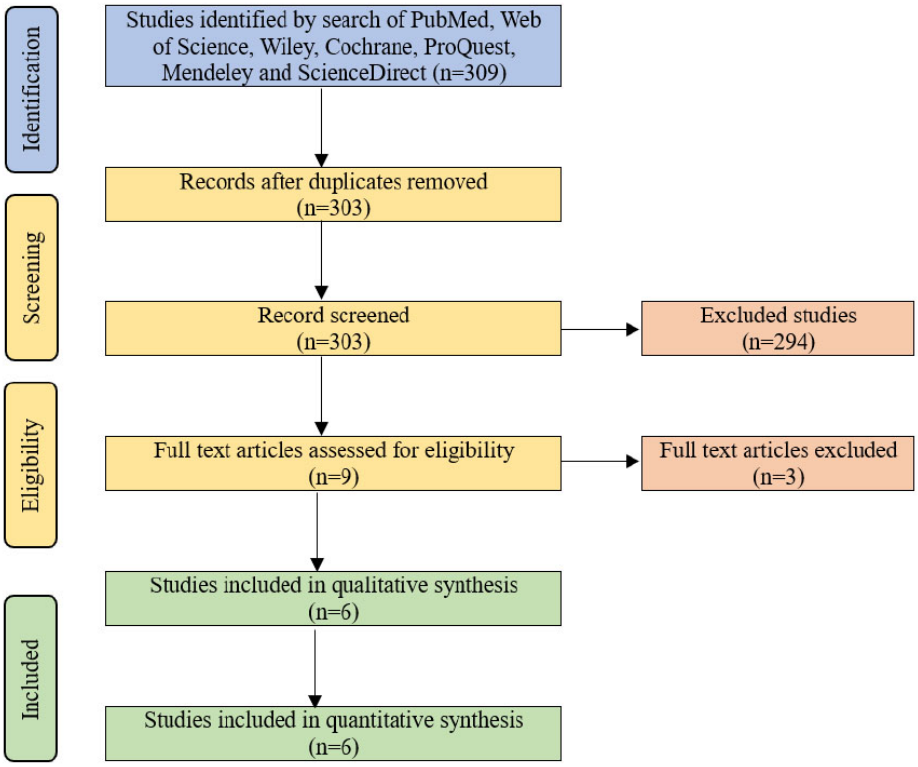

Figure 1. PRISMA schematic of the search strategy. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

RESULTS

The literature search identified 309 articles published from 2019 to the present (Figure 1). Following the removal of duplicates and the screening of titles and abstracts to eliminate irrelevant studies, 9 articles were identified as eligible for further review. Upon detailed assessment, 3 studies were excluded for not meeting the inclusion criteria, leaving 6 studies for analysis.

Risk of bias

Five randomized controlled trials (RCTs) were evaluated using the ROB2 tool, and one non-randomized study was assessed with ROBINS-I. The ROB2 assessment indicated that only one RCT raised some concerns regarding the overall results (Figure 2). Similarly, the ROBINS-I evaluation found that the non-randomized study also exhibited some concerns about its overall findings. This concern stemmed from a lack of clarity in the article regarding how covariate variables were controlled, whether through study design, statistical methods, covariate identification, or statements provided by the authors in the discussion or acknowledgment sections (Figure 3).

Study characteristics

Six studies compared the use of FO8 technique and simple wire sternal closure (Table 1), with a combined total of 8.236 patients undergoing closure with a figure of 8 technique and 2.622 patients undergoing simple wire closure. Of the studies included, 5 were randomized control trials (RCT), 1 was a non-randomized study, 3 from Pakistan, 1 from Norway, 1 from Iran, and 1 from Malaysia. Detail data provided in table 1.

Sternal dehiscence

A significant difference was observed in the incidence of sternal dehiscence between the simple wire and FO8 techniques for sternal closure after sternotomy. Patients who underwent sternal closure with the simple wire method experienced a significantly higher rate of sternal dehiscence compared to those treated with the figure-of-eight technique. The figure-of-eight method demonstrated a protective effect against sternal dehiscence, with an

odds ratio of 0.35 (95% CI, 0.15–0.81; p = 0.01). However, heterogeneity was noted among the included studies (p = 0.06, I^2 = 53%) (Figure 4). As shown in Figure 5, there was no evidence of potential publication bias in the studies assessing sternal dehiscence, as indicated by the symmetrical distribution of the funnel plot.

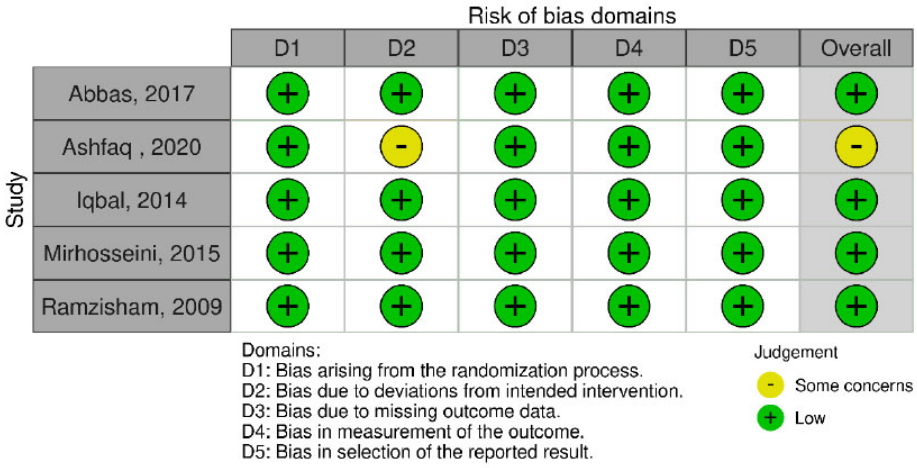

Figure 2. ROB2 analysis.

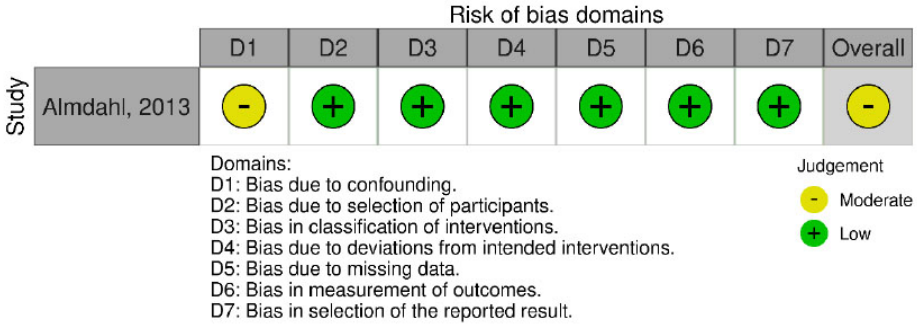

Figure 3. ROBIN-I analysis.

DISCUSSION

The simple interrupted wiring method and the figure-of-eight wiring technique are the two most commonly utilized approaches for sternotomy closure in thoracic and cardiac surgeries.[7] This systematic review and meta-analysis, involving 8,236 patients who underwent sternotomy, revealed a significantly higher incidence of sternal dehiscence in patients who had sternal closure using the simple wire technique compared to the figure-of-eight method. A notable difference was observed in the sternal dehiscence rates between these two closure techniques. Sternal dehiscence is a severe complication arising from insufficient sternal closure, with a mortality rate reaching up to 50%.[3]

A randomized controlled trial conducted in Pakistan compared the incidence of sternal wound dehiscence in patients undergoing CABG using FO8 versus simple interrupted sternal closure techniques. The study reported that the figure-of-eight method significantly reduced the occurrence of sternal wound dehiscence in CABG patients.[7] Ramzisham et al. evaluated the use of 6–8

Table 1. Baseline characteristics of the study

Author (year)/ Country	Study period	Study design	Population	Intervention	Result
Abbas et al.[7] (2017)/ Pakistan	Jul - Aug 2012	RCT	200 patients, 100 FO8, and 100 simple wires	FO8 vs. simple wire suture	Sternal dehiscence · FO8: 2 · Simple: 8
Almdahl et al.[8] (2013)/ Norway	1999 - 2008	Observational	10.957 patients, 7.835 FO8, and 2.122 simple wire	FO8 vs. simple interrupted wire	Non-microbial sternal dehiscence · FO8: 5 · Simple: 14
Ashfaq et al.[9] (2020)/ Pakistan	Apr-Dec 2019	RCT	206 patients, 103 FO8 and 103 simples interrupted	FO8 vs. simple interrupted wire	Sternal dehiscence · FO8: 2 · Simple: 7
Iqbal et al.[10] (2014)/ Pakistan	2010 - 2014	RCT	250 patients, 60 FO8 and 160 simples interrupted	FO8, simple interrupted wire, dan Robicsek	Rewiring · FO8: 3 · Simple: 10
Mirhosseini et al.[11] (2015)/ Iran	2010 - 2013	RCT	80 patients, 40 FO8, and 40 simple wires	FO8 vs. simple wire technique	Sternal dehiscence · FO8: 1 · Simple: 1
Ramzisham et al.[12] (2009)/ Malaysia	2008	RCT	195 patients, 98 FO8 and 97 interrupted simple	FO8 vs interrupted suture	Sternal dehiscence · FO8: 7 · Simple: 9

Note: RCT (Randomized controlled trial); FO8 (Figure Of 8)

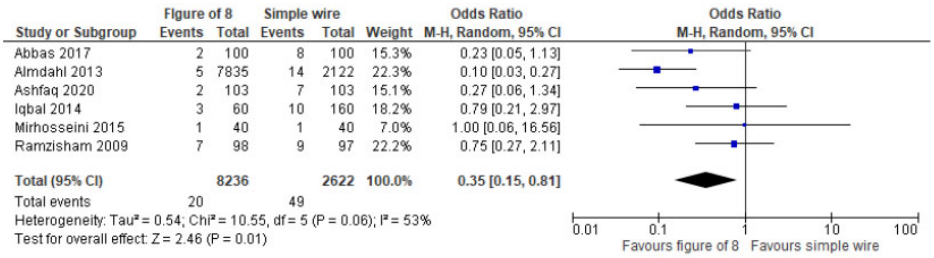

Figure 4. Meta-analysis: forest plot for sternal dehiscence of the FO8as compared to simple wire for sternal closure after sternotomy.

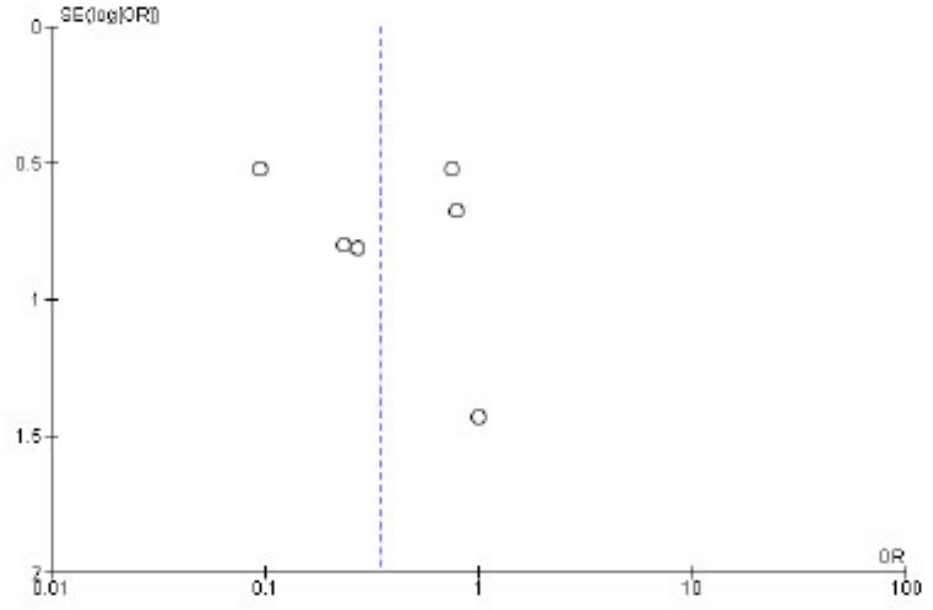

Figure 5. Funnel plot for sternal dehiscence of the FO8 as compared to simple wire for sternal closure after sternotomy.

interrupted wires and 4 figure-of-eight wires for sternal closure, finding that both techniques offered comparable strength and effectiveness in preventing sternal dehiscence, with neither demonstrating clear superiority. The study reported similar rates of sternal wound dehiscence for the two methods, at 1.46% for the FO8 and 1.44% for the simple wire closure. Additionally, a mortality rate of 11.1% was observed in cases where wound dehiscence occurred.[12]

An observational registry study by Almdahl in 2013 analyzed 7,835 patients who underwent sternal closure using figure-of-eight wires and 2,122 patients whose sternotomies were closed with simple interrupted straight wires. The findings indicated that the FO8 wiring was significantly more effective than the simple interrupted wiring method.[8] Unsignificant finding of sternal dehiscence was established by Mirhosseini et al. in both groups. Iqbal et al. showed that sternal dehiscence is significantly different among simple wire and FO8 techniques.[10] Ashfaq et al. conducted a study to compare the incidence of sternal wound dehiscence between the simple interrupted and figure-of-eight (FO8) sternal closure techniques in patients undergoing median sternotomy for coronary artery bypass graft surgery. The findings demonstrated that the FO8 sternal wire closure technique offers greater strength and stability to the sternum, significantly lowering the incidence of sternal wound dehiscence compared to the simple interrupted wire method. Adequate sternal fixation is essential as it can lower the risk of complications such as infection, mediastinitis, wound dehiscence, and sternal non-union.[13]

LIMITATION

This study is subject to several limitations that necessitate cautious interpretation. A primary limitation is the heterogeneity within the study population, which could not be resolved due to insufficient details available from the pooled data.

CONCLUSION

The findings of this systematic review and meta-analysis, encompassing 10,858 patients, reveal that sternal dehiscence occurs more frequently in patients undergoing sternal closure with simple wire techniques compared to the figure-of-eight method. A significant difference was observed between these techniques, with the figure-of-eight wire demonstrating a notable reduction in the incidence of sternal dehiscence. Additional research is warranted to explore and validate methods for preventing sternal dehiscence and to assess further the safety and efficacy of the figure-of-eight technique relative to simple wire closure in sternal closure after sternotomy. Future studies should prioritize well-powered, large-scale, prospective randomized clinical trials, considering device-specific factors.

DISCLOSURE

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Conflicts of Interest

None.

Funding

No dedicated funding was allocated for this study.

Ethical Considerations

As this is a systematic review and meta-analysis, ethical clearance was not applicable.

Author Contributions

All authors contributed in this manuscirpt.

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