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Does Bone Wax Increase Sternotomy Wound Infection? A Single Center Experience

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Abstract **Original Research Article**

Introduction: Median sternotomy can result in significant bleeding, and the application of bone wax helps to control bleeding on the cut edges of the bones. Increasing evidence suggests that bone wax potentially increases the risk of postoperative sternal dehiscence. We aim to investigate whether or not the use of bone wax will increase sternal wound infection rate. ***Methods:*** In a retrospective cohort study with propensity score matching conducted on 390 patients undergoing elective isolated coronary artery bypass grafting (CABG), there were 195 patients each in the bone wax group and non-bone wax group. The demographics and perioperative data were collected and compared using statistical analysis. ***Results:*** The demographics and perioperative data such as diabetic status, smoking, pulmonary diseases, bypass and cross clamp time of both the groups were similar (P>0.05). The number of superficial sternal wound infection in bone wax group was 4, whereas in the non-bone wax group was 6, this result was not statistically significant (P=0.5). ***Conclusion:*** The use of bone wax does not increase sternal wound infection rate. However further randomized controlled trials with larger sample size are needed to verify this result.

Keywords: Bone Wax, Sternotomy, Coronary Artery Bypass Grafting, CABG, Wound Infection, Propensity Score Matching.

INTRODUCTION

Median sternotomy is a commonly used incision technique in open heart surgery, providing improved visibility and access to the heart.[1] However, this method can result in significant bleeding, and the application of bone wax creates a barrier that helps control bleeding on the cut edges of the bones.[2] Increasing evidence suggests that bone wax may trigger a foreign body reaction and hinder the activity of osteoblasts, potentially raising the risk of postoperative sternal dehiscence.[2] Reports indicate that sternal wound infections and dehiscence occur in only 0.5% to 5% of cases.[3] According to the AATS guideline for the prevention and management of sternal wound infections, it is a class III recommendation that bone wax should not be applied to the cut edges of the sternum at any time.[4] We aim to investigate whether or not the use of bone wax will increase sternal wound infection rate.

DEFINITIONS

Sternal wound infections can be categorized as either superficial or deep. Superficial sternal wound infections affect the skin, subcutaneous tissue, and deep fascia, whereas deep sternal wound infections may involve more extensive structures, including muscle tissue, the sternum, sub-sternal areas, and the mediastinum. [5]

METHODS

We conducted a retrospective cohort study in National Heart Institute (or *Institut Jantung Negara*, IJN) in Kuala Lumpur Malaysia. The aim is to determine whether the use of bone wax will increase sternotomy wound infection by comparing the sternotomy wound infection rate between the bone wax and non-bone wax groups.

We collected and recorded clinical information from IJN clinical research database and patient medical records of patients who underwent isolated Coronary Artery Bypass Grafting (CABG) via median sternotomy in 2022 and 2023. All adult patients who underwent elective isolated CABG surgery via a median sternotomy were included in this study. Exclusion criteria was any

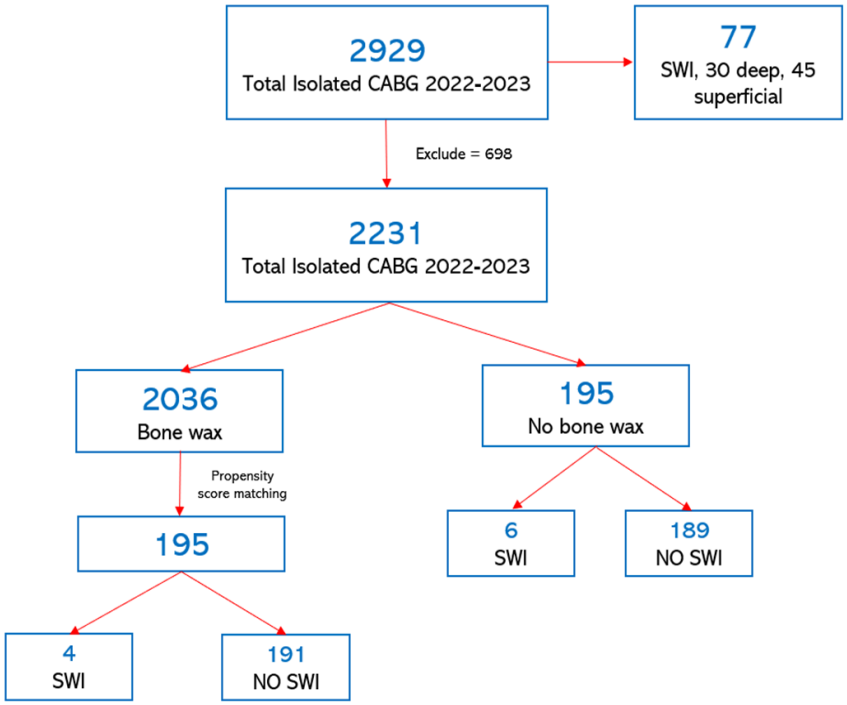
emergency CABGs, chest left open after primary surgery, and patients requiring chest reopens after primary surgery.

All data were analyzed using SPSS 20.0. Descriptive analysis was done using Chi Square test for categorical data, and Mann Whitney test for continuous data.

Our primary outcome is the rate of sternotomy wound infection (SWI) 30 days post open-heart surgery. Secondary outcome is to find out the overall sternotomy wound infection rates for elective isolated CABGs.

RESULTS

A total of 2929 patients underwent isolated CABG in the year 2022-2023. After excluding patients based on exclusion criteria, 2231 were included into this study. They were further divided into the bone wax group 2036 patients, and no-bone wax group 195 patients. In view of the large discrepancy in numbers between the 2 groups, propensity score matching (PSM) was done, which resulted in 195 patients in each group.



Flowchart 1: Methodology

Perioperative data of both the groups were compared. Patient demographics consist of gender, race, age and BMI. Preoperative comorbidities include hypertension, diabetes, HbA1c control, hypercholesterolemia, smoking, ejection fraction, symptoms of angina and dyspnea, history of MI or PCI, renal impairment, pulmonary disease, and poor mobility. Intraoperative data were cardiopulmonary bypass time and cross clamp time. Post operative data includes sternal wound infection, fever, pericardial effusion, pleural effusion, and mortality. In all perioperative data compared, no significant differences were observed between both the groups.

Table 1: Results of demographics, pre-operative, intraoperative and post-operative data.

Demographics	Bone Wax, N = 195	No Bone Wax, N = 195	p-value
Sex			0.7
Female	20 (10%)	22 (11%)	
Male	175 (90%)	173 (89%)	
Race			>0.9
Chinese	29 (15%)	32 (16%)	
Indian	27 (14%)	26 (13%)	
Malay	134 (69%)	130 (67%)	
Others	5 (2.6%)	7 (3.6%)	
Age	61 (54, 66)	62 (55, 67)	0.4
BMI	27.0 (24.2, 29.8)	26.7 (24.0, 29.4)	0.4
Pre-operative	Bone Wax, N = 195	No Bone Wax, N = 195	p-value

Demographics	Bone Wax, N = 195	No Bone Wax, N = 195	p-value
Angina			0.9
CSS (NO SIGN)	90 (46%)	91 (47%)	
CSS1	68 (35%)	71 (36%)	
CSS2	37 (19%)	33 (17%)	
Dyspnea			0.8
NYHA I	112 (57%)	117 (60%)	
NYHA II	82 (42%)	77 (39%)	
NYHA III	1 (0.5%)	1 (0.5%)	
MI	128 (67%)	121 (63%)	0.5
PCI	24 (13%)	25 (13%)	0.9
Pulmonary disease	11 (5.6%)	9 (4.6%)	0.6
Poor Mobility	3 (1.5%)	4 (2.1%)	>0.9
Diabetic	96 (63%)	91 (58%)	0.4
Hb1Ac (%)	6.10 (5.55, 6.80)	6.10 (5.50, 7.10)	0.7
Smoking	83 (52%)	76 (46%)	0.2
Hypertension	161 (83%)	162 (83%)	0.9
Hypercholesterolemia	176 (90%)	172 (88%)	0.5
Renal Disease	36 (23%)	42 (25%)	0.5
Ejection Fraction (%)	48 (40, 55)	49 (40, 56)	0.8
Intra-operative	Bone Wax, N = 195	No Bone Wax, N = 195	p-value
CBP time (mins)	69 (57, 84)	66 (56, 78)	0.083
Clamp time (mins)	50 (42, 65)	50 (42, 58)	0.3
Post-operative	Bone Wax, N = 195	No Bone Wax, N = 195	p-value
Sternotomy wound infection			0.5
No	191 (98%)	189 (97%)	
Superficial	4 (2.1%)	6 (3.1%)	
Deep	0	0	
Pericardial Effusion	12 (6.3%)	10 (5.2%)	0.7
Pleural Effusion	8 (4.3%)	15 (7.8%)	0.2
Fever	15 (7.7%)	9 (4.6%)	0.2
Pt Discharge Status			0.7
Alive	191 (98%)	193 (99%)	
Dead	4 (2.1%)	2 (1.0%)	

In the bone wax group there were 4 patients with SWI, whereas in the no-bone wax group there were 6 patients with SWI. There was no significant difference between sternotomy wound infection rates between the bone wax and no bone wax groups (p=0.5). As for our secondary outcome to find out the overall sternotomy wound infection rates, a total of 2231 elective isolated CABGs were performed in the year 2022-2023, of which only 77 patients had sternotomy wound infection, giving and over all sternotomy wound infection rate of 0.03%.

Discussion

The use of bone wax in surgery dates back to 1950.[6] Bone wax is made from water-insoluble beeswax that is softened with paraffin and/or isopropyl palmitate. It does not have intrinsic hemostatic properties; instead, it works by tamponading the vascular spaces within bone.[7] Over the past 20 years, various studies have examined the impact of bone wax on sternal wound infections, yielding mixed results. In one animal study, bone wax was found to induce a significant inflammatory response, which led to osteomyelitis and destruction of bone marrow.[7]

A retrospective observational study by Cem Alhan *et al.,* involving 5,318 patients identified several independent risk factors for postoperative sternal dehiscence, including age over 70, chronic obstructive pulmonary disease, use of bone wax, non-elective operations, and a body mass index greater than 30.[2] Ahmet C. Özdemir *et al.,* conducted a retrospective review of 184 patients who underwent median sternotomy, finding that bone wax did not reduce bleeding from the sternum and showed no evidence linking its use to deep sternal infections.[1] A prospective randomized study by Jörg Przborowski *et al.,* compared 400 patients undergoing isolated CABG, evaluating the effects of bone wax on blood product consumption, reoperations, sternal stabilization, and mediastinitis. They concluded that while bone wax was not associated with adverse outcomes, it also did not provide significant benefits. [8] In our study, both patient groups had similar baseline characteristics, and we found no statistically significant evidence that the use of bone wax increases the rate of sternal wound infections. A limitation of our research is that it is a retrospective observational study with a relatively small sample size.

CONCLUSION

The use of bone wax does not increase sternal wound infection rate. However further randomized controlled trials with larger sample size are needed to verify this result.

Ethical Approval: This retrospective observational study has been approved by IJN Research Ethics Committee (IJNREC)

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Author Contribution: KM Cheng is the primary author who did the literature research and write up. Qalida M assisted in writing and proof-reading. Intan FG, Aini SK, Haidatul IS assisted with data collection and analysis. Abdul RS the supervisor for this write up.

Conflict of Interest Disclosure: The authors declare no conflict of interest with regards to the content of this report.

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