STUDY OF PERIOPERATIVE FACTORS IN POSTOPERATIVE CHRONICITY OF STERNAL PAIN

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ABSTRACT

Over two million people undergo sternotomy worldwide for heart surgery each year, and post operative sternal pain may last for months or reappears a long time after sternotomy. The exact etiology of post sternotomy pain is unknown. We aim to find out the association of peri-operative factors with chronicity of sternal pain after open-heart surgery. This is a retrospective observational study on 121 patients who underwent open heart surgeries for various cardiac problems from January 2020 to July 2022 at a tertiary care center. Convenient sampling was performed. Data were analyzed using SPSS-17. Male to female ratio similar with male 60 (49.6%) and female 61 (50.4%), and 95.0% had body mass index (kg/m2) <30. Ninety (76.9%) were individuals without diabetes, 75 (62.0%) were non-hypertensive, 97 (80.2%) were nonsmokers and 22 (18.2%) had abnormal thyroid function. Only 2 (1.7%) had chronic obstructive airway disease and 1 (0.8%) had renal failure. Majority was in sinus rhythm 88 (72.7). Forty (33.1%) had valvular and 53 (43.8%) had ischemic etiology. Majority 110 (90.9%) were ventilated for less than 6 hours and 15 (9.4%) had surgical site infection. Peri-operative risk factors like age of patient, etiology, hypertension, operative procedure, ventilator hours, cardiopulmonary bypass time, intensive care unit stay, and total hospital stay had a significant association with chronicity of pain.

KEYWORDS

Cardiopulmonary bypass, perioperative period, post-operative pain, sternotomy

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INTRODUCTION

Post sternotomy pain (PSP) is defined as the pain that must be continuously present up to three months post-intervention, and pre-existing causes which may lead to pain in the thorax should not be present.[1,2] Cardiac surgery may cause severe post operative pain, if not treated adequately, the patient may suffer increased morbidity, a longer hospital stay and higher overall costs.[3] It is estimated that over two million people worldwide undergo median sternotomy for heart surgery each year.[3,4] PSP is a common problem, with an incidence of 7%–66% within one year after the operation.[3-5] Although, the incidence of chronic post-sternotomy pain seems to be underestimated.[6] The exact etiology of PSP is unknown. Numerous hypotheses have been considered, including entrapment neuropathy caused by sutures or scar tissue at the site of sternotomy, and intercostals neuralgia resulting from damage to the intercostals nerves during the dissection of the internal mammary artery.[6-8] It has been suggested that PSP can be a result of rib fractures related to the surgical procedure, an injury to the brachial plexus due to patient positioning during the intervention, Costo-sternal syndrome, or an allergy to metal sutures (nickel).[9,10] There are different reasons for these symptoms, and they do not seem to be related to the type of intervention. In addition to the diverse characteristics of pain in the various body tissues, sensitivity to pain varies between individuals depending on age, gender, and the underlying disease itself.[8] Other psycho social factors such as depression, anxiety, low education level and fear of surgery are established risk factors for PSP.[11,12]

To our knowledge, the source of this pain has not been studied and attempts have not been made to distinguish the contributions of different types of peri-operative factors like age, gender, body mass index (BMI), Type 2 diabetes mellitus (T2DM), hypertension (HTN), thyroid status, smoking history, chronic obstructive airway disease (COAD), rhythm, renal failure (RF), diagnosis, operative procedure, cardiopulmonary bypass (CPB) time, ventilator hours, ICU stay, hospital stay, surgical site infection (SSI) in chronicity of PSP.

MATERIALS AND METHODS

This is a retrospective cross-sectional study on 121 patients over a period of 30 months (from January 2020 to July 2022) at Nobel Medical College Teaching Hospital, Biratnagar in the Department of Cardiothoracic and Vascular Surgery (IRC-NMCTH: 61572022). Convenient sampling was performed. All the patients who underwent cardiac surgery were included in this study. Those patients who expired, lost to follow-up and were unable to communicate were excluded. The qualitative risk factors like gender, BMI, active smoker, HTN, COAD, T2DM, thyroid status, renal failure, rhythm diagnosis, operative procedure, ventilator hours and SSI will be cross-evaluated with outcome i.e., chronicity of sternal pain using Chi-Square test or Fisher Exact test whenever necessary. However quantitative risk factors like age, ICU stay, CPB time and hospital stay will be cross-evaluated with outcome using ANOVA (analysis of variable). All of these test are done using SPSS-17.

RESULTS

There was a total of 121 patients in our study, among which three patients were excluded because of mortality and three patients had undergone Patent Ductus Arterious (PDA) ligation through thoracotomy. Frequency distribution of different variable tabulated in (Table 1) displays male to female ratio was almost same with male 60 (49.6%) and female 61 (50.4%), and 95% had BMI<30. Out of 121 patients 93 (76.9%) were non-diabetic, 75 (62%) were non-hypertensive, 97 (80.2%) smokers and 22 (18.2 %) had abnormal thyroid function. However only 2 (1.7 %) had COAD and 1 (0.8%) renal failure. Most of patients were in sinus rhythm 88 (72.7). Out of all 121 cases most of them were of valvular 40 (33.1%) and ischemic pathology 53 (43.8 %). Out of total no of patients 110 (90.9%) were ventilated for less than 6 hours and 15 (9.4%) had SSI.

The association with preoperative variables like gender, BMI, DM, HTN, smoker, thyroid status, COAD, RF and rhythm with PSP is tabulated in (Table 2). Which showed significant association with HTN; showing significant number of patients with past history of HTN had persistent PSP after surgery when compared with those with no history of HTN. In (Table 3) when Chi-square test was applied to show the association between operative procedure and PSP, the result showed significant association with overall operative procedure rather than with particular operative procedure. Like-wise ventilator hours also have a significant correlation with PSP. While studying continuous variable like age, ICU stay, CPB time and hospital stay, and its association with PSP, ANOVA was applied (Table 4). Result showed very significant association of the entire above continuous variable with PSP.

Table 1: Frequency table of the different study variables			
Variables		**n**	**%**
Age	Less than 50 years	51	42.1
	More than 50 years	70	57.9
Gender	Female	60	49.6
	Male	61	50.4
BMI	Less than 30	115	95.0
	More than30	6	5.0
T2DM	No	93	76.9
	Yes	28	23.1
HTN	No	75	62.0
	Yes	46	38.0
Smoker	No	97	80.2
	Yes	24	19.8
Thyroid status	No	99	81.8
	Hypothyroidism	21	17.4
	Hyperthyroidism	1	0.8
COAD	No	119	98.3
	Yes	2	1.7
RF	No	120	99.2
	Yes	1	0.8
Rhythm	Sinus rhythm	88	72.7
	AF	33	27.3
Diagnosis	RHD (mitral)	40	33.1
	BAV	3	2.5
	RHD (dual valve)	1	0.8
	CCP	4	3.3
	Aortic dissection	1	0.8
	PDA	3	2.5
	TOF	1	0.8
	ASD II	12	9.9
	PAPVC	2	1.7
	CAD	53	43.8
	TAPVC	1	0.8
Operation	MVR	32	26.4
	AVR	5	4.1
	DVR	8	6.6
	Pericardiectomy	4	3.3
	Bentall	1	0.8
	PDA ligation	3	2.5
	ICR	1	0.8
	ASD closure	10	8.3
	Rerouting of PAPVC	3	2.5
	CABG	53	43.8
	Rerouting of TAPVC	1	0.8
Ventilator hours	Less than 6 hours	110	90.9
	More than 6 hours	10	8.3
	Death on table	1	0.8
SSI	Yes	11	9.1
	No	110	90.9

**Abbreviation RHD: Rheumatic Heart Disease, BAV: Bicuspid Aortic Valve, CCP: Chronic Constrictive Pericarditis, ASD: Atrial Septal Defect, PAPVC: Partial Anomalous Pulmonary Venous Connection, CAD: Coronary Artery Disease, CABG: Coronary Artery Bypass Graft, TAPVC: Total Anomalous Pulmonary Venous Connection, MVR: Mitral Valve Replacement, AVR: Aortic Valve Replacement, DVR: Double Valve Replacement, ICR: Intra Cardiac Repair*

Table 2: Chi square test of preoperative variable with PSP

			Chronic Pain		Total	P value
			No	Yes		
Gender	Female	Count	48	10	58	0.21
		% within gender	82.8	17.2	100	
	Male	Count	45	15	60	
		% within gender	75.0	25	100	
BMI	Less than 30	Count	91	23	114	0.19
		% within BMI	79.8	20.2	100	
	>30	Count	2	2	4	
		% within BMI	50	50	100	
T2DM	No	Count	76	16	92	0.056
		% within T2DM	82.6	17.4	100	
	yes	Count	17	9	26	
		% within T2DM	65.4	34.6	100	
HTN	No	Count	63	10	73	**0.011***
		% within HTN	86.3	13.7	100	
	Yes	Count	30	15	45	
		% within HTN	66.7	33.3	100	
Smoker	No	Count	77	18	95	0.176
		% within smoker	81.1	18.9	100	
	Yes	Count	16	7	23	
		% within smoker	69.6	30.4	100	
Thyroid status	No	Count	76	21	97	0.483
		% within thyroid status	78.4	21.6	100	
	Hypothyroidism	Count	16	4	20	
		% within thyroid status	80	20	100	
	Hyperthyroidism	Count	1	0	1	
		% within thyroid status	100	0	100	
COAD	No	Count	92	24	116	0.380
		% within COAD	79.3	20.7	100	
	Yes	Count	1	1	2	
		% within COAD	50	50	100	

**Abbreviation AF: Atrial Fibrillation , P-value<0.05 shows significance*

DISCUSSION

PSP is a common complication that affects both patients and health care systems and can have serious consequences on patients' daily living.[13,14] This is a retrospective study of intra-operative risk factors for patients undergoing open heart surgery through sternotomy. All the patients were looked for PSP three month after cardiac surgery. Out of 121 patients, 24 (19.8%) had persistent PSP three month after cardiac surgery. The incidence of chronic post-sternotomy pain seems to be underestimated compared to other studies.[15] A meta-analysis that included 11,057 cardiac surgical patients across 23 studies demonstrated a 37% incidence of PSP in the first 6 months and up to 17% at 2 years after surgery.[16] Although the exact etiology of PSP is unknown, there has been several attempts to differentiate different types of pain, like somatic, visceral, neuropathic or that due to scar. In past few decades, numerous literature were considered regarding entrapment neuropathy caused by scar over sternotomy, and intercostals neuralgia caused by damage of intercostals nerve while harvesting internal thoracic artery.[5,8,9] There are also severe hypotheses suggesting that PSP might be a result of rib fracture related to diagnosis and its operative procedure or allergy to metal suture (sterna wire).[5,6] Similarly in some patients undergoing emergency cardiac surgery have greater risk of experiencing PSP.[2]

There are various pre-operative risk factors that might have direct association with postoperative chronicity of sternal pain. More severe acute postoperative pain has been associated with a greater incidence and severity of PSP.[15,16] There has been various studies regarding association of different intraoperative and preoperative risk factors and their relation to PSP. Factors like age and gender may contribute to PSP, in particular female sex with age less than

Table 3: Chi square test of intra operative factors with PSP

			Chronic Pain		Total	P value
			no	yes		
Operation	MVR	Count	29	1	30	**0.002***
		% within operation	96.7	3.3	100	
	AVR	Count	5	0	5	
		% within operation	100	0	100	
	DVR	Count	5	3	8	
		% within operation	62.5	37.5	100	
	Pericardiectomy	Count	3	1	4	
		% within operation	75	25	100	
	Bentall	Count	0	1	1	
		% within operation	0	100	100	
	PDA Ligation	Count	3	0	3	
		% within operation	100	0	100	
	ICR	Count	1	0	1	
		% within operation	100	0	100	
	ASD Secundum	Count	9	1	10	
		% within operation	90	10	100	
	SVASD	Count	3	0	3	
		% within operation	100	0	100	
	CABG	Count	34	18	52	
		% within operation	65.4	34.6	100	
	TAPVC	Count	1	0	1	
		% within operation	100	0	100	
Ventilator hours	Less than 6 hours	Count	90	20	110	**0.011***
		% within ventilator hours	81.8	18.2	100	
	More Than 6 hours	Count	3	5	8	
		% within ventilator hours	37.5	62.5	100	
SSI	No	Count	85	21	106	0.128
		% within SSI	80.2	19.8	100	
	Yes	Count	7	4	11	
		% within SSI	63.6	36.4	100	

**P-value<0.05 shows significance*

Table 4: ANOVA study of continuous variables with PSP

ANOVA		Mean Square	p value
Age	Between groups	3157.865	0.000
	Within groups	237.104	
ICU Stay	Between groups	2.591	0.000
	Within groups	0.196	
CPB Time	Between groups	25564.343	0.000
	Within groups	633.150	
Hospital stays	Between groups	29.594	0.000
	Within groups	1.427	

**Abbreviation CPB: Cardio Pulmonary Bypass*

70 years may be more likely to experience chronic pain.[3,5] Likewise other contributing factors for PSP were reported to be obesity, smoking history and preoperative depression and anxiety. Psychosocial factors such as depression, anxiety, low education level and fear of surgery are established risk factors for PSP.[18]

Although there are some reports on the relationship between surgical wound

complications and PSP, strong data on its support is lacking. Einsenberg *et al*[19] suggested that sternal surgical wound infection is one of the likely causes of PSP. In our study, we did not find the significant difference in PSP with or without surgical site infections.

Comparing our study to various above-mentioned study, and their statement, its shows that age, ICU stay, hospital Stay and CPB time are strong predictor which may cause PSP. But it didn't show any particular age group, gender variability, probable time of ICU stay, hospital stay and CPB time that may have direct correlations with PSP. Likewise, our study also showed that HTN is a predictor of PSP which wasn't mentioned in any of the literature. Lastly, two intraoperative predictor diagnosis and operative procedure in our study also have significant association with PSP, and comparing with other above-mentioned literature which shows that diagnosis with increased operative time, fracture of ribs and sternum and harvesting of internal thoracic artery has correlation with increased incidence of PSP.

Limitations: This study is a single-center hospital-based study with a limited sample size, so may not reflect the same result with a different technique in a different center and the finding of this study might not hold the exact mirror for the general population.

In conclusion, peri-operative risk factors like age of patient, etiology, hypertension, operative procedure, ventilator hours, cardiopulmonary bypass time, intensive care unit stay, and total hospital stay had a significant association with chronicity of pain.

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