

Sternal Osteomyelitis in Post- Sternotomy Patients: Results of A Novel Semiconservative Approach at Our Centre

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ABSTRACT

Introduction: Sternal chronic osteomyelitis and costochondritis following median sternotomy is a serious complication of open heart surgery. Current research aimed to study the efficacy of a semi-conservative approach in patients diagnosed with post-surgical sternal osteomyelitis, in terms of relief of symptoms, need for reintervention.

Material and methods: A single-centre retrospective study was carried out in the Department of Cardiovascular Thoracic surgery in our hospital. Data was extrapolated from the records of all the patients operated from January 2011 to December 2019. Indoor and outdoor records of all the patients was studied. Most common presentation was a discharging sinus. After taking respective wound swabs for culture and sensitivity, and radiological confirmation, the patients were subjected to sternal wire removal and curettage of the sinus tract. If patients did not improve with this intervention, they were subjected to more extensive local wound debridements with curettage of the unhealthy tissue and debris if any.

Results: Of the 4054 patients who underwent open heart surgery requiring median sternotomy at our institution in the span of 9 years, 96 patients were diagnosed with sternal osteomyelitis. 84 patients were managed by sternal wire removal and sinus tract curettage with single staged closure of the wound under local anesthesia alone. For 9 patients wire removal was not sufficient and the patients needed reintervention in the form of local debridement of the wound with curettage of the unhealthy tissue, followed by closure in a staged manner. 3 patients needed intervention from pain management team in view of persistent pain.

Conclusion: Patients diagnosed with post-surgical sternal infection can be managed by a semiconservative approach with satisfactory results instead of a conventionally described radical sternectomy with concomitant chest wall reconstructions.

Keywords: Post-Sternotomy, Sternal Osteomyelitis, Semi-Conservative Approach.

INTRODUCTION

Sternal chronic osteomyelitis following median sternotomy is a serious complication of open heart surgery. The most common mode of presentation is purulent draining sinus tracts in patients with a closed sternal wound.¹ However they also present as persistent pain on the chest which is very debilitating and cumbersome for the patients. The post-surgical osteomyelitis is a chronic, low virulence infection, without systemic symptoms, which has been associated with increased healthcare costs and an impaired quality of patient

life.²

There are very few studies about the incidence, the treatment and outcomes of sternal chronic osteomyelitis post open heart surgery. Some studies have proposed the total eradication of the infection which may require partial or total sternectomy and a further excision of all infected costal cartilage, should this also be compromised with the infection, followed by a chest reconstruction by using muscle flaps to fill the chest gap as the primary modality of treatment.²⁻⁴ This however is associated with a high rate of morbidity (51% had persistent pain or discomfort, 44% had numbness or paresthesia, 42% complained of sternal instability, and 33% claimed to have shoulder weakness) and mortality (5.4%). Thus surgeons often prefer using repeated curettages or conservative debridements followed by antibiotic therapy to avoid total or partial sternectomy. Nevertheless, procedures of surgical debridement are associated with a high rate of failures (13.2%).⁵ With regard to the medical therapy and particularly the duration necessary to avoid any relapses, research seems to be lacking and insufficient, with only a very limited number of studies published on the topic.⁶ Current research aimed to study the efficacy of a semi-conservative approach in patients diagnosed with post-surgical sternal osteomyelitis, in terms of relief of symptoms, need for reintervention.

MATERIAL AND METHODS

A single-centre retrospective study was carried out in the Department of Cardiovascular Thoracic surgery in our hospital. After taking appropriate institutional ethics committee approval, data was extrapolated from the records

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How to cite this article: Shaikh NK, Suryawanshi SS, Raut C, Mishra P, Khandekar JV. Sternal osteomyelitis in post- sternotomy patients: results of a novel semiconservative approach at our centre. International Journal of Contemporary Medical Research 2021;8(8):H1-H5.

DOI: <http://dx.doi.org/10.21276/ijcmr.2021.8.8.4>



of all the patients operated from January 2011 to December 2019. Indoor and outdoor records of all the patients was studied. Period for onset of discharge/fistulas from or around the sternal wound site from the time of surgery was recorded in each case. Data records regarding microbiological wound swabs, antibiotic sensitivity and antibiotic administered after the sensitivity reports were also collected. Subsequent procedures for the management were taken into account. Record of patients needing involvement of pain management team and their subsequent interventions (which included Intercostal nerve blocks, Radiofrequency ablations) were also taken into account and the outcomes noted. Radiological findings including Chest Xrays, and CT chest were also noted for the patients.

Definition: Sternal osteomyelitis with costochondritis was defined as any patient presenting with a sterno-cutaneous fistula or a chronic breakdown in the healed wound involving the soft tissue and the bone, including wound dehiscence existing for a period of over 2 months following surgery or persistent pain on the anterior chest wall, the involvement of the bone in the infection corroborated by radiologic findings.

Inclusion Criteria

All patients under the undergoing cardiac surgery (elective and emergency) with or without cardiopulmonary bypass, but needing median sternotomy diagnosed with sternal osteomyelitis.

Exclusion Criteria

- All patients undergoing minimal access surgery or patients not needing conventional median sternotomy.
- All patients who were diagnosed to have concurrent mediastinitis were excluded from the study as that would entail the patients to undergo a radical procedure.

Institutional Protocol for management

At our institution most patients with post-surgical osteomyelitis present with discharging sinus. The patients are first subjected to a wound swab for culture and antibiotic sensitivity. After this the patient is subjected to chest Xray (lateral and PA view with markers) or CT Chest. Patients with suspected presternal collections are also subjected to local ultrasound examination. Patients are started with the appropriate antibiotics.

After confirming the location of the sinus tract, the patient is subjected to sternal wire removal and curettage of the sinus tract. The primary procedure in these patients diagnosed with sternal osteomyelitis was removal of the sternal wire which was closest to the site of osteomyelitis. After achieving hemostasis, closure was done primarily with simple sutures using Nylon sutures.

However patients who failed to respond to this, were subjected to a thorough debridement of the entire sternal wound, which reached up to periosteum of the sternum. However no bone was resected in these procedures. The closure of the wound is done in a staged manner with selective usage of Vacuum assisted closure (depending on the amount of subcutaneous fat).

STATISTICAL ANALYSIS

All possible predisposing factors were evaluated separately by means of a univariate analysis. Contingency tables (chi-square) were used for categorical variables, and *t* tests were calculated for continuous variables, always comparing the infected with the noninfected patients. Next, a multiple stepwise logistic regression analysis was undertaken for factors that were significant.

RESULTS

Of the 4054 patients who underwent open heart surgery requiring median sternotomy at our institution in the span of 9 years, 96 patients were diagnosed with sternal osteomyelitis. The mean age of patients diagnosed with sternal osteomyelitis being $51.3\text{years} \pm 4.4\text{years}$. Amongst the 96 patients 64 patients were male (70.8%) and 32 patients were female (29.2%). 84 patients of these 96 patients had diabetes ($\text{HbA1c} > 7$). These 96 patients included patients undergoing open heart surgery for various diagnoses. Coronary artery bypass graft surgery (CABG) was the surgery that had the highest incidence of sternal osteomyelitis with 78 patients of the diagnosed 96. 34 patients underwent off pump CABG surgery the rest were performed on cardio-pulmonary bypass. Of these 78 patients 19 patients were underwent an emergency CABG, 4 patients underwent CABG surgery with ventricular septal rupture repair, 9 patients underwent CABG surgery with mitral valve replacement surgery, 5 patients undergoing redo CABG surgery and 2 patients underwent CABG surgery with double valve replacement surgery. Other surgeries included Double valve replacement surgeries (12 patients out of 96), Redo mitral valve replacement surgery (2 out of 96), Redo aortic valve replacement surgery (3 out of 96) and a patient with completion Fontan surgery. The mean cardiopulmonary bypass pump time for the patients who underwent surgery on cardiopulmonary bypass was $103.1\text{minutes} \pm 19.03\text{minutes}$, and cross clamp time being $64.2\text{minutes} \pm 13.4\text{minutes}$.

The patients at the time of diagnosis had various presentations. Of the 96 patients 85 patients presented with a discharging sinus along the sternal incision site (Figure 1,2). 5 patients had a breakdown of the healed wound with a boggy swelling prior to the breakdown. 6 patients had severe pain in near the sternal wound which was not relieved despite analgesic medication. The average period of presentation for the patients was $178.5\text{days} \pm 19.4\text{days}$. The mean period for intervention in the form of wire removal was done on an average of $187.2\text{days} \pm 3.4\text{days}$.

As given in table 1, 2,3 after a univariate analysis, it was observed that presence of Diabetes, patients undergoing redo surgery or emergency surgeries, or procedures which involved longer duration of crossclamp time and longer duration of cardiopulmonary bypass were associated with higher incidence of sternal osteomyelitis.

As per institutional protocol, all patients with discharging sinus or dehisced wounds underwent wound culture and antibiotic sensitivity. Patients were started on an empirical regime of Ampicillin after sending the wound swabs for culture and were later shifted to the appropriate antibiotic as

Variables	No. of patients	Cases of sternal osteomyelitis	Percentage of patients	P value
Sex:				0.382
Male	2936	64	2.17%	
Female	1118	32	2.86%	
Diabetes				0.028
Y	2598	84	3.23%	
N	1456	12	0.82%	
Resurgery				<0.001
Yes	330	16	4.8%	
No	3724	80	2.1%	
Emergency surgery				<0.001
Yes	434	19	4.37%	
No	3620	77	2.12%	

Table-1: Predisposing Factors for Major Sternal Wound Infections after Open-Heart Procedure by Univariate Analysis

	Patients without sternal osteomyelitis and costochondritis	Patients with sternal osteomyelitis and costochondritis	P value
Age (yrs)	57.3years±5.2years	51.3years±4.4years	0.743
Duration of CPB(min)	74.32minutes ± 12.4 minutes	103.1minutes±19.03 minutes	0.001
Duration of cross clamp(min)	46.23minutes± 9.04minutes	64.2 minutes± 13.4minutes.	0.001

Table-2: Predisposing Factors for Major Sternal Wound Infections after Open-Heart Procedure by Univariate Analysis

	P value	Logistical co-efficient
Diabetes	0.028	0.02769±2.3981
Resurgery	<0.001	1.436+ 5.4871
Emergency Surgery	<0.001	1.0972+3.2271
Duration of CPB	0.001	1.143+4.3882
Duration of cross clamp	0.001	0.9772+3.657

Table-3: Predisposing Factors for Major Sternal Wound Infections after Open-Heart Procedure by Stepwise Logistic Regression

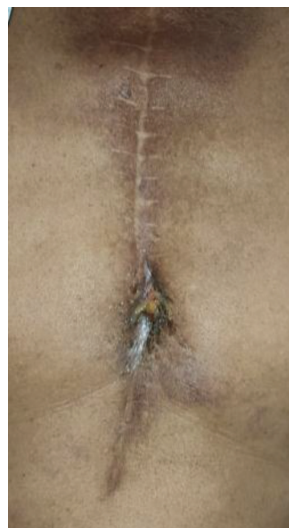


Figure-2: Patient with post-op Sternal osteomyelitis with discharging sinus



Figure-1 : Patient with post-op Sternal osteomyelitis with discharging sinus

per sensitivity. Of the 96 patients, six patients did not show growth of any micro-organisms on culture. Staphylococcus aureus was the most common growth on microbiology culture, and was present in 67 patients of the 90 patients. Staphylococcus aureus was susceptible to injection ampicillin in 53 patients, but we encountered coagulase negative Staphylococcus aureus in 10 patients which were sensitive to vancomycin. 15 patients cultivated growth of

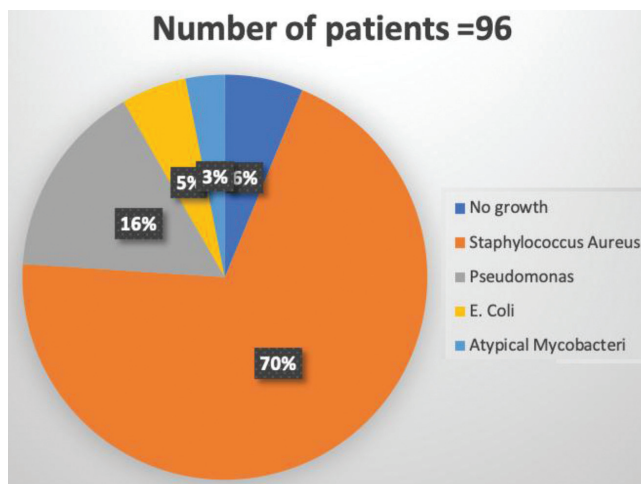


Figure-3: Signifying the different micro-organisms grown on culture

Pseudomonas aeruginosa species, which were susceptible to 2nd and 3rd generation cephalosporins. 5 patients had *Escherichia coli* which was sensitive to Linezolid. 3 patients had atypical mycobacteria and had to be started on a multi antibiotic regimen. (summarised in figure 3)

9 patients underwent local ultrasound sonography study, of which 5 patients had obvious collection in the presternal space, which was characterised by multiple echoes within. All patients were subjected to a Computed tomography of the chest. Of the 85 patients which had presented with discharging sinus opening, 80 patients had linear sinus tracts extending upto the steel wires in the sternum, while 5 had complex fistulas which had communications with multiple steel wires in the sternum. Almost all patients showed soft-tissue swelling, sternal bone erosions, periosteal reactions and parasternal inflammatory changes. None of the patients had any underlying mediastinitis.

84 patients were managed by sternal wire removal and sinus tract curettage with single staged closure of the wound under local anesthesia. For 9 patients wire removal was not sufficient and the patients needed reintervention in the form of local debridement of the wound with an extensive debridement up to the periosteum of the sternum, followed by closure in a staged manner over multiple sittings.

Of the 6 patients who presented with pain, 3 patients did not show any relief of symptoms and were referred to pain management team, which was managed by intercostal nerve blocks or radio frequency ablation.

DISCUSSION

The fistulas first present themselves after the patient is discharged from the hospital post open heart surgery, generally weeks, months or even years after the patient had the median sternotomy.²⁻⁴ This makes it difficult for the clinician to determine the true incidence of sternal osteomyelitis. It is thought that the occurrence of sternocutaneous fistulas may be greatly underreported. Furthermore, in the presence of a chronically infected wound dehiscence, it is difficult to understand whether it is a wound infection alone or actually an emergence of an underlying sternal osteomyelitis.

Sternal osteomyelitis and costochondritis post median sternotomy remains a serious post-operative complication of open heart surgeries, with an incidence ranging from 0.4-6%. This complication not only has a high morbidity in surviving patients, but is often associated with readmission to hospital and prolonged recovery period and a severe strain on resources.^{7,8}

All predisposing factors like age, sex, presence of diabetes, resurgeries, emergency surgeries, duration of cardiopulmonary bypass and duration of crossclamp time were evaluated by univariate analysis. Presence of diabetes, resurgeries, emergency surgeries, duration of cardiopulmonary bypass and duration of crossclamp time were statistically significant. A stepwise logistical regression analysis was performed as mentioned in table 3.

Steingrimsson S et al have proposed the importance of removal of infect bone for the better healing of chronic

osteomyelitis.¹ Gentry et al⁹ in their study suggested and postulated about the presence of biofilm on all foreign material, and suggested a modality of treatment which included removal of the steel wire along with the affected sternal bone.

In our study all patients who presented with a discharging sinus or dehiscd wounds had a wound culture sent, and started on empirical antibiotics as per protocol. The antibiotics were either continued or stepped up as per the sensitivity reports. In our study *Staphylococcus aureus* sp. was the most common species grown on cultures. Unlike in a study conducted by MP Tocco et al¹⁰ where the most common micro-organism grow was Coagulase negative *Staphylococcus*. In their study the patients were subjected to oral antibiotic therapy as the preferred treatment of choice, where the oral antibiotics were continued for a period of 4-6 weeks. Unlike Tocco et al, in our study the empirical therapy was continued for 3-4 days till the antibiotic sensitivity was made available and after confirmation of presence of sinus tracts or underlying osteomyelitis, the appropriate antibiotics were continued for a period of 2 weeks. Antibiotics more than the stipulated 2 weeks were carried on for the patients who underwent multiple procedures. The maximum period for antibiotic therapy being 5 weeks in only 2 patients.

A study by Tzanavaros et al. on 154 patients who underwent sternal wire removal showed improvement of symptoms in 94.8% of patients recommending it to be offered for patients with persistent chest pain after exclusion of serious pathology. Similar conclusion was given by Rashidi et al. who showed complete pain relief in 83% of patients, and 10% had improvement of their symptoms.^{11,12} Our protocol of treatment is based on these studies, where we try a semiconservative approach which is not morbid to the patient.

We think it is important to address removal of wires as a line of treatment of persistent post sternotomy pain as well. Study done by Huang et al restricted to use of different types of analgesia as nerve block, spinal analgesia, infiltration with local anesthesia and intravenous opioid with varied and inconclusive responses.¹³ The intercostal nerve blocks can be a second line treatment modality for patients who do not respond satisfactorily in terms of persistent post sternotomy pain.

Uptill recently, sternectomy and removal of the affected sternal bone was the treatment of choice for sternal osteomyelitis.¹⁴ However these procedures are associated with high rates of morbidity with prolonged hospital stay. These patients usually need a multidisciplinary approach with involvement of plastic surgery intervention to plan flaps for reconstruction of the debrided portion of the chest wall.¹⁵⁻¹⁶ Our study suggests that a sternocutaneous fistula almost always harboured a focus or foci of chronic sternal osteomyelitis in a post-operative patient of open heart surgery through median sternotomy with history of wound infection. An unrecognized or suboptimally treated wound infection with a peculiar presence of a draining fistula in an otherwise healed sternal wound is an important

predecessor of a massive and fulminant focus of chronic sternal osteomyelitis when presented at later date can only be treated by a radical sternectomy and excision of even the costochondral segments. Such a massive resection compels a complex chest wall reconstruction and prolonged hospital stay adding to the cost of health care.

Our strategy of assumption of a draining fistula as a potential case of chronic osteomyelitis in past history of wound infection in post-op period helped us to arrest the pathophysiology of chronic osteomyelitis in early-stage easily amenable to aggressive debridement, curetting of the tract with need of wire removal, if warranted, and prolonged antibiotics till resolution of sternal lesions on CT.

A false underestimation of any draining fistula to be simply a wound infection leads to magnification of the osteomyelitic focus which in later stages warrants only radical sternectomy and complex chest wall reconstructions adding to the cost and morbidity and mortality. As advised in the study done by Culliford et al we too believe in early diagnosis of sternal osteomyelitis and arresting the progression of the disease at an early stage.

In our opinion, the key to prevent a radical sternectomy and chest wall reconstruction due to chronic osteomyelitis lies in an aggressive diagnosis of focus of chronic sternal osteomyelitis with CT and clinical examination in any draining sternocutaneous fistula in other wise healed sternal wound and arresting the pathophysiology of it immediately by prompt debridement, curettage, wire removal and appropriate antibiotic therapy.

Limitations

Our study was a single centre retrospective study. There was no comparative arm to prove that our modality is superior. All the findings were exclusively limited to just the study arm without any comparison to other modality. Though our patients were counselled to report immediately when a draining fistula is noticed, we cannot accurately account if there was any delay on the side of the patient.

CONCLUSION

Patients diagnosed with post-surgical sternal infection can be managed by a semiconservative approach with satisfactory results instead of a conventionally described radical sternectomy with concomitant chest wall reconstructions.

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Source of Support: Nil; **Conflict of Interest:** None

Submitted: 25-06-2021; **Accepted:** 11-08-2021; **Published:** 30-08-2021