CASE REPORT

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Sternal resection and reconstruction due to sternal destruction caused by malignancy: a case report

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ABSTRACT

Introduction: Sternal resection and reconstruction are uncommon chest wall procedures but can pose significant challenges in their management. Sternal resection may lead to thoracic cavity instability, making careful patient selection followed by an appropriate reconstruction technique.

Case: We report a case of sternal resection and reconstruction using reconstruction plates and hernia mesh. A 21-year-old male presented with a rapidly growing anterior chest wall mass, increasing in size over three months prior to surgery. The mass measured 15 x 10 x 8 cm, was firm, and fixed. A CT scan revealed an irregular solid mass originating from the sternum, with destruction of the sternal bone. A procedure was performed involving the resection of anterior chest wall and reconstruction using reconstruction plates and hernial mesh. The resection of large portions of the chest wall poses complex challenges due to technical difficulties, surgical complications, and respiratory failure caused by chest wall instability and paradoxical movements. Four types of sternal defects are generally defined: partial longitudinal sternectomy > 75% of the sternal width, subtotal lower, subtotal upper, and subtotal mid sternectomy. Full reconstruction is generally indicated for resections involving the entire width of the sternum. Various techniques have been proposed, including myocutaneous flaps, the use of mesh and patches supplemented with methacrylate composites, titanium mesh, autograft or allograft bone, and prosthetics. However, no standardized technique exists. The choice of technique is largely based on the surgeon's experience. This report describes a relatively simple technique using readily available and economical prostheses to achieve a functionally stable chest wall. In this case, total mid-sternectomy was performed, followed by reconstruction using two reconstruction plates placed transversely on the second and third ribs, with hernia mesh beneath. The patient was extubated 24 hours postoperatively, although minimal paradoxical movements were observed without accompanying respiratory difficulty.

Conclusion: Reconstruction plates and hernia mesh can maintain respiratory mechanics but require refinement to improve chest wall stability and protective function against external trauma.

Keywords: reconstruction plates, sternal reconstruction, sternal resection.
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INTRODUCTION

Primary malignant tumors of the sternum are uncommon, with chondrosarcomas being the most prevalent, while secondary tumors more frequently manifest as locoregional recurrences of breast cancer. These patients often have a history of treatment for recurrent tumors involving surgery, systemic chemotherapy, and radiotherapy. Surgical resection of these lesions significantly enhances both quality of life and survival, especially when radical resection ensures tumor-free surgical margins. However, radical resections often result in extensive sternal and costal defects, creating complex reconstructive challenges. Consequently, many surgeons are hesitant to undertake such procedures.[1] Sternal resection and reconstruction are uncommon procedures involving the chest wall, yet managing such cases can be highly challenging. Even minor partial resections of the sternum pose a risk of thoracic cavity instability, making it essential to prioritize cosmetic restoration and protective and functional outcomes to maintain respiratory mechanics. As such, every sternal resection must start with meticulous patient selection, assessing both operability and resectability, followed by choosing the most suitable reconstruction technique.[2] The availability of chest wall reconstruction techniques has enabled more radical excision of large malignant chest wall tumors. Various methods are employed to reconstruct the resulting defects, including pedicle grafts, methyl methacrylate, metallic plates, stainless steel mesh, and other materials. Achieving wide resection is crucial to minimize the risk of local recurrence. For large sternal defects, musculocutaneous flaps can be utilized for reconstruction. This study primarily focuses on evaluating the functional outcomes of nonrigid reconstruction methods.[3] In this report, we share our experience on a case of sternal resection and reconstruction using reconstruction plates and hernia mesh.

CASE PRESENTATION

A 21-year-old male presented to the outpatient department of Prof. Ngoerah Hospital with a rapidly growing anterior chest wall mass over the central region, increasing in size over three months prior to surgery. The mass measured 15 x 10 x 8 cm, was firm in consistency, and fixed (Figure 1). The patient reports pain in the anterior chest without associated shortness of breath, cough, hoarseness, or difficulty swallowing. The patient also denies experiencing fever, weight loss, weakness, or fatigue.

A CT scan revealed an irregular solid mass in the sternal region, suspected to originate from the sternum, with extension into the bilateral pectoralis major muscles and lytic destruction of the sternum. No abnormalities are observed in the bilateral lungs, mediastinum, or visualized abdomen (Figure 2).

A procedure was performed with a vertical incision from the jugular notch to the xiphoid process in the supine position, and with the neck slightly extended. The skin and muscle layers were dissected to expose the mass. A mass was identified, adhering to the chest wall, measuring approximately 15x8x10 cm, with ill-defined borders and destruction of the sternum (Figure 3). After retracting the muscle layers laterally, we resected parts of the pectoralis major muscles and costal cartilages 2–5. We transected the sternal body along the sternal angle, which provided a sufficient tumor-free margin. Then a hernial mesh was applied to cover the resected areas of the sternum and ribs. Sternal reconstruction was performed using two 3mm reconstructive titanium plates affixed to the third and fourth ribs (Figure 4). A 14 Fr Redon drain was placed with an exit site at the subxiphoid region. The wound was closed by approximating the pectoralis major muscle, fascia, subcutaneous tissue, and skin.

Postoperatively, the patient was admitted to the intensive care unit (ICU) and placed on mechanical ventilation. Evaluation X-ray after procedure shows reconstruction plate in good position (Figure 5). On the following day, the patient achieved spontaneous breathing and was extubated. After extubation, the patient was able to breathe spontaneously with the assistance of a simple oxygen mask at 6 LPM. Paradoxical movement was observed in the lower midsection of the chest. The patient was transferred to the low care unit on postoperative day 4 and discharged from the hospital on postoperative day 8.

Figure 1. Clinical photograph of a chest wall tumor.

DISCUSSION

Resection of large portions of the chest wall poses significant challenges due to technical complexities during surgery, potential complications, and respiratory instability caused by paradoxical chest wall movement. Surgery remains the preferred treatment for primary chest wall tumors, including those of the sternum. Achieving a stable reconstruction of the sternum after tumor resection is critical for preventing pulmonary complications, protecting underlying structures, and ensuring functional and aesthetic outcomes. However, constructing a stable sternal reconstruction can be difficult, leading some surgeons to hesitate in performing extensive chest wall resections involving the sternum.[2]

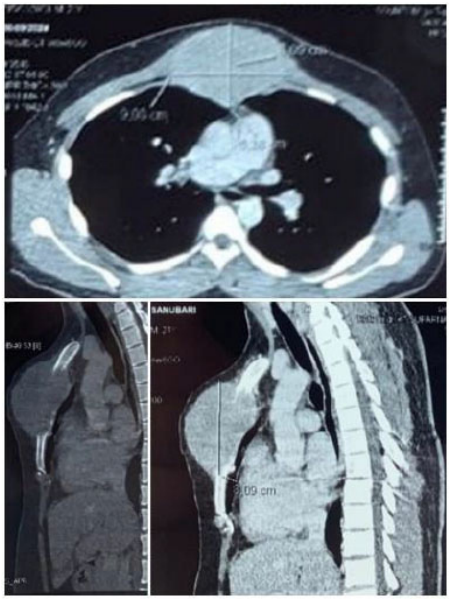

Figure 2. CT-Scan Images of the Chest Wall Tumour.

Primary malignant sternal tumors, predominantly sarcomas, encompass

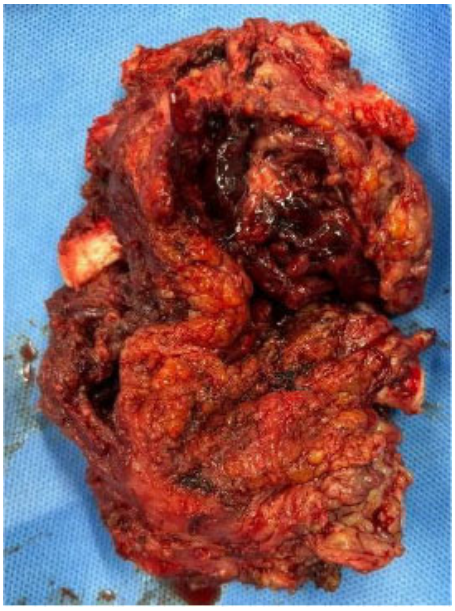

Figure 3. Resected sternal mass.

various histological types, while hematologic malignancies such as lymphomas or plasmacytomas may occasionally present as localized sternal masses. For anterior chest wall tumors involving bones, muscles, and soft tissues, surgical resection with wide margins is a key prognostic factor for disease-free survival, often necessitating extensive resections to achieve good outcomes.[4-6]

The extent of tumor involvement in the sternum and adjacent chest wall is typically assessed using conventional radiography, computed tomography (CT), and magnetic resonance imaging (MRI). These imaging modalities are also used to evaluate potential invasion into critical structures such as the lungs, pericardium, brachiocephalic vein, and superior vena cava.[5]

When tumors span multiple regions of the sternum, including the manubrium, middle sternal body, and lower body with the xiphoid process, subtotal or total sternectomy is often required. More localized tumors may be managed with partial sternectomy. While some surgeons advocate preserving the posterior sternal cortex, this approach is debated due to the high risk of recurrence if an R0 resection (complete tumor clearance) is not achieved. In practice, even limited resections often involve the removal of the skin, soft tissues, or ribs, making their benefits questionable. A minimum surgical margin of 3 cm is widely accepted

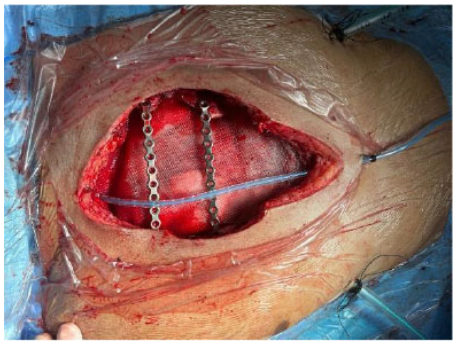

Figure 4. Sternal reconstruction with 3mm reconstruction plate and hermial mesh.

to minimize local recurrence risk. Given the extensive nature of these resections, careful planning for both skeletal and soft tissue reconstruction is essential. In cases where reconstruction is not feasible due to the proximity of vital organs, a positive margin (R1 resection) may be acceptable, with postoperative radiotherapy considered to address residual disease.[1]

The primary objectives of chest wall reconstruction are to eliminate dead space, re-establish skeletal stability, prevent lung herniation and scapular impingement, protect underlying vital organs, and preserve cosmetic appearance. In cases requiring full-thickness reconstruction, it is crucial to determine whether the reconstruction should involve only skeletal structures or be combined with an overlying myocutaneous flap for added coverage and functionality. Various materials are available for anterior chest wall reconstruction, including polypropylene mesh, titanium mesh, allografts, and custom-designed three-dimensional printed titanium sternal and rib implants.[7]

This article outlines a relatively straightforward and modified technique designed to achieve functional stability of the sternum following total resection of sternal tumors. Typically, four categories of sternal defects are identified: partial longitudinal sternectomy involving resection of less than 75% of the sternal width, subtotal lower sternectomy, subtotal upper sternectomy, and subtotal mid sternectomy. In cases of partial longitudinal sternectomy affecting no more than 50% of the sternal width, rigid reconstruction is not always necessary, irrespective of the specific area of the

Figure 5. X-Ray after procedure.

sternum involved.[2,7]

In this case, we performed a radical sternectomy with rib resection, achieving a macroscopic resection margin of 2–3 cm. Rigid reconstruction was carried out in accordance with prior research, which recommends rigid reconstruction for sternal resections involving the entire width of the sternum. Chest wall reconstruction in this case utilized reconstruction plates and hernial mesh. While respiratory mechanics were preserved, paradoxical movement was observed, indicating that chest wall stability and protection against external trauma remain suboptimal.

CONCLUSION

In conclusion, radical excision is indicated for primary tumors and solitary metastases of the sternum. Radical excision involving more than 50% of the sternal width requires rigid reconstruction. Extensive chest wall defects can be rigidly reconstructed using reconstruction plates and hernial mesh, which maintain respiratory mechanics with relatively accessible and cost-effective materials. However, chest wall stability and protection against external trauma remain suboptimal. Rigid reconstruction techniques using reconstruction plates can be improved by incorporating myocutaneous flaps or utilizing methacrylate or bone cement.

CONFLICT OF INTEREST

All author declares there is no conflict of interest regarding the publication of this report.

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None.

AUTHOR CONTRIBUTION

All authors had contributed to the manuscript writing and agreed on the final version of the manuscript for publication.

ETHICAL CONSIDERATION

The patient had received a signed written informed consent for publication of their medical data in a scientific medical journal with confidentiality of personal information.

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