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Chondrosarcoma from the sternum: Reconstruction with titanium mesh and a transverse rectus abdominis myocutaneous flap after subtotal sternal excision

Authors' Contribution:

- A** Study Design
- B** Data Collection
- C** Statistical Analysis
- D** Data Interpretation
- E** Manuscript Preparation
- F** Literature Search
- G** Funds Collection

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Summary

Background:

Chondrosarcoma arising from the sternum is extremely rare and is often untreatable. Removal of the sternum for malignant tumor results in large defects in bone and soft tissue, causing deformity and paradoxical movement of the chest wall and making subsequent repair of the thorax very important. We report a very rare patient with a chondrosarcoma of the sternum who underwent case chest wall resection, followed by reconstruction using a titanium mesh covered with a transverse rectus abdominis myocutaneous (TRAM) flap.

Case Report:

A 63-year-old man was referred to our hospital with progressively enlarged swelling of his anterior chest wall. Physical examination showed a 2.5×2.0 cm mass fixed to the sternum, which was diagnosed as a chondrosarcoma based on clinical findings, imaging characteristics and incision biopsy results. The patient underwent a subtotal sternal and chest wall resection to remove the tumor, followed by reconstruction with a titanium mesh and a TRAM flap. There were no complications associated with surgery.

Conclusions:

We report an extremely rare case of a patient who underwent subtotal sternal resection, followed by reconstruction, for a large chondrosarcoma. The elasticity and rigidity provided by the titanium mesh and the complete coverage of the surgical wound by a TRAM flap suggest that these procedures may be useful in reconstructing large defects in the chest wall.

key words:

chondrosarcoma • sternum • transverse rectus abdominis myocutaneous flap • titanium mesh • reconstruction • bone tumors

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BACKGROUND

Primary tumors of the sternum are very rare, accounting for <1% of primary bone tumors [1]. In particular, chondrosarcoma arising from the sternum is extremely rare, observed in only 86 of 49,768 (0.17%) of patients diagnosed with bone tumors in Japan from 1972–2003. Removal of the sternum for a malignant tumor results in a large defects in bone and soft tissue, causing deformity and paradoxical movement of the chest wall. The chest wall may be reconstructed, using methods such as musculocutaneous flaps and alloplastic materials. Although these techniques have enabled wide resection and relieved troublesome complaints, such as a frail chest, each has advantages and disadvantages. We describe here a patient with a chondrosarcoma arising from the sternum, who underwent resection of the sternum and chest wall, followed by thoracic reconstruction with the combination of a titanium mesh and a transverse rectus abdominis myocutaneous (TRAM) flap.

CASE REPORT

A 63-year-old man was referred to our hospital with progressively enlarging swelling of his anterior chest wall. He had no significant past medical or surgical history. A physical examination showed a 2.5×2.0 cm mass fixed to the sternum. No pulsation was noted. All laboratory tests at admission, including for tumor markers, were within normal limits. A roentgenogram of the sternum showed no apparent shadow of the tumor. Computed tomography showed a tumor shadow on the cancellous bone, which expanded across the destroyed cortex to the parietal and visceral soft parts. The lesion involved some parts of the costal cartilage and most of the sternum body (Figure 1). MR imaging showed a relatively well-defined and heterogeneous mass, primarily in the body of the sternum, but expanded into the soft tissues. The mass was isointense to the adjacent skeletal muscles on T1-weighted images and highly

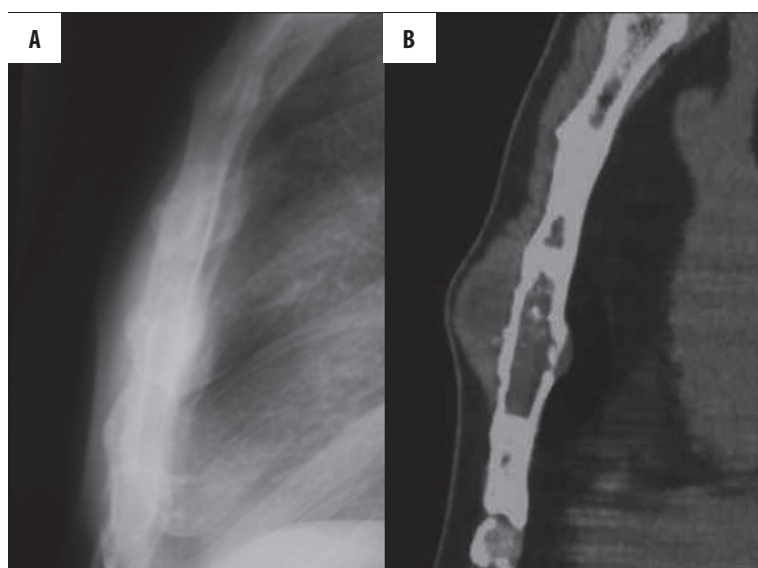


Figure 1. (A) Roentgenogram of the sternum. (B) Computed tomography scan, showing a tumor shadow in the cancellous bone, expanding across the destroyed cortex to the parietal and visceral soft parts.

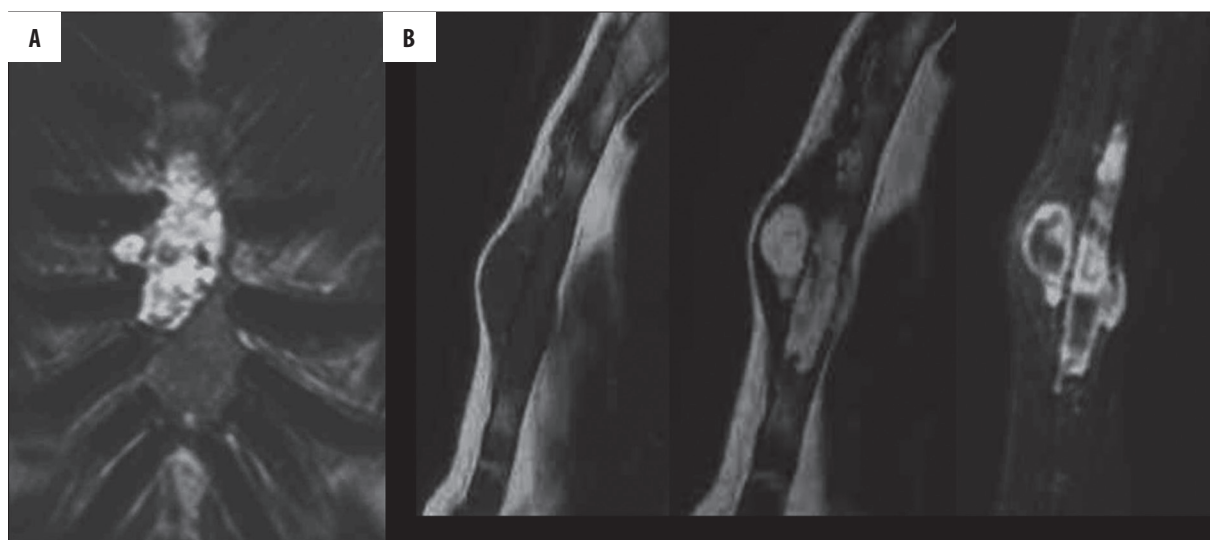


Figure 2. MR images showing a relatively well-defined and heterogeneous mass, located primarily in the body of the sternum, but expanding into the soft tissues. (A) T2-weighted images. (B) Gd-DTPA images, showing that some parts of the mass were well-defined and contrasted. Left; T1-weighted images. Middle; T2-weighted images. Right; Gd-DTPA images.

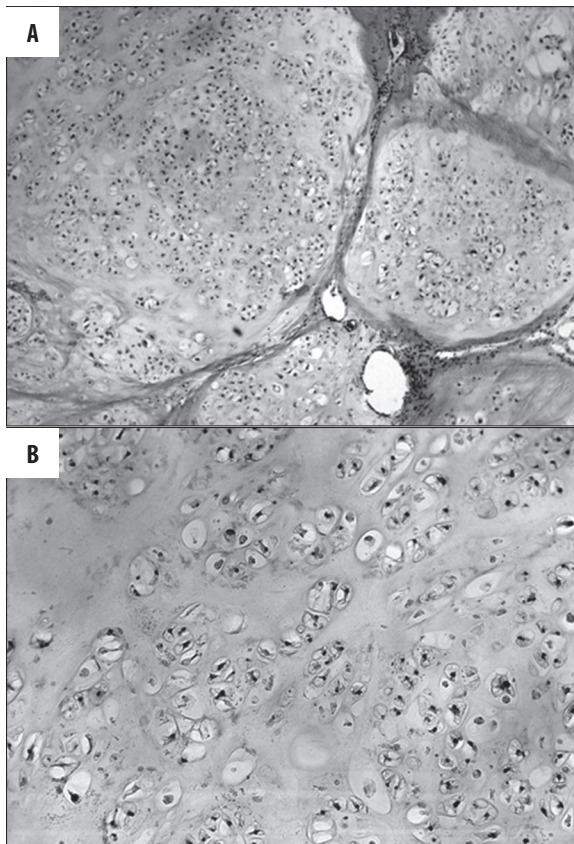


Figure 3. (A) Low-power microscopic examination, showing sheets of cartilaginous cells with a lobulated growth pattern and the tumor cells permeating into the host trabeculae. (B) High power microscopy, showing that the tumor cells varied in size and shape, with a greater degree of nuclear atypia and larger nuclei.

intense with slight heterogeneity on T2-weighted images (Figure 2A, B). On Gd-DTPA images, some parts of the mass were well-defined and contrasted (Figure 2B). A bone scintigram showed a slightly abnormal accumulation, whereas positron emission tomography showed no evidence of abnormal accumulation.

Based on clinical findings and imaging characteristics, the tumor was diagnosed as being either a primary bone tumor arising from the body of the sternum or a metastatic bone tumor. An incisional biopsy was therefore performed. Microscopically, the tumor was composed of sheets of cartilaginous cells, with a lobulated growth pattern. We also observe cells permeating between preexisting bony trabeculae. The tumor cells varied in size and shape, and contained a greater degree of nuclear atypia, hyperchromasia and nuclear size. Myxoid changes in the matrix were also seen. We therefore diagnosed this tumor as a grade II chondrosarcoma (Figure 3A, B). To remove the tumor and obtain wide surgical margins, we performed a subtotal sternal excision, resecting four-fifths of the sternum body and the right third, fourth and fifth ribs with involved soft tissues at a position 2 cm lateral to the right sternal edge. This excision resulted in a huge defect (14.0×8.0 cm) in the anterior chest wall. Macroscopically, the tumor had expanded across the destroyed cortex to the visceral soft parts (Figure 4).

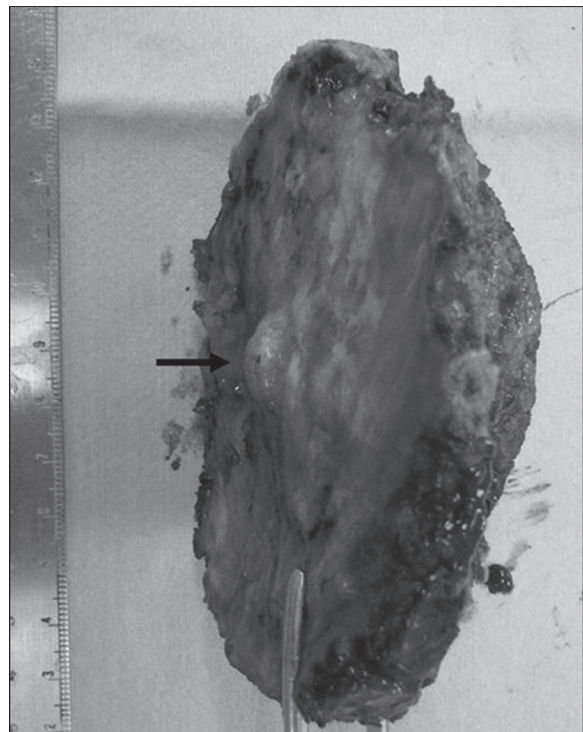


Figure 4. Subtotal sternal excision and removal of involved soft tissue. The tumor (arrow) had expanded across the destroyed cortex to the visceral soft parts.

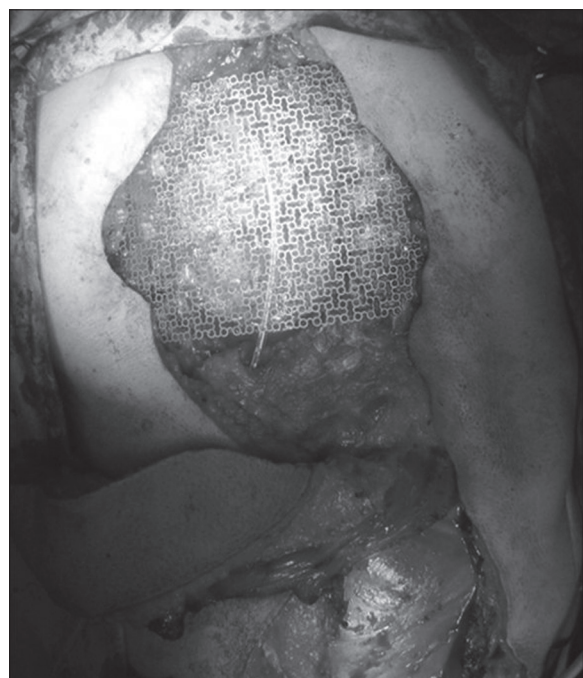


Figure 5. Reconstruction of the thorax with titanium mesh.

To reconstruct the thorax, titanium mesh was placed over the defect and fixed with screws to the bony rib (Figure 5). A musculocutaneous flap was harvested from the rectus abdominis muscle to close the resultant soft tissue defect. Immediately after surgery, the patient had good respiratory condition and immediate chest wall stability. In addition,

the TRAM flap was taken up successfully. Although some fixed screws had dropped off, paradoxical movement of the chest wall was not observed. At the present time, 64 months after the surgery, the patient is physically active with a stable chest wall, and computed tomography has shown no evidence of local recurrence or distant metastasis.

DISCUSSION

A chondrosarcoma is a malignant tumor with pure hyaline cartilage differentiation that may be accompanied by myxoid changes, calcification or ossification. Primary chondrosarcoma is the second most common primary malignancy of bone after osteosarcoma, accounting for approximately 20% of malignant bone tumors in one large series [2]. The most common skeletal sites of chondrosarcoma are the bones of the pelvis, especially the ilium, followed by the proximal humerus, the distal femur and the ribs. Most patients are older than 50 years, and there is a slight male preponderance [3].

Primary malignant tumors of the sternum are very rare, accounting for only nine of 2004 (0.45%) primary bone tumors in the Leeds Bone Tumor Registry [4]. Although chondrosarcoma is the most common malignant bone tumor of the sternum [5–9], its frequency was less than 0.2% [2].

Current therapy for chondrosarcoma requires adequate surgical excision; radiation therapy and chemotherapy have not been shown effective [10–20]. The goal of surgery is to resect the tumor with a wide margin of normal tissue, ensuring that all tumor cells have been excised and resulting in local disease control. Inadequately tumor resection is associated with a high incidence of recurrence (69% compared with 6% in adequately treated patients) [15]. The exact surgical procedure depends on the location of the tumor, the extent of the disease, and the grade of the lesion.

Sternal tumors are difficult to treat because of the anatomic proximity of vital neurovascular structures and the limited surgical margins that can be achieved. The adequacy of surgical resection is of paramount importance in determining clinical outcome [18,21]. Although it has been recommended that the incision be placed 2 to 6 cm from the margin of the tumor to minimize the risk of local recurrence [6,22–24], this requirement is not always fulfilled. Total sternectomy also has drawbacks, including chest wall instability, exposure of thoracic organs and possible paradoxical respiration.

Reconstruction after resection is necessary to prevent respiratory deficits and to protect mediastinal structures. Various reconstruction techniques using prosthetic or homologous material have been described, including synthetic and metallic grafts, pedicled skin and muscle flaps, free skin grafts, fascia lata and autologous bone transplants, with the choice of reconstruction technique dependent on the size and site of the defect, minimizing any deleterious effects. Skeletal reconstruction is not necessary for defects less than 5 cm in diameter [25]. If only the upper sternum is resected (i.e. the manubrium with ribs 1 to 3), muscle flaps alone may be sufficient for reconstruction. In contrast, resection of the lower sternum frequently requires rigid structures to protect the heart and stabilize the bony thorax [24].

The ideal characteristics of a prosthetic material include rigidity, reducing paradoxical chest motion; inertness, to allow in-growth of fibrous tissue and decrease the likelihood of infection; malleability, to enable the material to be fashioned to the appropriate size and shape at the time of surgery; and radiolucency to allow radiographic follow-up of the underlying problem [26]. Polypropylene mesh (Marlex mesh,R) is used most frequently for the reconstruction of chest wall defects. Although this mesh is relatively easy to handle and has a high affinity for tissues [27], its lack of rigidity in patients with large defects may result in paradoxical chest wall motion [28]. In contrast, methyl methacrylate and titanium plates are highly rigid but insufficiently malleable. Titanium mesh may be complicated by infection or fragmentation of the graft, but it is more rigid and osteoconductive than polypropylene mesh, easy to handle and mold to the shape of the defect, appropriately elastic, less visible on MR imaging than stainless steel, and assimilates well with surrounding soft tissues [29]. Since the protection of visceral organs after wide resection was the most important consideration in our patient, we used titanium mesh. We observed no change in postoperative pulmonary function, providing further evidence for the effectiveness of our procedure for large chest wall reconstruction.

Artificial materials are prone to infection and induce allergic reactions, factors not observed with autologous tissues [30]. TRAM flaps, based on the superior epigastric artery, are elegantly designed musculocutaneous flaps that have become the mainstay for breast reconstruction. Moreover, these flaps have been used in reconstruction of the chest wall, such as in patients with sternal wound infections and chest wall ulcers after irradiation [31]. One advantage of the TRAM flap is that the patient does not have to be moved throughout the procedure [32]. In addition, the graft survival rate is high because it TRAM flaps can be used as pedicle flaps in chest wall reconstruction. The size of the defect in our patient required a large volume of tissue, such as a TRAM flap, to reconstruct the chest wall. Since the tumor was located in the precordia, surgery was performed with the patient in the supine position, allowing the TRAM flap to be collected while the patient is in the same supine position.

CONCLUSIONS

We have described an extremely rare case of subtotal sternal resection and reconstruction of the sternum for a chondrosarcoma. Chest wall resection, followed by reconstruction with titanium mesh and a TRAM flap can be safely and effectively performed as a one-stage surgical procedure on patients with large chondrosarcomas arising from the sternum. The postoperative course of our patient was good, without infection, because the titanium mesh and TRAM flap provided appropriate rigidity and elasticity and covered the surgical wound fully. Our findings suggest that these procedures may be useful for reconstructing large defects in the chest wall.

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