

# Surgical Resection of Giant Chest Wall Chondrosarcoma Combined with Sandwich Chest Wall Reconstruction in One Case

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**Introduction:** Primary chest wall tumors account for 5% of all thoracic neoplasms and 1% of all primary tumors. Chondrosarcoma is a rare solid tumor, with an annual incidence of <0.5 per million people per year. It predominantly occurs in the pelvis and femur, occasionally occurs in flat bones such as the sternum and ribs, and rarely invades lung tissue. Chest wall chondrosarcomas represent only 5–15% of all chondrosarcomas. Radical surgery often leads to a large range of chest wall defects, especially when the range exceeds 6 cm × 6 cm and involves the sternum, spine, or multiple consecutive ribs. The reconstruction of the chest wall bone should be considered to restore the integrity and stability of the chest, prevent chest wall softening and abnormal breathing, and ensure the stability of respiratory circulation. Chest wall reconstruction can help restore thoracic hardness and integrity, prevent lung hernia and abnormal breathing, while also ensuring a positive aesthetic outcome. The chest wall reconstruction includes reconstruction of the pleura, bony structures, and soft tissues.

**Case Report:** In our case of an adult male, after the resection of the third and fourth anterior rib chondrosarcoma, the common anatomical plate was shaped and fixed to the stump of the third rib with screws to ensure the stability of the thorax while retaining the mobility of the thorax. After applying hernia mesh pruning, the chest wall defect was stitched to complete the pleural reconstruction of the defect area. This procedure can effectively maintain the stability of the pleural cavity, provide more effective support for the chest wall soft tissue, and promote the recovery of upper limb function and lung function.

**Conclusion:** The radical surgery of giant chest wall chondrosarcoma often leads to a large range of chest wall defects. Chest wall reconstruction needs to be carried out at the same time to restore the integrity and stability of the chest wall, to avoid chest wall softening and abnormal breathing, and to ensure the stability of respiratory circulation. Using the “sandwich” method for chest wall reconstruction, in which an anatomical plate is combined with hernia mesh and muscle soft tissue, and during which pleura, bony structure, and soft tissues are reconstructed, can provide more effective support for chest wall soft tissue, effectively prevent postoperative muscle tissue collapse, avoid postoperative abnormal breathing, and promote the recovery of postoperative upper limb function and lung function. It is a very effective method for chest wall reconstruction.

**Keywords:** chest wall tumor; chondrosarcoma; chest wall reconstruction

## Introduction

Primary chest wall tumors account for 5% of all thoracic neoplasms and 1% of all primary tumors [1]. Chondrosarcoma is a rare solid tumor with an annual incidence of less than 0.5 per million people per year [2]. It most commonly occurs in the pelvis and femur, with occasional occurrences in flat bones such as the sternum and ribs. Chest wall chondrosarcomas represent only 5–15% of all chondrosarcomas, and it is extremely rare for them to invade lung tissue [3]. Chondrosarcoma often grows very large prior to the development of symptoms. It is not sensitive to radiotherapy and

chemotherapy, and the best way to treat it is radical surgical resection [4]. Radical surgery often leads to a wide range of chest wall defects, especially when the range exceeds 6 cm × 6 cm, involving the sternum, spine, or multiple consecutive ribs [5, 6]. Bone reconstruction of the chest wall should be considered to restore the integrity and stability of the chest, avoid chest wall softening and abnormal breathing, and ensure the stability of respiratory circulation [7]. There is no clear specification for the surgical methods and reconstruction materials of chest wall reconstruction, which are mainly based on the experience and personal tendency of the surgeon. Herein, we report a case of surgical resection and chest wall reconstruction in a patient with giant anterior chest wall.

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## Case Series

### Clinical Data

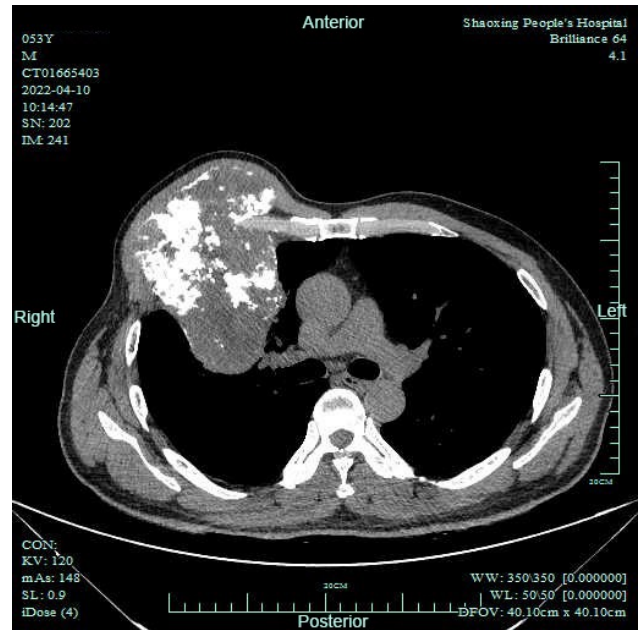
The patient a 53-year-old male, complained of a hard, immobile, slightly raised mass in the right anterior chest wall. The patient presented without pain, fever, chills, night sweats, cough, sputum cough, or dyspnea. Without special treatment, the chest wall mass had gradually increased since 2021, and the size of the mass on the body surface at presentation was 12 cm × 13 cm. He was admitted on April 10, 2022 for specialist examination regarding the mass in the right anterior chest; the mass was hard and fixed to the touch, and presented with no surface skin swelling, venous irritation, or obvious tenderness (Fig. 1).



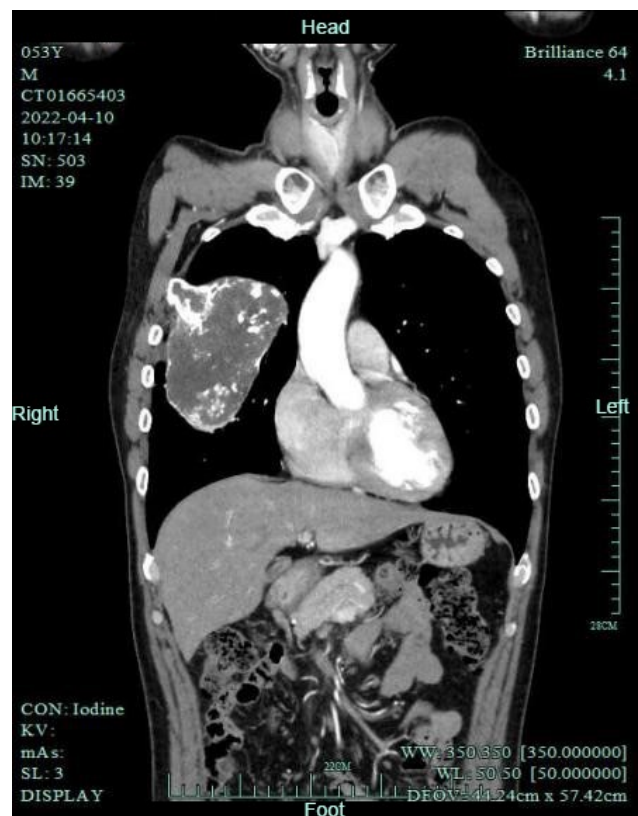
**Fig. 1.** Photo of the giant chest wall chondrosarcoma before surgery.

Auxiliary examination: Contrast-enhanced chest CT shows the large, right chest wall tumor with multiple popcorn-like calcifications and soft tissue shadows, which is highly suggestive of a malignant tumor of cartilaginous origin; there was damage to the right third costal area, upper and lower costal and thoracic junction involvement, the tumor size on the chest wall was about 7 cm, it was about 8 cm deep within the chest cavity, and was pressing closely to the surface of the upper lobe of the right lung (Figs. 2,3,4).

The admission diagnosis was a large tumor of the right chest wall and a chondrosarcoma of the ribs. After admission,

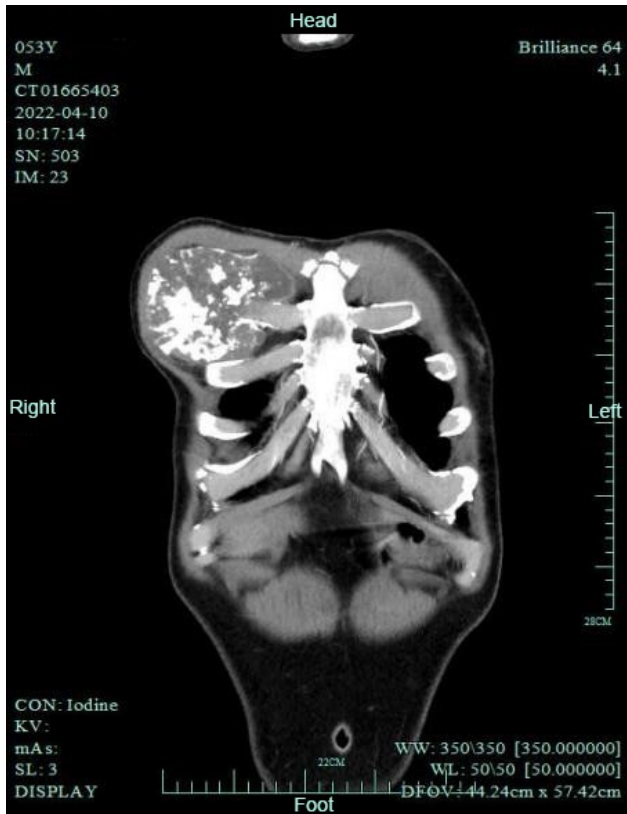


**Fig. 2.** The Contrast-enhanced chest CT shows the tumor in the horizontal plane.



**Fig. 3.** The Contrast-enhanced chest CT shows the tumor in the coronal plane.

the preoperative examination was completed, and the right chest wall tumor resection + right lung wedge resection + chest wall reconstruction surgery was performed on April 18, 2022. The procedure was performed with a right ante-



**Fig. 4.** The Contrast-enhanced chest CT shows the lesion located in the right third costal area, involving the upper and lower costal margins and thoracic junction.

rior thoracic approach. During the operation, the tumor expanded and grew along the third rib outside the chest wall and inside the thoracic cavity. The tumor had a diameter of 15 cm and had invaded the lungs. The pectoralis major muscle was freed to the tumor surface fascia, the lower edge of the second rib and the upper edge of the fifth rib, along with the third and fourth anterior costal rib, were cut and freed to 3 cm from the outer margin of the tumor, the affected lung wedge was removed using a straight cutting closure, and the area was flushed with water using sterilized injection. The Reconstruction Locking Plate used by the patient is a type of direct reduction locking plate (170901388, Trauson Company, Changzhou, China) that was used to connect the broken end of the sternum and the third rib, establishing bone support after ensuring good pulmonary expansion and no significant air leakage. A chest drain tube was placed after the trimming of the hernia mesh. On the inside of the plate, the chest wall defect was sutured to prevent lung hernia occurrence. The surgical field was soaked with distilled water for 10 min, the wound was washed with normal saline, the pectoralis major muscle was sutured and the grooved negative pressure suction tube was placed to promote the fit of the chest wall muscles and the hernia mesh. After the suture, the water column of the closed chest drain fluctuated well, and there was no obvious collapse or abnormal movement of the chest wall in the surgical area (Figs. 5,6,7).



**Fig. 5.** Appearance of the chest wall after tumor resection.

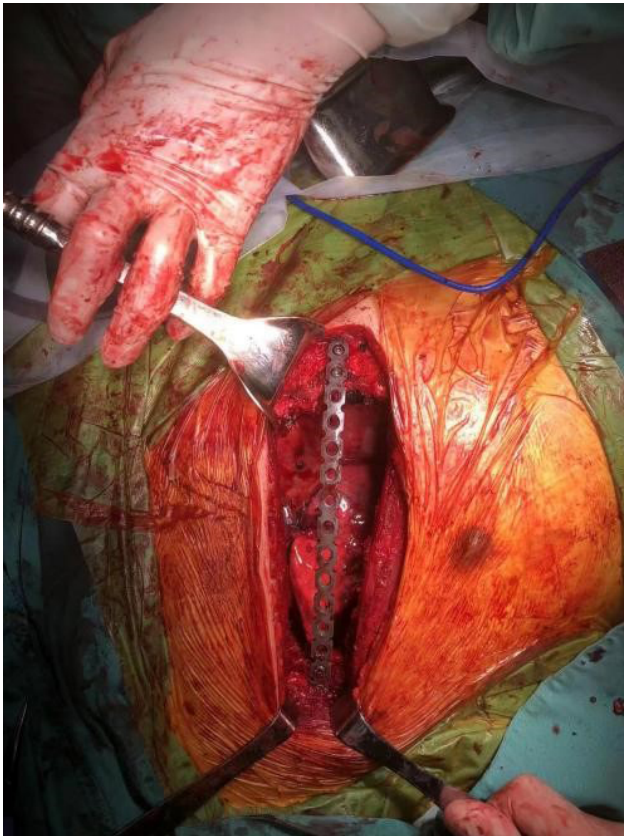
Intraoperative bleeding was 50 mL with no blood transfusion. The negative pressure suction tube was removed on the 6th day and the closed chest drainage tube was removed on the 7th day. The patient's breathing was stable. After chest X-ray review, the internal fixation position was good, with no atelectasis or pleural effusion (Fig. 8), and he was discharged at 10 days after surgery.

Postoperative pathology: highly differentiated chondrosarcoma clinically classified as negative adjacent to tissue and lung margin (Figs. 9,10), the incision of the right chest healed well 2 weeks after surgery, respiratory sounds in both lungs indicated no abnormal respiration or chest wall softening.

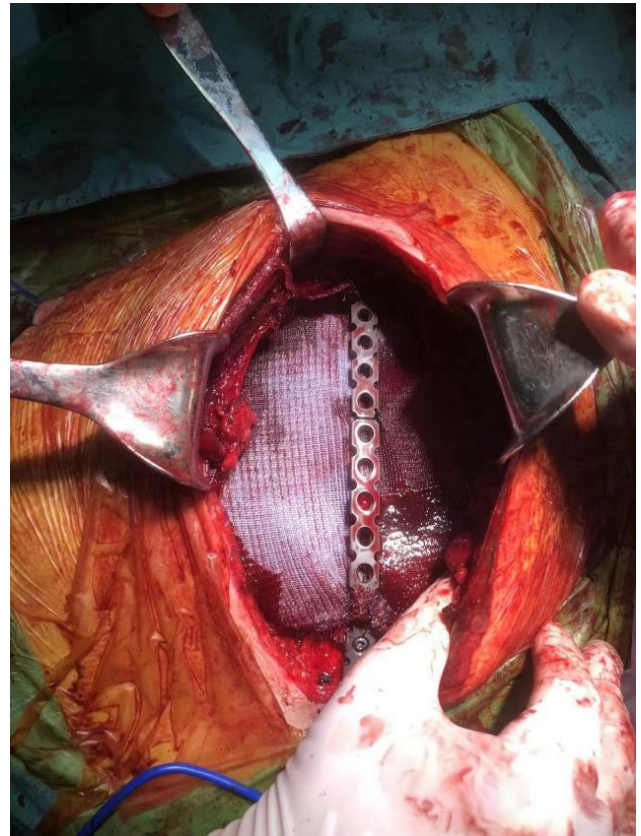
## Discussion

Radical surgical resection is the most commonly used treatment for chest wall tumors. Rib-derived chondrosarcoma is usually asymptomatic in the early stage, and symptoms occur only when the tumor growth is sufficient to cause compression of adjacent organs or vascular nerves and joints. More than half of all chondrosarcomas will have a maximum diameter of over 10 cm. Chondrosarcoma is insensitive to chemoradiotherapy, so R0 resection with a guaranteed negative resection margin is the preferred treatment modality for chest wall tumor resection. Studies have shown that extended resection can reduce the local recurrence rate after resection, and most literature suggests that



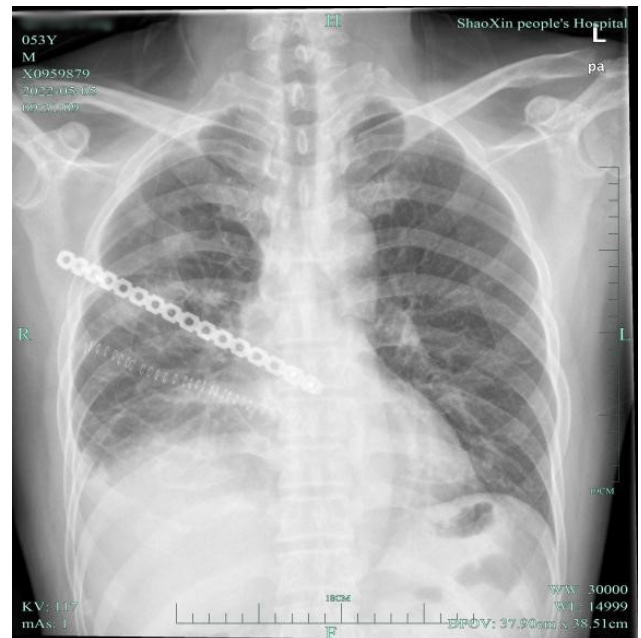


**Fig. 6. The Reconstruction Locking Plate used to connect the broken end of the sternum and the third rib.**



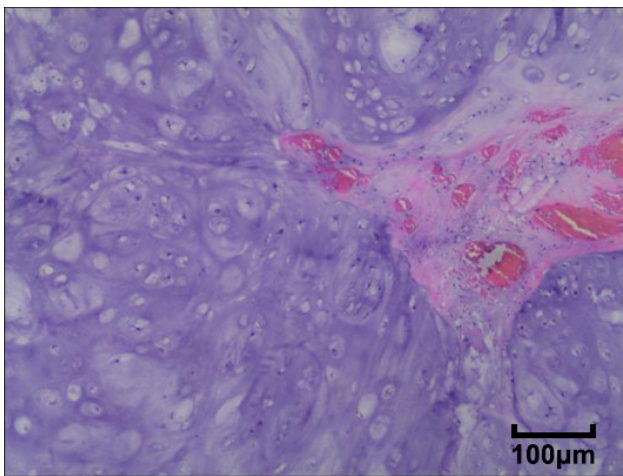
**Fig. 7. The hernia mesh was placed on the inner side of the reconstruction locking plate to prevent herniation.**

the osteotomy boundary should be at least 3 cm away from the tumor to ensure no tumor residue at the resection margin. When the chest wall tumor invades the lung, the pleural and local lung resection, and even lung lobectomy, should be carried out according to the actual intraoperative situation. In this case, after the ribs were severed 3 cm from the tumor, the tumor was resected and the wedge was removed using a straight-line cutting closure device 3 cm from the cutting edge. The postoperative pathology indicated that the lung resection margin was negative. When tumor resection causes an anterior chest wall defect diameter greater than 5 cm, chest wall floating, abnormal breathing, and/or respiratory failure often occurs following simple muscle soft tissue suture; therefore, when the chest wall resection range exceeds 6 cm × 6 cm, concurrent chest wall reconstruction is recommended. Chest wall reconstruction is performed to achieve the restoration of chest hardness and integrity, and to prevent lung hernia and abnormal breathing, while ensuring a positive aesthetic outcome. The choice of reconstruction methods and materials is more based on the surgeon's experience and personal tendency. Following thoracic wall tumor resection, surgical experts recommend a "sandwich" method of chest wall reconstruction involving the pleura, bone structure, and soft tissue, respectively. In the present case, after the removal of the third and fourth anterior ribs, the excessive plate fixation limited





**Fig. 9. Macroscopic view of the tumor postoperatively.**



**Fig. 10. Microscopic view of the tumor postoperatively.**

third rib and the sternum, which not only ensured the stability of the thoracic cage, but also retained the mobility of the thoracic cage. The pleural reconstruction in the defect area can effectively maintain the stability of the pleural cavity, ensure the adhesion of the visceral pleura of the lung surface and the artificial pleural membrane, promote the fit of the chest wall muscle and the pleural membrane, and reduce the occurrence of effusion and gas accumulation, so as to effectively maintain the stability of the pleural cavity. In this case, the hernia mesh was fixed after molding using 4-0 prolene thread in the chest wall defect, a chest tube was inserted, a grooved negative pressure suction device was placed in the muscle and mesh gap, and a surgical incision pressure dressing was applied. This allowed drainage to stop after less than the extubation standard, which aided lung soft tissue and implant adhesion and promoted rehabilitation [8, 9]. More effective support for the chest wall soft tissue can effectively prevent postoperative muscle tissue collapse [10]. The postoperative breathing of the patient was relatively stable and did not show obvious abnormality, proving the effectiveness of this surgical procedure.

Currently, despite the limited efficacy of chemotherapy, various treatment methods are actively being explored, including immunotherapy and targeted therapy [11, 12]. The tumor microenvironment plays a crucial role in the progression and metastasis of chondrosarcoma. Hou SM [11] has found that hypoxic conditions enhance the release of extracellular vesicles by chondrosarcoma cells, which in turn promote the polarization of macrophages towards the M2 phenotype, ultimately facilitating the malignant behavior of chondrosarcoma. Other study [12] has indicated that the infiltration of immune cells around chondrosarcoma is closely associated with the progression of the tumor. In Swarm rat chondrosarcoma, selective depletion of T cells accelerates tumor growth, while depletion of CD163+ macrophages slows down tumor progression. Furthermore, research by Nguyen BT [13] has highlighted the significant role of MMP7 in the proliferation, migration, and resistance to apoptosis in chondrosarcoma. By promoting the expression level of miR-520f-3p through melatonin, the synthesis of MMP7 can be reduced, thereby inhibiting the occurrence and metastasis of chondrosarcoma. These efforts have opened up new possibilities for the treatment of chest wall chondrosarcoma beyond surgery.

## Conclusion

This paper is a case report on chest wall chondrosarcoma, and the follow-up time is less than two years. Until now, the patient's postoperative survival status has been good, which to some extent reflects the success of the surgery; thus, it does not permit evaluation of the long-term effect of anatomical plate combined with hernia mesh and muscle soft tissue “sandwich” reconstruction. During recovery, the effect of extended resection on postoperative pulmonary function may be mitigated through later pulmonary function rehabilitation exercise. Patients after rib chondrosarcoma must be followed up for long-term review to prevent local recurrence and undergo therapeutic intervention. In this case, the authors believe that giant chest wall chondrosarcoma with enlarged radical resection combined with “sandwich” reconstruction is an effective method.

## Availability of Data and Materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## Author Contributions

Study design: ZFM, PX. Data acquisition and processing: PX, GMY, HYW. Analysis and interpretation of data: QYJ, ZFM. Writing important parts of the article: ZFM, QYJ. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

## Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Shaoxing People's Hospital (2021-K-Y-007-01) and conducted in accordance with the Helsinki Declaration. Informed consent forms for the use of biological samples and health-related information were obtained from the patients or their guardians.

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## Conflict of Interest

The authors declare no conflict of interest.

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