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## Reconstruction of chest wall with digital material after resection of sternal tumor

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### Abstract

After sternal tumor resection, the chest wall appears secondary defect, which requires chest wall reconstruction. In the past, there were many kinds of reconstruction materials, each of which had its own characteristics. We use digital material for reconstruction, which fully reflects the characteristics of personalized design, greatly facilitates the implementation of surgery, and also maximizes the recovery of chest wall structures. In this article, the operation of a 47-year-old male patient with sternal body tumor is reported. We first removed the tumor, then reconstructed the chest wall with digital material, and achieved satisfactory results.

**Keywords:** Digital material, sternal tumor, chest wall reconstruction

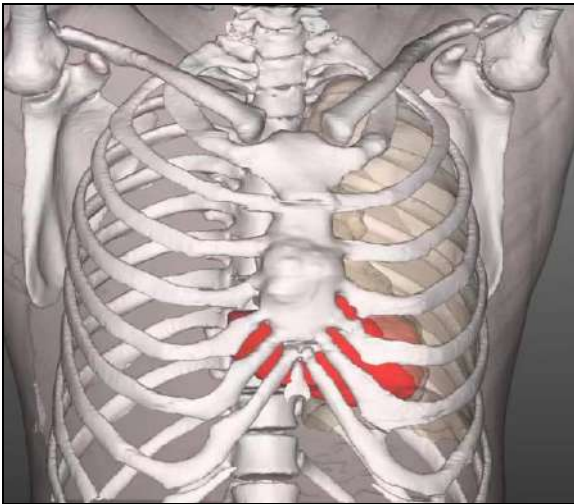
### Introduction

Chest wall tumor is a kind of chest wall disease, which can occur in various parts of the chest wall and involve a variety of structures<sup>[1-3]</sup>. Sternal tumor is a common tumor of chest wall. Because of its serious harm, surgical resection is generally required once it is found. However, because the sternum is an important part of the thorax, it is necessary to reconstruct the chest wall after tumor resection<sup>[4, 5]</sup>. In the past, there were many kinds of materials used in reconstruction surgery<sup>[4-7]</sup>. Each material had different properties, and the surgical effect was different. In recent years, 3D printing materials are gradually used in clinic<sup>[6, 7]</sup>. The greatest advantage of this material is considered to be personalized design. However, this material also has its defects. In 2018, we proposed the concept of digital material and used it in clinical practice<sup>[1-3, 8]</sup>. This paper introduces the operation of a 47-year-old patient with sternal tumor. During the operation, we used digital material for reconstruction and achieved satisfactory results.

### Case Report

The patient was a 47-year-old male patient. One year before admission, the patient found a mass in the middle of the anterior chest wall, which was asymptomatic in the early stage, and then had local pain. He was diagnosed with sternal tumor in the local hospital. For surgical treatment, the patient was admitted to our hospital. Physical examination showed that there was a mass in the middle of the front chest wall, about 5X7cm in size, with normal surface skin. Imaging examination revealed sternal tumor involving all sternal body and the surrounding costal cartilages (Fig 1). The patient's diagnosis was clear. Before surgery, digital material needed to be designed and processed in advance. The first step was to obtain the patient's chest and focus data from the CT examination results, and then the processing scheme of the reconstruction material is designed according to the data. Finally, the digital material was processed with the titanium alloy by the numerical control machine tool (Fig 2). The patient's operation was performed under general anesthesia. In the supine position, all sternal body and the surrounding costal cartilages and ribs were exposed through the median incision. The tumor was removed along the periphery of the tumor, and the resection range was about 3 cm away from the tumor (Fig 3). The digital material was put into the defect after tumor resection, and firmly fixed with the surrounding structures (Fig 4). The internal and external sides of the digital material were covered with fibrous membranes (Fig 5), drainage tubes were placed in the operation field, the incision was closed, and the operation was completed (Fig 6). The operation was smooth without complications. The postoperative X-ray examination showed that the reconstruction effect was satisfactory (Fig 7). The patient was discharged 10 days after operation.

Follow up for 2 years showed that the patient did not complain of discomfort and had no tumor recurrence. Imaging examination showed that the thoracic structure was satisfactory (Fig 8).



**Fig 1:** 3D image of sternal tumor and chest wall



**Fig 2:** Digital material after processing



**Fig 3:** The sternal tumor was removed



**Fig 4:** Reconstruction of chest wall with digital material



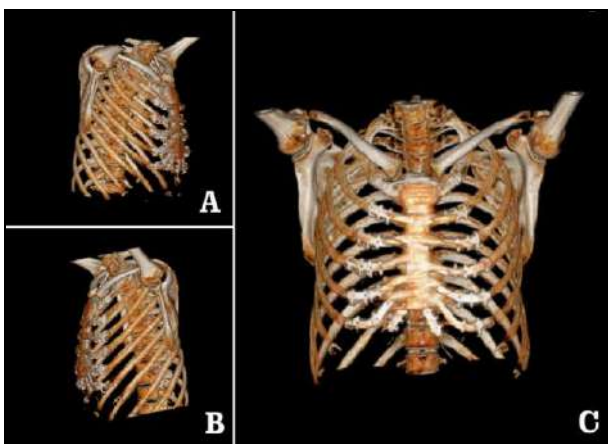
**Fig 5:** Fibrous membranes were used to cover the digital material



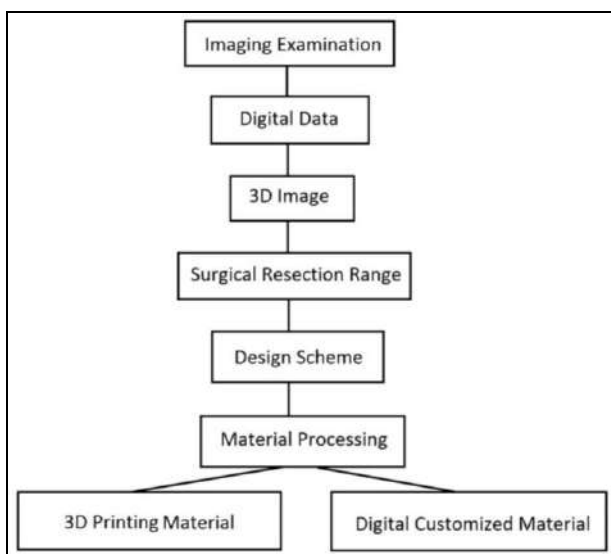
**Fig 6:** Postoperative appearance of chest wall



**Fig 7:** Postoperative X-ray examination



**Fig 8:** 3D image of chest wall 2 years after operation



**Fig 9:** Flow chart of design and processing of digital material

**Discussion**

Chest wall tumor is a common disease in chest wall surgery, which can invade all structures of chest wall, and chest wall skeleton is the most common structure [1-3]. After this kind of structure is removed, there will be secondary defect on

the chest wall. If the defect is large, chest wall reconstruction is necessary [4, 5]. Chest wall reconstruction requires to restore all structures that have been removed, including skin, soft tissues and bone structures in general. If the range of skin and soft tissues resection is limited, they can be directly sutured. If the range is too large, various types of flaps are needed for reconstruction. The reconstruction of bone structures require special materials. Due to the limitation of autologous materials, the most ideal materials are artificial materials [4, 5]. So far, a large number of materials have been used clinically. These materials have their own characteristics, but they also have certain defects. In recent years, 3D printing materials have been used in clinic [6, 7]. The biggest advantage of this material is personalized design, that is, to design material for the need of specific surgery, so as to meet the need of surgery to the maximum extent. Theoretically, this material is the most ideal. However, the problems of processing methods still limit the wide use of this material.

In 2018, we proposed the concept of digital material, which refers to all materials directly designed based on patient's digital information [1-3, 8]. This material has roughly fixed processing procedures (Fig 9). First, imaging examination for patient is performed to obtain digital data of the tumor and surrounding structures, and 3D image is obtained based on the digital data with special software. Then, the surgical resection range is simulated using this image, and the design scheme of digital material is completed according to the resection range. Finally, the material is processed accordingly to obtain the finished product.

From the above concept and process, digital material actually includes two specific types: one is 3D printing material, and the other is digital customized material. The only difference between the two materials is the final processing method. The former uses 3D printing, while the latter uses numerical control machine tool (Fig 9). We have used a lot of digital customized materials in our surgeries, and found that this kind of material has many advantages and is convenient to use.

In the operation of this patient, because the sternum body and the costal cartilages connected with it were removed, the reconstruction material must be fixed with the surrounding ribs. In order to meet the requirements of surgery, the material we designed not only include the sternum and costal cartilage, but also include the fixed part as a claw like structure, which can make the fixed operation easy to complete.

Digital material are mainly reconstruction materials designed for bone structures [6-8]. Because there is a large gap in the material equivalent to the intercostal part, the intercostal structures also need to be reconstructed. This reconstruction is very important, because it can not only prevent the occurrence of intercostal hernia, but also eliminate the existence of chest wall defects as much as possible to prevent abnormal breathing. Our practice is to use fiber membrane to cushion inside and outside of digital material. This method can maximize the reconstruction of the intercostal structures. Some authors call this operation pleural reconstruction, which we think is an inappropriate term.

**Conclusion**

The biggest feature of digital material is personalized design. Theoretically, this material is the most ideal

reconstruction material. However, it has many practical problems. First of all, this material has no ready products and can only be processed temporarily. This is often a long time, which is obviously unfavorable to the treatment of patients. Secondly, sometimes this material is difficult to truly reflect the advantages of personalized design, which will bring difficulties to the actual surgery. Obviously, there are still a lot of works to be done before large-scale application of this material.

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#### **Author's Contribution**

Not available

#### **Conflict of Interest**

Not available

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#### **Reference**

1. Wang W, Long W, Liu Y, Cai B, Luo J. Progress in chest wall surgery. *International Journal of Surgery Science*. 2022;6:161-6. DOI: [doi.org/10.33545/surgery.2022.v6.i3c.938](https://doi.org/10.33545/surgery.2022.v6.i3c.938).
2. Wang W. Basic theories and concepts of chest wall surgery. *International Journal of Surgery Science*. 2022;6(3):12-4. DOI: [doi.org/10.33545/surgery.2022.v6.i3a.909](https://doi.org/10.33545/surgery.2022.v6.i3a.909).
3. Wang W. Chest wall surgery: Chest wall plastic surgery or chest wall orthopedics. *International Journal of Orthopedics Sciences*. 2022;8(3):82-4. DOI: [doi.org/10.22271/ortho.2022.v8.i3b.3174](https://doi.org/10.22271/ortho.2022.v8.i3b.3174).
4. Gonfiotti A, Salvicchi A, Voltolini L. Chest-Wall Tumors and Surgical Techniques: State-of-the-Art and Our Institutional Experience. *J Clin Med*. 2022;11:5516. DOI: [10.3390/jcm11195516](https://doi.org/10.3390/jcm11195516).
5. Wang W, Long W, Liu Y, Cai B, Luo J. Reconstruction of chest wall with MatrixRIB plate after sternal tumor resection in children. *International Journal of Orthopedics Sciences*. 2022;8:236-8. DOI: [doi.org/10.22271/ortho.2022.v8.i3d.3205](https://doi.org/10.22271/ortho.2022.v8.i3d.3205).
6. Hoang D, Perrault D, Stevanovic M, Ghiassi A. Surgical applications of three-dimensional printing: a review of the current literature & how to get started. *Ann Transl Med*. 2016 Dec;4(23):456. DOI: [10.21037/atm.2016.12.18](https://doi.org/10.21037/atm.2016.12.18).
7. Wen X, Gao S, Feng J, Li S, Gao R, Zhang G. Chest-wall reconstruction with a customized titanium-alloy prosthesis fabricated by 3D printing and rapid prototyping. *J Cardiothorac Surg*. 2018 Sec;13(1):4. DOI: [10.1186/s13019-017-0692-3](https://doi.org/10.1186/s13019-017-0692-3).
8. Liu Y, Wang W, Long W, Cai B, Chen C, Wang W, *et al*. Chest wall reconstruction with digitally designed materials for straight back syndrome with tracheal stenosis: A case report. *Ann Transl Med*. 2021 Aug;9(16):1357. DOI: [10.21037/atm-21-3976](https://doi.org/10.21037/atm-21-3976).

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