



## A Different from of Sternal Reconstruction: A Case Study

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### Authors' contributions

This work was carried out in collaboration between all authors. Authors HT, MA and TSE designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors MD and BK managed the literature searches and revised it critically for important intellectual content. All authors read and approved the final manuscript.

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Case Study

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### ABSTRACT

Currently, almost all sternum defects, with or without tissue loss, can be repaired through various kinds of surgical procedures and grafts. A patient diagnosed with multiple myeloma one and a half years earlier experienced during therapy a pathological fracture of the sternum that healed with a "staircase" like complication. Reconstruction of the sternum using the "nitinol plaque" was performed on the patient, who came to have the deformity corrected. We present our first case of reconstruction using a new material, which had a successful outcome.

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## 1. INTRODUCTION

Chest wall reconstruction is necessary in cases where there are congenital pathologies like pectus, defects stemming from wide tumor excisions, necrosis resulting from treatments such as radiotherapy, and tissue losses and deformities secondary to trauma. Although autologous muscle grafts are most commonly used for reconstruction, synthetic or metal grafts are also frequently utilized in patients with large defects. The necessary functionality of the method used is better appreciated considering the direct effect of chest wall reconstruction in respiratory physiology. Furthermore, in addition to being functional, the reconstruction has to be as resistant to impact as possible for the protection of vital organs.

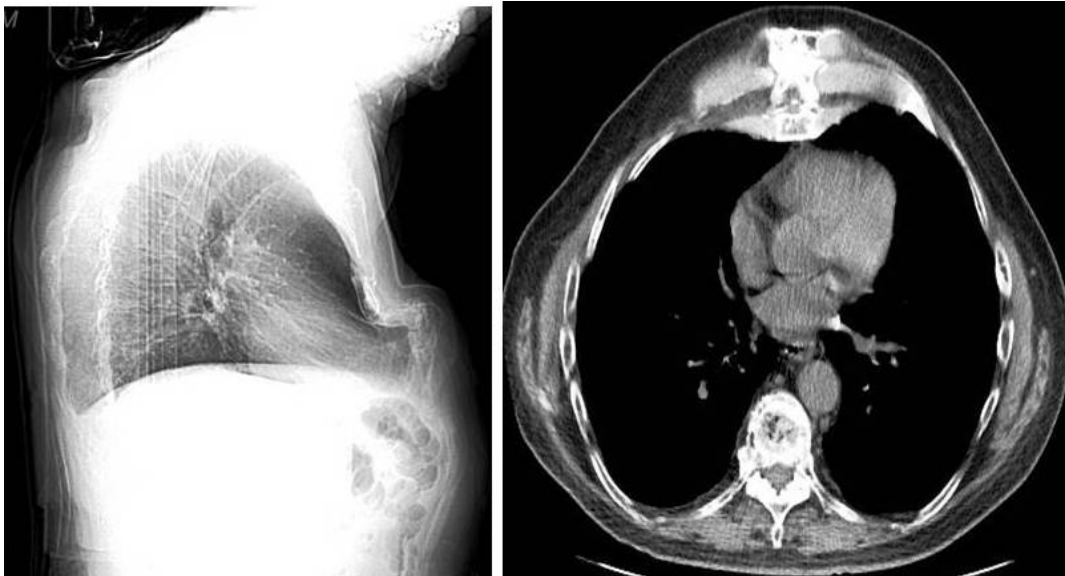
## 2. CASE

A 58 year-old male patient came to our clinic with complaints of "deformity in front part of the chest wall" and "feeling pressure while breathing" (Picture 1). It was discovered that the patient had been diagnosed with multiple myeloma a year and a half earlier and that during chemotherapy had experienced a spontaneous sternum fracture, which was not treated at the time. The fracture line healed with a "staircase"-like deformity, causing disfiguration on the anterior chest wall (Pictures 2-3). After general evaluation

did not reveal any contraindications in the patient, who was in complete remission in his primary illness, surgical reconstruction was planned. Nitinol clamps, which are shape-memory alloys, were preferred to fuse the sternum of the patient, who had low bone density due to both multiple myeloma and chemotherapy. The upper part of the defect area was reached through a skin cut at the midline (Picture 4A). The sternum was separated from the heads of costal cartilages and pectoral muscles on each side. After liberating it from the mediastinum with blunt finger dissections, the "staircase" like fracture was corrected by cutting both corners and was fixed with two "nitinol clamps" after straightening it on the proximal-distal planes (Picture 4B). Subsequently, the costal cartilage heads were cut up into pieces and used to fill the spaces (Picture 4C) The patient was followed up with a sternum corset and discharged after 8 days (Picture 4D). He used the corset for two months. The patient received follow up care for 9 months after the operation without any complications (Picture 5).

## 3. DISCUSSION

The most frequent reason for reconstruction of the sternum, which is the underlying structure of anterior chest wall, is deformities and impairment in respiratory functions [1]. While surgical repairs are commonly necessary in cases of congenital



**Picture 1.** A scan of lateral chest X-ray and CT of the patient when he first came to see us

anomalies, reconstruction may be need in the case of fractures occurring after tumor surgery. Similar indications were present in our case,

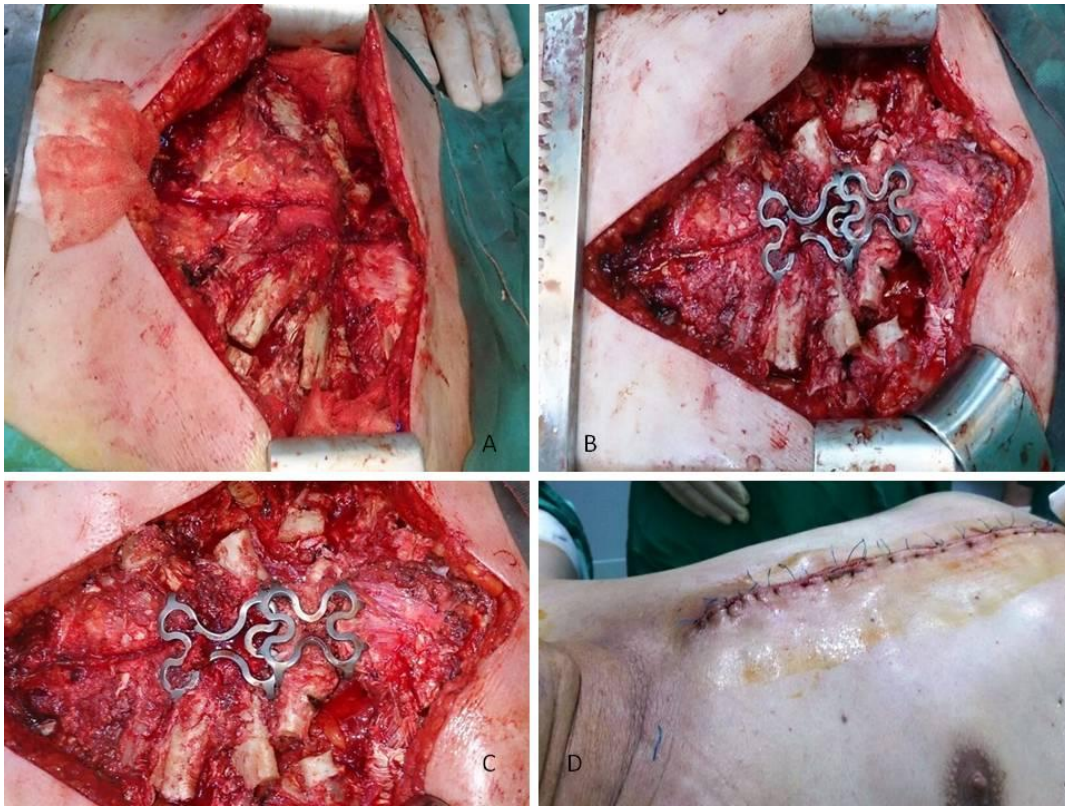
where surgery was performed on a sternum that had healed with severe esthetical and functional sequelae in the presence of multiple myeloma.



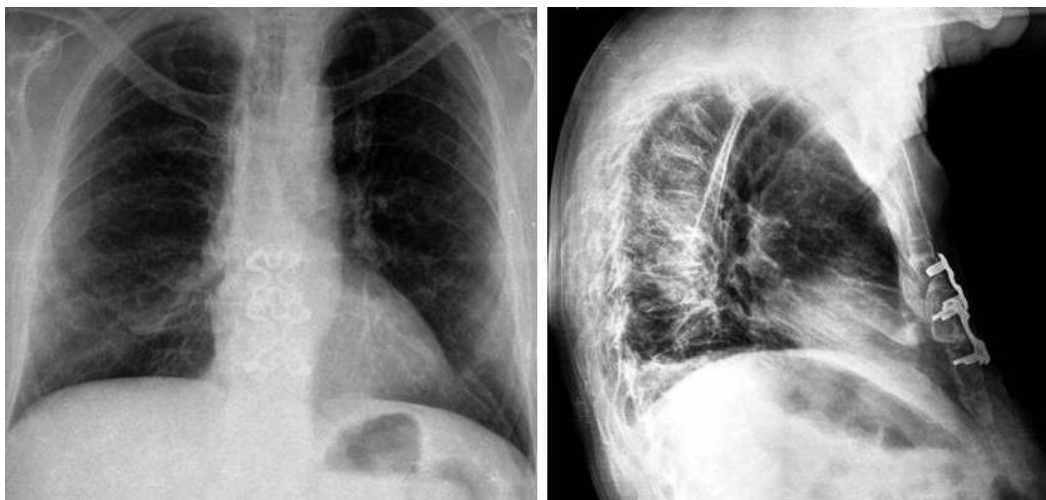
Picture 2. A preoperative lateral CT scan of the patient



Picture 3. 3-dimensional CT scans of the patient



**Picture 4. A- Intraoperative appearance of the defect B- The appearance of the defect after the placement of nitinol clamps C- The appearance after the filling of spaces with removed costal cartilages D- The appearance at the end of the operation**



**Picture 5. Control X-rays 9 months after operation**

Pectoral muscle is the preferred autologous graft in sternum reconstruction. However, other methods include the use of synthetic materials, such as the mesh sandwich, which is obtained by

placing methyl methacrylate in prolene mesh [2-3]. Its major advantage is that these meshes form a strong barrier for the anterior chest wall. Furthermore, a variety of titanium-based metal

products have been employed in recent years. However, all of them require the use of classical steel wires or metal screws to fix the patch on remaining bone tissue. Therefore, the efficacy of the patch depends on the strength of the tissue. In our case, the strength of the bone could not be relied on due to the osteoporosis caused by a severe chemotherapy as well as the underlying multiple myeloma in remission. Under the circumstances, nitinol clamps, which are shape-memory metal alloys, were preferred to other options.

Nitinol was first produced as a shape-memory alloy from titanium and nickel in 1965 [4]. The alloy has the ability to reclaim its initial shape at high temperatures which alters with external forces in low temperatures. In today's medicine, they are used in many areas, ranging from coronary stents to reconstruction surgery. Sternal reconstruction is quite problem in some cases. This plate should be useful for some cases. The greatest advantage of using nitinol clamps in connecting the sternum is its reduction of the risk of hemorrhage and damage to the bone. This lessening of risk is achieved by the uniform pressure the clamps exert by having a surface area 5 to 10 times greater than standard wire [5]. Nitinol clamps are fast and simple to use, and are compatible with CT and MRI [6]. Furthermore, their application allows 10-15% flexibility which is advantageous in cases such as severe coughing [7].

Other studies have provided varying results. For example, Alhalawani [8] argues that plating and interlocking techniques are superior to wiring in terms of stability and reduced rate of post-operative complications but add that more clinical studies and long-term follow-up are required.

Guler [9], on the other hand, states that the implantation of the thermoreactive nitinol clip is an effective and easy method for fixing the sternum and can be performed rapidly and securely.

Albayrak [10] argues that titanium plate stabilization is a safe and satisfactory fixation method and should be kept in mind for complicated sternal dehiscence cases.

However, Srivastava [11] maintains that thermoreactive clips do not have an advantage in the prevention of superficial or deep sternal wound infection in obese patients undergoing sternotomy [11].

Considering these facts, we felt it was the most appropriate choice for our patient, who we found during surgery to have extremely fragile bone structure. The absence of complications in the patient, who was supported with a sternum corset in the post-operative period, has also been encouraging.

#### 4. CONCLUSION

In conclusion, it is possible to successfully reconstruct a sternum that has been dislocated for whatever reason. However, we feel the success of the operation is directly affected by the choice of appropriate material selected for the patient.

#### CONSENT

Written and verbal informed consent was obtained from patient who participated in this case.

#### ETHICAL APPROVAL

It is not applicable.

#### COMPETING INTERESTS

Authors have declared that there is no conflict of interest regarding the publication of this paper.

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