Sternum reconstruction using titanium plates matched with "sandwich" Gore-Tex meshes

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Abstract: Chest wall reconstruction after extensive resection may be technically difficult, and which technique permits to obtain the right compromise between rigidity and plasticity of the chest wall is still argument of debate. Indeed, many techniques and materials have been proposed and tested to cover chest wall defects and to ensure correct respiratory movements, but unique results still miss. We herein report the case of a 55-years old woman with soft-tissue sarcoma involving the sternum treated with sternum and anterior ribs arch resection (from the second to the fourth). The chest wall defect was repaired using titanium plates and Gore-Tex meshes combined as a "sandwich". The scope was to obtain a synchronous movement of the prosthesis with the titanium ribs, reducing the scratching between the different materials and avoiding paradox chest wall movements.

Keywords: Chest wall; reconstruction; soft tissue sarcoma

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Introduction

Chest wall reconstruction after extensive demolition is often very challenging also for expert surgeons and many techniques and materials have been proposed and tested to cover chest wall defects.

The goal of chest wall reconstruction is to provide protection of mediastinic organs to external injuries avoiding paradoxical movements that could create respiratory discomfort (1). In particular, achieving malleability and rigidity of the thorax may be difficult, especially when reconstructing the sternum. Prolene, Marlex, Polytetrafluoroethylene (PTFE), Methyl methacrylate and Vicryl are now diffused in general surgery obtaining successful results in terms of rib cage physiological function and aesthetics recovery (2,3).

Conversely, more rigid materials are available, particularly, titanium based materials such as bars and plates that have obtained good long term results when used to replace or stabilize ribs (4). Furthermore, it is now possible to plan tailored coverage of the sternum defects designing titanium shields or meshes based on the biometric parameters of the patient (5). However, it is also true that it is not always possible to prepare patients as well as have the time and resources to obtain new prosthesis or allografts in a short time.

We herein report a reconstruction technique using titanium plates and Gore-Tex meshes combined as a "sandwich", with the aim to improve the motility of the chest wall for correct breathing movements and obtaining good results in terms of plasticity of the chest wall and protection of the chest cavity.

Case presentation

A 55-year-old woman with no history of previous malignancy was referred to our department for the appearance of a solid mass in the sternum. A fine needle biopsy was performed and a primitive soft tissue sarcoma was diagnosed. The body of the sternum and the articular cartilage revealed infiltration by a neoplasm from the second to the fourth left intercostal space (*Figure 1*). Surgery confirmed involvement of the

sternum, the major pectoralis muscle, soft tissue and the derma. In particular, the sternum revealed infiltration in the superior to the middle part of the body in correspondence to the second, third and fourth left rib. An en-bloc resection of the upper half of the body of the sternum with the anterior arch of the second, third and fourth left rib, part of the major pectoralis muscle , soft tissue and skin lozenge was required to ensure free margin from the sarcoma. The defect of the chest wall is shown in *Figure 2*.

To cover the sternum defect a good compromise between rigidity and elasticity of two different prosthetic materials were used: Gore-Tex mesh (GORE-TEX® Soft Tissue Patch, W. L. Gore & Associates, Newark, DE, USA) and titanium plates. After measuring the intercostal distance and planning the right collocation of the titanium plates, two Gore-Tex prosthesis were fixed together with a suture in prolene, leaving three pockets for the titanium plate (*Figure 3*). After having passed the plates through the pockets in the matched meshes, they were fixed at the second, third and fourth rib bilaterally with screws (*Figure 2B*). In this manner, appropriate movement of the plates with the Gore-Tex meshes was obtained, reducing shift and chafing that could create uncoordinated movements or mesh breakages. The meshes were covered by a major pectoralis muscular flap.

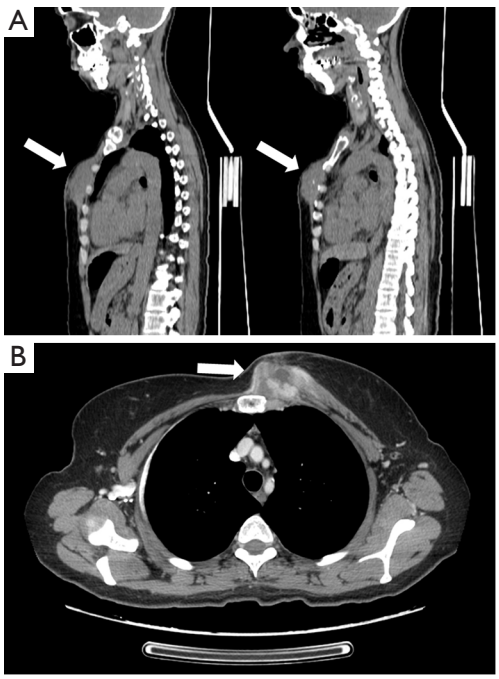

Figure 1 (A,B) The soft-tissue sarcoma located in the anterior arch of the second, third and fourth ribs (arrows).

Finally, two chest drainage tubes were placed into the two pleural cavities and two small soft drainage tubes were left between the prosthesis and the muscular flap to avoid serum accumulation (*Figure 2C*). Post-operative recovery was regular and the patient was consequently discharged on 7th postoperative day. The patient did not present paradoxical movement of the chest wall nor respiratory distress. The patient received traditional dose analgesic therapy with intravenous morphine and ketorolac for the first 48 hours and then received ketorolac and paracetamol per os without supplements

Post-operative period was regular with discharge on 7th postoperative day. The patient did not present paradoxical movement of the chest wall nor respiratory distress at the discharge and after 1 and 6 months of follow-up.

Discussion

Covering chest wall defects after surgery may be challenging

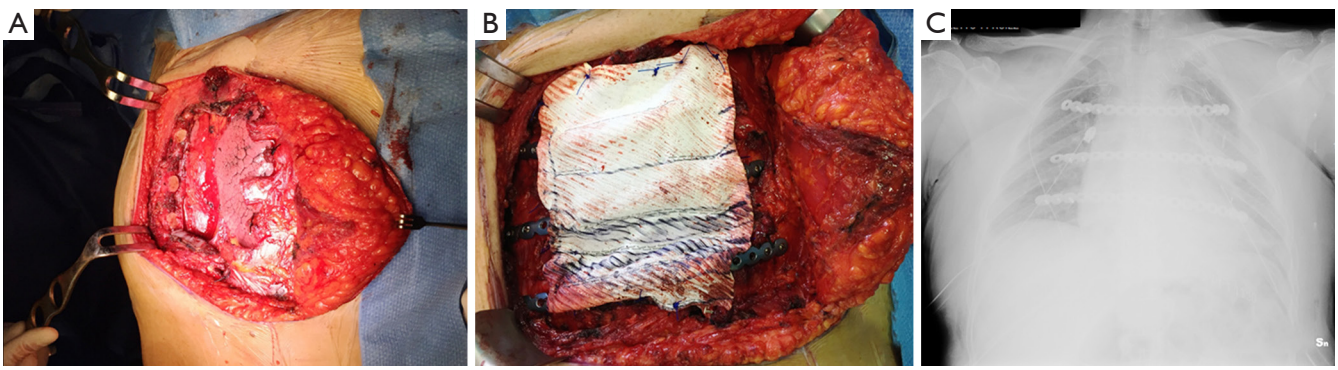

Figure 2 Surgical outcome. (A) The defect of the chest wall after sternectomy; (B) the sandwich prosthesis in situ after positioning and fixing at the ribs completely covering the sternum defect; (C) the post-operative chest X-ray showing the final results of the technique.

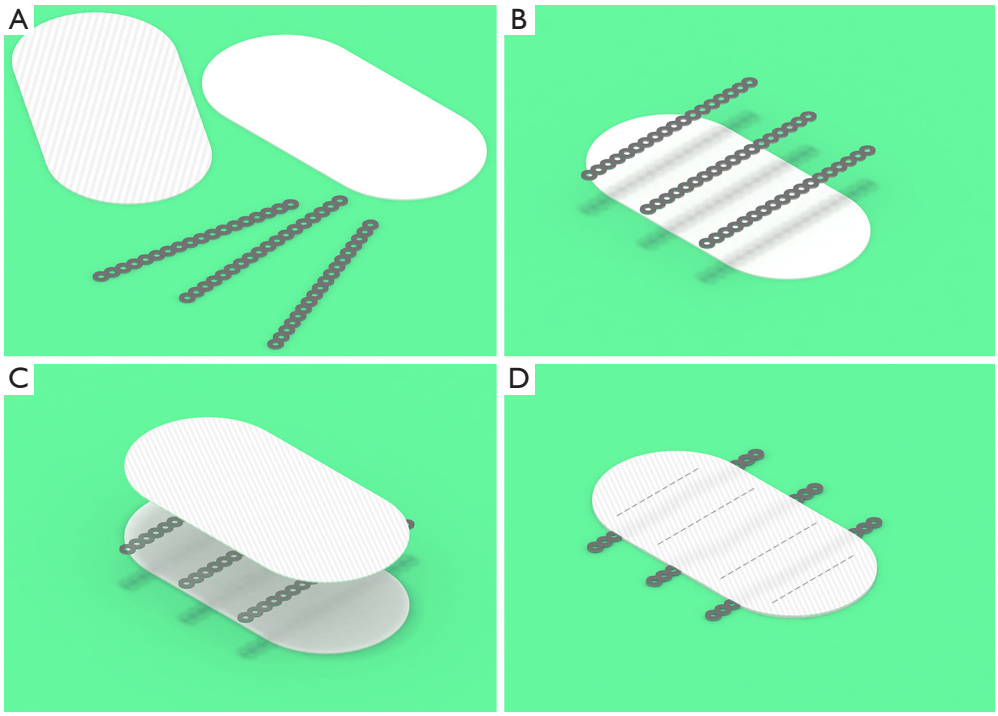

Figure 3 Building the "sandwich Mesh". (A) The materials consisting of two Gore-Tex meshes tailored on the sternum defect and three titanium plates; (B,C) the titanium plates are collocated between the prosthesis meshes after calculating the distance between the ribs; (D) three pockets are created between the two meshes and are fixed with prolene suture to completely unite the system with the titanium plates.

and difficult, especially if the defect is large or if the resection was not completely planned. Moreover, also if tailored materials and prosthesis are now available, the may request increased costs and preoperative planning that is not always possible (5).

We herein propose technique that may be useful in covering sternum or ribs defects, creating a resistant but elastic system using two Gore-Tex meshes in association with titanium plates. Also other authors proposed the combined use of PTFE/Gore-Tex and titanium plates, in some cases with the mesh covering the plates or vice versa, as Hamad (6) and Berthet (7) respectively did. In this way we think that a complete union between the two parts is missing, with the risk to have friction between the different materials or to have uncoordinated movement of the chest. On the other hand, by creating a sandwich, the meshes are jointly connected with the titanium plates, reducing any contrasts between the two materials providing more stability and avoiding respiratory distress or failure.

This solution is quite simple and rapid to realize, with easy steps that permit in every moment the possibility to change the planning. In fact, building the composite system intraoperatively, is possible a real time measurement and construction, avoiding the risk to be unprepared if a modification respect the preoperative planned was needed.

Another important advantage is that in this manner is possible to add the plasticity of the Gore-Tex to the resistance of the titanium plates, giving a resistant coverage to the internal organs but maintaining the elasticity of the chest wall, as confirmed by the absence of respiratory failure or discomfort.

In conclusion, even though further studies are needed, this technique seems to provide good results regarding chest wall stability and pulmonary function efficacy, this solution could also be repeated and used for chest-wall defects after rib resections in relationship to the good compromise between rigidity and elasticity of two different prosthetic materials and presents the advantage to be easy and rapid to realize.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Informed Consent: Written informed consent was obtained from the patient for publication of this case report.

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