Proposal for bail-out procedures - Thoracic general
Donor cryopreserved rib allografts for chest wall reconstruction

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Abstract

Reconstruction after large chest wall resections must ensure not only anatomical coverage but a normal respiratory function, specially in the case of associated ventilatory disturbance. Since prosthetic reconstruction can present some problems such as rejection, excessive rigidity or infection, bone grafts have been proposed as an alternative to synthetic materials, due to their effectiveness and capability of integration with host tissues. Although iliac bone allograft or autologous ribs harvested from the opposite operative side are described for reconstruction, we present here the first reported clinical case of donor cryopreserved rib allografts use after extensive chest wall resection in a patient with severe COPD, showing excellent short-term results in the absence of pulmonary function impairment.

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1. Introduction

Extensive chest wall resections often suppose a challenge for reconstruction, in order to achieve not only anatomical coverage but a normal respiratory function. This is particularly important in the case of associated ventilatory disturbance, because a flail chest wall segment causes hypoventilation and increase in respiratory work [1].

Due to some problems related to foreign material use, such as rejection, excessive rigidity or infection [1, 2], bone grafts have been proposed as an effective, durable and biologically tolerated solution. Either iliac bone allograft from a tissue bank [1] or autologous ribs harvested from the opposite operative side [2] have been used. However, to our knowledge, this is the first reported clinical case of rib allografts for reconstruction after extensive chest wall resection.

2. Case report

A 70-year-old man was admitted to our Service due to left upper anterior chest wall mass. He presented a past history of TBC and severe COPD with FEV₁ of 1160 ml (33% theoretical) under bronchodilator treatment. His physical examination showed a resting dyspnea with bilateral decrease of pulmonary sounds and wheezes.

CT-scan showed a 15 cm mass abutting the upper anterior region of the left hemithorax, close to the clavicle and invading the three first ribs, pectoralis minor muscle and part of the anterior segment of the left upper lobe (Fig. 1), without infiltrating pectoralis major. First, we detached this muscle and the skin from the mass, verifying the absence of infiltration of the clavicle and subclavian vessels. Next, we performed a full thickness en-block resection of chest wall and pectoralis minor, with wedge resection of the left upper lobe.

Reconstruction was achieved by covering the defect with a 2 mm GoreT ex prosthesis, on which a multiorganic donor cryopreserved rib allograft was placed. Two costal arches were properly tailored and fixed to the sternum by osteosynthesis with Sternalock® titanium plates and screws (Wal ter Lorenz Surgical Inc., Jacksonville, FL, USA) and to the rib stumps by steel wires (Fig. 2). Finally, the plastic surgery team was in charge of soft tissue reconstruction maneuvers, using a pedicled left latissimus dorsi muscle flap.

Postoperative course was uneventful, with great chest wall stability, as confirmed for the absence of paradoxical movement and normal blood gases. Two weeks after surgery, the healing of the allograft was excellent, without signs of rejection, infection or migration. After review by both thoracic and plastic surgeons up to complete wound healing, the patient was discharged at day 19 after surgery. Histology was positive for grade II inflammatory sarcoma.

3. Comments

Application of rib grafts to chest wall reconstruction used to be limited to sternal reconstruction [2–4]. It was not until the mid-1990s when authors like Mathes [5] or Arnold [6] first covered a large postresectional defect with costal autografts. More recently, some centers have developed...
new reconstructive techniques in collaboration with tissue banks, implanting iliac bone or fibula for sternal or rib cage repair [1, 7].

After extensive resections, chest wall stabilization might decrease the need for prolonged mechanical ventilation and improve postoperative pulmonary function [8]. For coverage, prosthetic materials are usually preferred because of their availability and easy use, along with muscle or musculocutaneous flaps to decrease the risk of infection and obliterate spaces [9]. However, their use is not without the risk of potential complications. Due to excessive rigidity, they can erode adjacent structures during ventilation moving. Moreover, although they not favour septic complications or foreign body reactions by themselves [10], rejection and infection may still occur.

The main advantage of bone grafts is their capability of integration with host tissues. In our case, this was ascertained both clinically (chest wall stability without rejection, infection or migration) and radiologically (presence of bone neoformation on the contact edges). While risk of disease transmission used to be high, present-day modern screening methods make it lower than that incurred in blood transfusions [1].

In our opinion, cryopreserved ribs are far better for reconstruction than other tissue bank bones [1, 7], because size and shape of ribs are adjusted to the defect very easily (even when it is irregular), while the limited measures of other implants can be clearly insufficient to cover large surfaces. Furthermore, costal grafts produce a lesser restrictive effect on chest wall movement and, therefore, a better pulmonary function. Another disadvantage of placing a rigid bone plate on the thorax could be the risk of erosion of adjacent tissues during the early period after implantation, as a rigid prosthesis can do. When choosing between auto and allografts, we personally prefer the latter, especially in the case of large resections. Tissue bank ribs eliminate possible morbidity at the contralateral hemithorax donor site (pain, instability, lung herniation) [2] and have no limitations regarding the amount of available bone, because multiple grafts can be obtained from every single donor. Costal arches are easily harvested, processed and stored for long periods of time at a reasonable cost, most of all taking into account that a small cryopreserved rib graft pool can be enough to serve the demands of multiple surgical specialties to a regional scale.

Obviously, the availability of a tissue bank integrated inside a bone graft donation program is the main limitation of this technique. As it has been only performed in one patient, a more extensive clinical practice is needed in order to check its total reproducibility, security and long-term results. Minimal alteration of pulmonary function was recorded but only on clinical parameters such as flail chest absence, no increase in work of breath and normal blood gases. It is also important to notice that the use of rib allografts neither exclude the use of prosthesis nor avoid the requirement for soft tissue coverage.

We believe that our positive initial clinical experience in the use of donor cryopreserved rib bone allografts prepares the way to its use as a valid alternative to prosthetic materials after full thickness chest wall resections. Costal allografts may offer good anatomical and functional results in reconstruction, especially when an associated ventilatory disturbance is present.

References


