Reconstruction with fascia lata after extensive chest wall resection: results

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Abstract

OBJECTIVES: Following extensive chest wall resection, the reconstruction technique should fulfill two opposing functional requirements: adequate rigidity and flexibility of the chest wall during the breathing phases. Reconstruction with fascia lata enables a balance between these two parameters, thus favouring the patients’ respiratory dynamics and producing low morbidity and good functional results.

METHODS: Sixty patients underwent chest wall reconstruction using fascia lata alone or in combination with titanium plates between 2006 and 2011, due to primary tumours in 28 patients, metastases in 23 and local recurrences in 9. The mean area of resected tissue was 107.7 cm², distributed among the anterior, anterolateral, lateral and posterior zones. One-to-eight ribs were resected, and additional sternum resection was performed in 75% of patients. Forced expiratory volume in 1 s (FEV1) and forced vital capacity (FVC) were evaluated in 33 patients.

RESULTS: 46.6% of patients underwent reconstruction with fascia lata alone, 1.6% with fascia lata, DualMesh® and titanium plates and 51.6% with fascia lata and titanium plates. There was no 30-day mortality. All patients were extubated after the operation with no need for reintubation. Five patients had postoperative complications: 2 wound dehiscences, 2 haematomas and 1 seroma. There were no significant differences between preoperative and postoperative FEV1 and FVC measurements in patients with or without lobectomy and wedge resections.

CONCLUSIONS: Chest wall reconstruction with fascia lata, alone or in combination with titanium plates, allows the surgeon to perform a dynamic reconstruction without flail chest in extensive exeresis. Risks of infection associated with the use of prosthetic materials are also minimized. In addition, the characteristic flexibility of this tissue makes it a precious tool in paediatric chest wall reconstruction, since fascia lata naturally adapts to the physiological growth of younger bodies, thus reducing the risk of scoliosis and local deformities.

Keywords: Fascia lata • Chest wall tumour • Chest wall resection • Chest wall reconstruction • Pulmonary function

INTRODUCTION

Tumour (primary, recurrent or metastatic), radiation necrosis and infection are the most common indications for chest wall resection. The main primary tumours include chondrosarcoma, soft tissue tumours, Ewing's sarcoma and osteosarcoma, whereas metastases derive mainly from breast and lung cancer [1-5].

The management of such chest wall lesions is based on large resections and reconstructions of the rib cage, from skeleton to soft tissues, in order to combine, in oncological patients, a radical chest wall exeresis with an adequate residual lung function. Surgical techniques for repairing chest wall defects are different and include the use of prosthetic, autologous or bank-derived means. Finally, the decision to reconstruct the chest lesion must take into account both remodelling of soft tissues and stabilization of the chest wall [3, 6-12]. In fact, the criteria for the selection of patients for the use of fascia lata alone with or without plaque-armed or DualMesh® depend on the type of resection: for anterior (with sternum) or anterolateral resection of more than two ribs and lateral and posterolateral resection of more than three ribs, fascia lata armed with plates and/or DualMesh® is used.

Therefore, the choice of the reconstruction technique and the material used must aim at preventing chest flail, paradoxical and insufficient breathing, and needs to protect underlying structures; in addition, good functional and cosmetic results should also be sought [13-16]. All these aspects must be finely tuned to manage such extended thoracic lesions correctly.

The authors present their experience with fascia lata used alone, or in combination with titanium plates, to restore thorax continuity after extensive chest wall resection.

MATERIALS AND METHODS

Patients

Sixty oncological patients underwent extensive resection of the chest wall between 2006 and 2011. The population included 20 women and 40 men with the mean age of 49 years (from 7 to
82 years old). The main indications for resection were primary chest wall tumours in 28 patients (13 chondrosarcoma, 12 soft tissue tumours, 9 Ewing sarcoma and 7 osteosarcoma), metastasis in 23 and recurrent tumours in 9 (Table 1).

The resections of the chest wall were anterior (n = 27), anterolateral (n = 19), lateral (n = 8) and posterior (n = 6). The sternum was removed in 8 patients and the diaphragm in 9 and wedge resection of the lung was performed in 9.

All patients underwent chest computed tomography (CT) for the staging of the disease and musculoskeletal ultrasound, with the purpose of defining the tumour margins and the oncological safety limits, mainly in cases with locally recurrent nodules [16]; all patients with soft tissue tumours underwent magnetic resonance imaging, an investigation with the greatest specificity, before and after surgery. Nineteen patients underwent neoadjuvant chemotherapy and 6, neoadjuvant radiotherapy. Before and after surgery, 34 patients underwent pulmonary function test (PFR) with the assessment of FEV1 and FVC.

The resected area included the excised tumoural lesion with perilobal soft tissue and skeletal tissue (the mean resected area was 107 cm², range from 12 to 576 cm²); in all cases, histological examination of the surgical specimen showed disease-free margins.

After resection, in 31 cases, the fascia lata was used in combination with titanium plates to restore the continuity of the chest wall; in 28, the fascia lata was used alone and, in 1, the fascia lata was used in combination with titanium plates and prosthetic DualMesh®.

Finally, 15 patients underwent postoperative chemotherapy and 6 patients postoperative radiotherapy. All patients were subjected to CT till 3-6-12-24 months, and an ultrasound of the soft tissues at surgical wound to 18 months, as it is area most at risk of recurrence (16, 17), in order to monitor any recurrence of the disease. Starting from 24 months after surgery, patients underwent CT and ultrasonography of soft tissue each year.

Recovery and banking of fascia lata

The reconstruction technique adopted by the authors’ surgical team is based on cadaver donor fascia lata transplantation. Such tissue is provided by Rizzoli Orthopedic Institute’s musculoskeletal tissue bank (MTB), which adopts all the highest international standards for tissue banking. Therefore, the cadaver tissue retrieval technique takes into account the quality of the tissue to be removed, and its appropriate handling after removal; thus, only the thickest part of the fascia—the iliotibial tract—is retrieved. Soon after surgery, the extracted cadaver fascia lata (CFL) is washed with a sterile physiological solution, soaked for 10 min in an antibiotic solution (rifampicin 0.05%), wiped with a sterile cloth, double-packed within two sterile bags and finally inserted in the final container, a sterilized tight-sealed plastic jar. Immediately after the packaging, the CFL is placed in a certified portable refrigerator (Tmax ≤ 10°C), rapidly taken to the MTB, and stored at −80°C. The time interval between tissue retrieval and implantation is compatible with the time it takes to perform all the relevant investigations to ensure CFL quality and safety. All these steps are performed according to Italian Guidelines, European Directives and International Standards operating procedures, within a strict quality assurance programme. Such safety procedures include appropriate microbiological risk assessments, to test the CFL for aerobic, anaerobic germs and fungi bioburden, as well as accurate donor screenings to exclude viral infections and other contagious diseases. During this period, the tissue is cryopreserved at −80°C. Only allografts negative for microbiological cultures and contagious diseases are then validated for clinical use. A rigorous documentation procedure allows a complete traceability of explanted CFLs, providing all the information required to track the tissues forward to recipients and back to the donor.

**Surgical technique**

Reconstruction of the chest wall was performed by using a particular method [5, 8, 10] that includes the use of a fascia lata and 1–2 metal plates (titanium) that can be shaped and fused to the whole rib cage through a non-absorbable sutures. Braided resorbable suturing material is used to anchor the fascia lata (Figs 1 and 2).

**Statistical analysis**

Survival and its influencing factors were calculated using the Kaplan–Meier method, P-values ≤ 0.05 were considered significant. Statistical analysis was performed with the programme LibreOffice 3.3.4.2.

**RESULTS**

Sixty oncological patients underwent wide resection of the chest wall between 2006 and 2011. In 53% of cases, reconstruction was performed by using the fascia lata in combination with titanium plates (including 1 case with the addition of prosthetic DualMesh®), and in 46% of cases, by using the fascia lata alone; the choice was mainly based on the extent of the removed area.

The average hospital stay was 7.9 (±4.1) days, with 3.2 days of intensive postoperative therapy. The patients were extubated in the early postoperative hours, and there was no need for reintubation. Five patients had postoperative complications (2 wound dehiscences, 2 haematomas and 1 seroma). There was no

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**Table 1:** Patients characteristics (n = 60)

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>n</th>
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<tbody>
<tr>
<td>Sex (male/female)</td>
<td>40/20</td>
</tr>
<tr>
<td>Type of tumour</td>
<td></td>
</tr>
<tr>
<td>Primary chest wall</td>
<td>28</td>
</tr>
<tr>
<td>Secondary chest wall</td>
<td>23</td>
</tr>
<tr>
<td>Recurrent</td>
<td>9</td>
</tr>
<tr>
<td>Type of surgical resection</td>
<td></td>
</tr>
<tr>
<td>Anterior</td>
<td>27</td>
</tr>
<tr>
<td>Anterolateral</td>
<td>19</td>
</tr>
<tr>
<td>Lateral</td>
<td>8</td>
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<tr>
<td>Posterior</td>
<td>6</td>
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<tr>
<td>Wedge pulmonary</td>
<td>9</td>
</tr>
<tr>
<td>Sternum (total or subtotal)</td>
<td>8</td>
</tr>
<tr>
<td>Ribs (1-9)</td>
<td>42</td>
</tr>
<tr>
<td>Diaphragm</td>
<td>9</td>
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<tr>
<td>Reconstruction</td>
<td></td>
</tr>
<tr>
<td>Fascia lata alone</td>
<td>28</td>
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<tr>
<td>Fascia lata + titanium plate</td>
<td>31</td>
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<td>Fascia lata + titanium plate + DualMesh®</td>
<td>1</td>
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</tbody>
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evidence of any infectious complications in patients undergoing preoperative chemotherapy. Nineteen patients underwent neoadjuvant chemotherapy and 6 underwent neoadjuvant radiotherapy. The follow-up ranged from 6 to 40 months. At the follow-up, 48 patients were alive (15 were alive with distant metastases or local recurrence and 33 were free from disease), 12 died (8 with metastatic disease, 4 with primary tumour; Fig. 3); at 12 months, survival was 85.6% and at 24 months, it was 76.9%.

In 38 patients, PFRs were performed with the preoperative assessment of FEV1 and FVC, and in 33 of them, breathing analysis was also performed 12 months after surgery (Figs 4, 5, 6 and 7). The PFR performed postoperatively confirmed that, in patients presenting an obstructive or restrictive syndrome preoperatively, the reconstructive technique did not worsen the pre-existing respiratory deficit, and in patients with normal PFR values, surgery did not alter the breathing capacity.

DISCUSSION

Tumours of the chest wall, primitive, metastatic or recurrent are the most frequent indications for extensive chest wall resections. The therapeutic approach to this disease is multidisciplinary since surgical removal is often associated with neoadjuvant and adjuvant chemotherapy and radiotherapy. In malignant tumours of the chest wall, surgical removal must exceed the tumour margin of 4 cm to minimize local recurrences [1–5]. The techniques of surgical reconstruction following the resection phase are different and require the use of synthetic (polypropylene mesh and polyethylene), or biological (fascia lata, latissimus dorsi, pectoralis major, serratus and omentum) prosthetic means [6–12].

A good material for the chest wall reconstruction should maintain adequate and physiological respiratory dynamics, so it should not be too rigid, as this would limit respiratory excursions, or too flexible, as that might increase the risk of flail chest [13–16].

In the present series, the use of fascia lata, fixed by pluriperforate and moldable metal plates in anterior and anterolateral resection, was an excellent reconstructive technique, as it allowed a constant breathing capacity to be maintained after surgery, as shown by pulmonary function tests performed postoperatively. In fact, the use of titanium plates prevents the formation of a
movable flap, and fascia lata maintains the chest wall flexibility, allowing a physiological expansion and shrinkage during the act of breathing.

The respiratory advantage associated with this surgical reconstruction combines low morbidity with the need to have large oncological tissue resection. Such a large resection minimizes the risk of postoperative complications without worsening the patient’s respiratory capacity, allowing discharge from the hospital in a relatively short time.

In children, wide chest wall resections for neoplastic lesion management are a more complex reconstructive issue. In fact, in such patients, static reconstructions can hinder the correct growth of the spine, often leading to severe scoliosis and the onset of local deformities. The characteristic flexibility of fascia lata makes it naturally adaptable to the growing young chest and does not impede regular body development. Moreover, due to its human tissue nature, the fascia lata provides the surgeon with a unique allo-biograft with very good biointegrative ability and an excellent adaptability to different physiological conditions. Such features also make the fascia lata a precious tool in paediatric reconstructive surgery. In our study, there were 3 paediatric patients (7-8-9 years, respectively), the follow-up was 5-3-2 years, respectively, and all patients are alive and free of disease, in the absence of problems related to the reconstruction of the chest wall.

In conclusion, the excellent elastic, dynamic and biointegrative properties of the fascia lata, both alone or in combination with titanium plates, allow a good breathing capacity to be maintained in the long term, even after extensive resection of the chest wall. Therefore, if the human donor-banked fascia lata is available, the possibility of adopting the described technique
should be taken into account when planning reconstruction of the chest wall after major oncological resections.

Conflict of interest: none declared.

REFERENCES