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IDEAS AND TECHNICAL INNOVATIONS

Chest wall reconstruction after en bloc Pancoast tumour resection with the use of MatrixRib and SILC fixation systems: technical note

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Abstract
Study design Technical note.
Objective In cases in which partial resection of the rib cage is accomplished with vertebrectomy, reconstruction of the chest wall may be challenging. That is because of lack of the anchor point which normally would be a proximal end of a rib or transverse process. We report a straightforward technique for chest wall reconstruction with the novel use of two systems of fixation commonly applied in spinal practice.
Methods The operation of a squamous cell carcinoma (Pancoast tumour) of the right lung infiltrating T2, T3 and T4 vertebrae was performed though T4 lateral thoracotomy. Posterior instrumentation with transpedicular screws T1–3–5 on the left and T1–5 on the right side was followed with the right upper lobectomy and hemivertebrectomy. The laminae and facet joints of T2–T4 vertebrae were removed on the side of the tumour. An osteotomy was performed medial to the pedicle at the lateral aspect of the dural sac on the side of the tumour. Proximal parts of four adjacent ribs were removed allowing radical en bloc resection with tumour-free margins. The distal end of each of four rib plates used (MatrixRib Precontoured Plate system) was attached to the proximal end of the rib. The proximal end of the plate was then attached to the rod of posterior fixation construct with the use of a flexible polyethylene terephthalate (PeT) band of the SILC^{TM} fixation system. The other end of the PeT band was then passed through the top-loading clamp subsequently attached to the rod of the posterior fixation.
Results The patient did not require additional procedures for chest wall reconstruction. On the 7-month follow-up, in chest CT he was found with satisfactory expansion of the remaining lung tissue with proper spinal alignment and anatomical shape of the rib cage.
Conclusions The reported technique can be applied for chest wall reconstruction in cases of total or subtotal vertebrectomy accomplished with the resection extending towards rib cage. It appears to be straightforward, safe and effective allowing good cosmetic and functional outcome.

Keywords En bloc resection · Pancoast tumour · Chest wall reconstruction · Rib plates

Introduction

According to many authors, prognosis in patients diagnosed with the Pancoast tumour depends mainly on T stage of tumour, response to preoperative chemo-radiotherapy and completeness of resection [1–6]. The surgical treatment itself is associated with 5 % mortality and 7–38 % mortality rates [4]. The overall 5-year survival for R0 resections appears to be as good as 60 % (54–77 %) [2, 4]. The main pattern of recurrence is that of distant metastases, especially in the brain. Invasion of the vertebral column is not a contraindication for surgery which should be made en bloc with pulmonary parenchyma resection [5, 7–12].

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The technical aspects of the spinal reconstruction necessary after the en bloc resection seem to be well described and established [3, 5, 10, 13–15]. Surprisingly, there are only few reports available describing in detail the methods of the rib cage repair after radical excision [12, 16]. None of these papers describes in detail the method of the chest wall reconstruction after an extensive resection of the Pancoast tumour including vertebrectomy and the excision of the proximal part of ribs. We decided to present our own technique finding it novel, relatively easy to apply and effective.

Materials and methods

Case presentation

A 66-year-old fit ex-smoker with a history of asbestos contact, a long history of coughing clear sputum with very occasional blood, breathlessness and 2–3 months of a dull pain in the back presented. On the chest XR and CT, he was found with a mass in the right upper lobe infiltrating the vertebra bodies of T2, T3 and T4 (Fig. 1a). Based on the biopsy, he was diagnosed with the squamous cell carcinoma meeting topographical criteria of the Pancoast tumour [17].

Surgical technique

The first stage of the operation was the posterior instrumentation T1–T3–T5 on the left. On the right side, transpedicular screws without the rod were inserted into T1 and T5 vertebrae.

A right posterior lateral thoracotomy was performed with the patient in the prone position. The table was then tilted to about 45° and the pleural cavity was entered through the 4th intercostal space. The tumour was attached to the anterior surfaces of T2, T3 and T4. The upper lobe was dissected and the case was taken over by the spinal team.

Hemivertebrectomy T2–4 was performed in a way similar to the one applied by Jain et al. [15]. The laminae and facet joints were removed on the side of the tumour. An osteotomy was performed medial to the pedicle at the lateral aspect of the dural sac on the side of the tumour. Proximal parts of three adjacent ribs were removed allowing radical en bloc resection with free margins to be achieved (Fig. 2). Anterior column was supported with an autologous rib graft (5th rib) fixed with screws to the remaining parts of vertebral bodies (Fig. 3a). Posterior fixation was accomplished with the insertion of a titanium rod on the right side.

The reconstruction was performed with the use of the authorial method. We used rib plates (MatrixRib Precontoured Plate system; Synthes®, USA) and SILC™ fixation system (Globus Medical, Inc., USA). Choosing a plate of appropriate length such that there were at least two screws on the proximal end of the rib, we fashioned the plate to the contour of the rib. Through a drill guide, two holes were created at the end and locking screws firmly secured the plate to the resected rib end. The proximal end of the plate was then attached to the rod of posterior fixation with the use of a flexible polyethylene terephthalate (PeT) band of the SILC™ fixation system, passing through the most proximal hole of the Matrix plate. The other end of the PeT band was then passed through the top-loading clamp

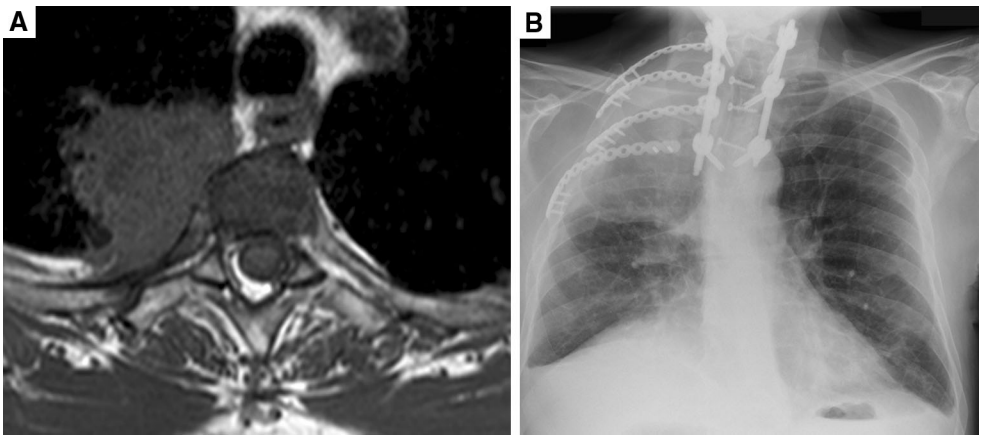

Fig. 1 Pre- and postoperative imaging. **a** Preoperative chest MRI (T1 post-gadolinium axial scan). Note the invasion on the 3rd rib (*white arrow*) whit changed signal of the bone marrow and vanished rib head. **b** Postoperative chest XR (7 months follow up). Note the posterior transpedicular fixation, locking screws fixing the rib graft supporting the anterior column and rib plates attached to the rod of the posterior fixation with clamps and bands

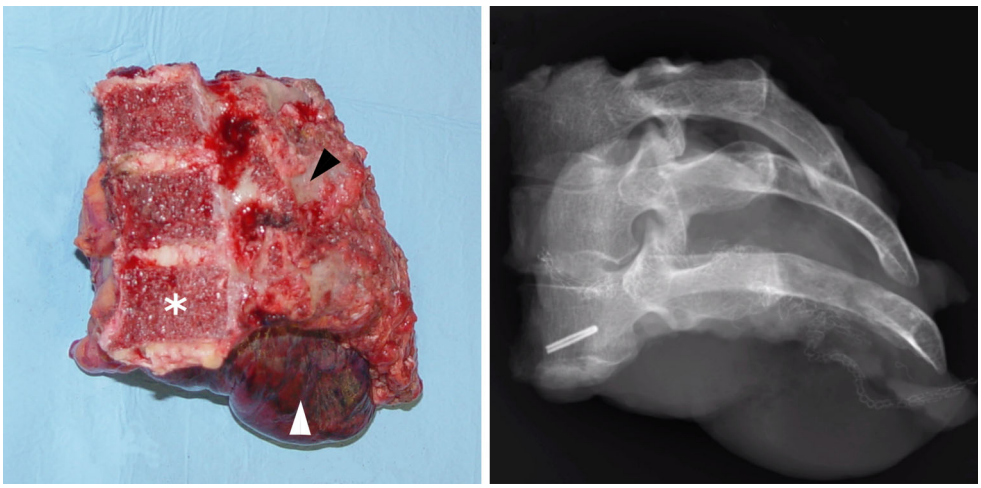

Fig. 2 Postoperative specimen. On the *right side* one can appreciate three hemivertebrae (*white asterisk* indicating T4), proximal part of ribs (*black arrow* indicating 4th rib) and tumour mass with excised upper lobe of the right lung (*white arrow*). On the *left side* roentgenogram showing the structure of the en bloc specimen. Note vascular clip projecting on the T4 vertebral body and small thoracic staples projecting on the ribs

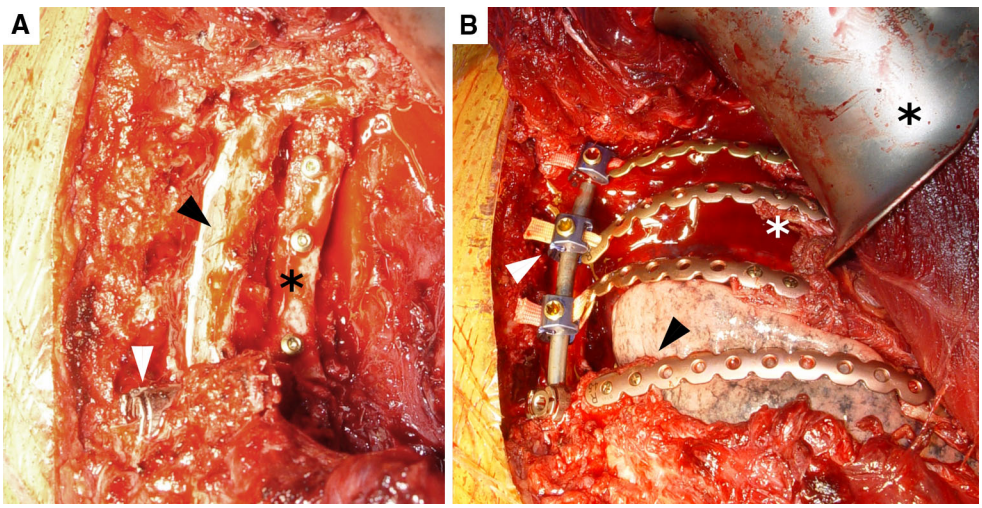

Fig. 3 Intraoperative views, head oriented upward. **a** The situation after en bloc T2-T4 hemivertebrectomy and anterior fixation with the autologous 5th rib graft attached with three screws (*black asterisk*). Note the head of transpedicular screw T5 (*white arrow*) and the intact dural sac (*white arrow*). **b** The view after the resection and reconstruction. Note clamps of the SILC fixation system (Globus Medical, Inc., USA) attached to the rod and bands passed through the hole of the rib plate MatrixRib Precontoured Plate system; Synthes®, USA) (*white arrow*); distal end of the plate secured to the resected rib end with two locking screws (*white asterisk*). Another plate (*black arrow*) connecting free ends of the 5th rib sacrificed as an autologous graft. One can appreciate the middle lobe of the right lung underneath. *Black asterisk* marking the blade of the retractor elevating the right scapula

subsequently attached to the rod of the posterior fixation (Figs. 3b, 4).

The wound was closed in a layered manner; two chest and one wound gravity drains were applied. We did not use Gortex® mesh as suggested by Ng et al. [18] as our defect was well covered by the scapula and trapezius muscle [19].

Results

The histopathological examination confirmed the initial diagnosis of the squamous cell carcinoma. All margins of the resected specimen were negative for neoplastic cells. The patient was treated in the intensive therapy unit for 3 weeks and eventually discharged from the Hospital after 8 weeks of the inpatient recovery. On the 8-month follow-up he was fully mobile and independent, without clinical or radiological signs of the recurrence. He had been suffering from a pain in the right arm and scapular region, which remained well controlled with 200 mg of Gabapentin per day.

On the follow-up chest XR performed 7 month after the operation, he was found with satisfactory postoperative picture of the remaining lung tissue as well as proper anatomical shape of the rib cage and good spinal alignment (Fig. 1b).

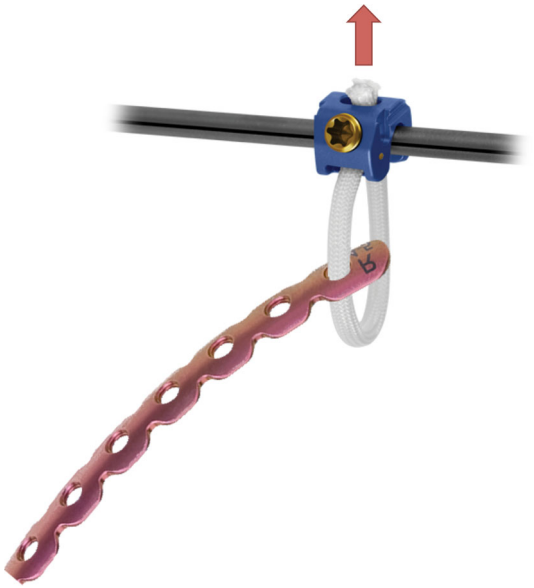

Fig. 4 Diagram presenting the way rib plate (MatrixRib Precontoured Plate system; Synthes®, USA) is connected to the PeT tape of the SILC™ fixation system (Globus Medical, Inc., USA). The tape was subsequently tightened allowing solid connection (*red arrow*). The top-loading clamp was connected to the rod of the posterior fixation. The distal part of the plate was firmly secured to the resected rib end with two locking screws

Discussion

Since the report of Parham describing resection and reconstruction of a chest wall in the late 19th century, several advances in reconstruction techniques have been made [20]. Despite that, the repair of full-thickness defects of the chest wall remains complex and controversial [19]. The widely accepted principle is, when a flail segment of the chest wall is greater than 5 cm, ventilation becomes progressively inefficient. In patients with two and more-rib segmental loss, surgical stabilisation has been shown to decrease mechanical ventilator days, improve long-term outcome and lower cost of hospitalisation [21, 22].

The introduction of alloplastic materials is considered to be a major advancement in chest wall reconstruction [20]. One of the available solutions gaining popularity is MatrixRib Precontoured Plate system involving the use of plates and screws to bridge any defect and provide support for the chest wall following resection [18, 23, 24]. However, in our case it seemed to be insufficient as after hemivertebrectomy we were lacking the proximal point of fixation. The initial idea of using a simple wire appeared to be suboptimal due to the possibility of fatigue failure. Hence, we decided to apply SILC fixation system designed primarily as a solution for multidimensional spinal deformities. Its band is normally applied on the lamina, or both the lamina and transverse process, while the top-loading clamp is attached to the rod. It allows performing standard reduction manoeuvres without requiring pedicle purchase. In our case, we were able to smoothly and firmly connect the rib plates to the rod of the posterior fixation.

Despite limited number of cases, according to our experience the technique is relatively straightforward, reproducible and cost-effective. We believe it can find its place in the surgical armamentarium while considering major resection and reconstruction in patients with locally advanced tumours of the lung and chest wall.

Compliance with ethical standards

Conflict of interest None.

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