Surgical treatment of Chest Wall Tumors (resection and reconstruction) A six years experience

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Background: Chest wall resection and reconstruction remains one of the most challenging areas of Thoracic & Plastic surgery. The purpose of this study is to report our 6-year experience with chest wall resections and reconstructions. **Methods:** A retrospective review of 36 patients who had chest wall resections from 1998 to 2003 was performed. **Result:** Patient demographics included tobacco abuse, hypertension, diabetes mellitus, niswar abuse, coronary artery disease, chronic obstructive pulmonary disease, and HCV +ve. Surgical indications included chest wall tumors, and lung cancer involving the chest wall. The mean number of ribs resected was 4±2 ribs. Thirty four patients underwent chest wall resections. Two patients underwent right upper lobectomy along with chest wall resections. Immediate closure was performed in all 36 patients. Primary repair without the use of reconstructive techniques was possible in 9 patients. Synthetic chest wall reconstruction was performed using Prolene mesh, Marlex mesh, methyl methacrylate sandwich, and polytetrafluoroethylene. Flaps utilized for soft tissue coverage were pedicled flaps (2 patients). Mean postoperative length of stay was 14±12 days. Mean intensive care unit stay was 5±4 days. In-hospital and 30-day survival was 100%.**Conclusions:** Chest wall resection with reconstruction can be performed as a safe, effective one-stage surgical procedure for a variety of major chest wall defects.

Key words: Chest wall tumour, resection, reconstruction

Chest wall tumors encompass a kaleidoscopic panorama of bone and the soft tissue pathologic conditions. Since the first known chest wall resection in the 18th century, improvements in surgical technique and anesthesia, critical care units, antibiotics, and the development and refinements in reconstruction techniques have allowed extensive chest wall resections to be performed with acceptable morbidity and mortality[1,2]. The most common indications for chest wall resection include primary or metastatic chest wall neoplasm, tumors contiguous from breast or lung cancer, radiation necrosis, congenital defects, trauma, or infectious processes from osteomyelitis or median sternotomy or lateral thoracotomy wounds[3]. After radical en bloc chest wall resection, skeletal reconstructions when appropriate and adequate skin coverage to preserve the reconstruction are the essential elements for successful management of these complex chest wall defects. If chest wall integrity is compromised, synthetic mesh e.g. Marlex (knitted polypropylene), Prolene, PTFE (polytetrafluoroethylene), Vicryl (polyglactin 910), Methyl methacrylate sandwich [polymethyl methacrylate] can be utilized for attaining rib cage or sternal stability. Although primary closure of muscle and skin after chest wall resection is attainable in most cases, many patients commonly require more sophisticated reconstructive soft-tissue and skin coverage. A variety of techniques including pedicle muscle transposition, free muscle flaps, and omental flaps have been used to provide adequate wound coverage that allows for quick healing, rehabilitation, and cosmetics. The purpose of this study is to retrospectively review our six year experience with chest wall resections and reconstruction.

Patients and methods

A retrospective review was performed on the available charts of 36 consecutive patients who underwent chest wall resection and reconstruction at Lady reading hospital, Postgraduate Medical Institute, Peshawar, Mayo Hospital Lahore, Surgimed Hospital Lahore, between 1998 and 2003. All patients with more than two rib resections were included in the present series. Patients with fewer than two rib resections, congenital chest wall deformity of chest wall, acute sternal infections after median sternotomy for cardiac surgery, or open thoracostomy (Eloesser procedures) were not included in the present series. Mean age was 38±16 years (range 10 to 56); 24(66.6%) were men and 12(33.3%) were women.

Preoperatively we routinely perform pulmonary function tests. All patients received conventional chest roentgenography, which occasionally detects a defect or mass. For patients with a mass, a computed tomography (CT) scan or magnetic resonance imaging (MRI) scan of the chest was done to evaluate the extent and exact nature of the lesion (Fig 1), and a tissue diagnosis utilizing fine needle aspiration was attempted. In patients with suspected distant metastases CT and MRI were used.

Patient's charts were retrospectively reviewed for age, sex, medical history, surgical history, history of tobacco abuse, the number of ribs or the portion of sternum resected, and the surgical reconstruction technique (skeletal defect reconstruction, soft tissue coverage). The in-hospital outcomes reviewed were morbidity, mortality

and length of stay (overall, postoperative, and intensive care unit). Chest wall tumors were resected to gross negative margins when possible.

The significant medical history of the study group is presented in Table 1. Indications for surgery were primary chest wall tumors (30 patients, 83.3%), secondary chest wall tumors (4 patients, 11.1%), primary lung cancer (2 patients, 5.5%) with extensions into the chest wall. (Table 2)

Fig 1. CT scan thorax showing chest wall tumor

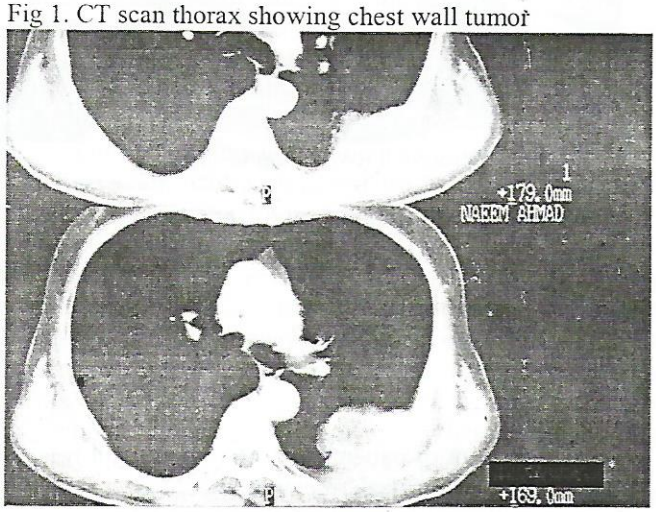

Table 1. Medical History of Patients

	n=	%age
Tobacco abuse	16	44.4
Hypertension	9	25
Diabetes mellitus	3	8.3
Niswar abuse	6	16.6
Coronary artery disease	4	11.1
Chronic obstructive pulmonary disease(COPD)	7	19.4
HCV +ve	2	5.5

Table 2. Indication for chest wall resection

	n=	%age
Primary chest wall tumor	30	83.3
Secondary chest wall tumor	04	11.1
Lung cancer involving chest wall	02	5.5

Results

The 36 patients underwent chest wall resection with an average of 4 ± 2 ribs (range 2 to 6). The anterior and lateral ribs were the most commonly resected (27 patients, 75%), posterior part of ribs resected in 7(19.4%) patients. Two (5.5%) patients underwent sternal resection; one patient underwent upper sternal resection and other underwent lower sternal resection (table 3). Immediate closure was performed in all 36 patients.

Primary repair of the soft tissue and skin was performed in 9 patients (25%) and synthetic materials were used for chest wall integrity reconstruction in 25 patients: Prolene mesh (10 patients, 27.7%), Marlex mesh (9 patients, 25%), methylmethacrylate sandwich (5 patients, 13.8%) and PTFE (1 patient, 2.7%).Two patients (5.5%) underwent pedicled muscle flap transposition (transverse rectus abdominis musculocutaneous (TRAM flap) (Table 4).

In-hospital outcomes are presented in Table 5. The overall length of stay (LOS) was 20 ± 16 days (range 6 to 37, median 12) and the postoperative LOS was 14±12 days (range 2 to 26). All 36 patients managed in intensive care unit postoperatively for an average of 5±4 days (range 1 to 10). There was no perioperative mortality.

Table 3. Chest wall resection: Anatomic defects

	n=	%age
Combined lung/chest wall resection	2	5.5
Rib defects		
• Anterior rib resection	10	27.7
• Anterolateral rib resection	10	27.7
• Lateral rib resection	7	19.4
• Posterior rib resection	5	13.8
Sternal defects		
• Upper sternal resection	1	2.7
• Lower sternal resection	1	2.7

Table 4. Chest wall reconstruction

	n=	%age
Immediate reconstruction	36	100
Primary chest wall closure	9	25
Prosthetic replacement		
• Prolene mesh	10	27.7
• Marlex mesh	09	25
• Methyl methacrylate	05	13.8
• PTFE	01	2.7
Autogenous replacement		
• TRAM flap	02	5.5

Table 5. Outcomes

Overall LOS*	20±16 days (6 to 37)
Postoperative LOS	14±12 days (2 to 26)
ICU admission (postoperatively)	36 patients (100%)
ICU, LOS	5±4 days (1 to 10)
Hospital mortality	Nil

LOS*=Length of stay

Shown are examples of successful reconstructions, a patient with upper sternal chondrosarcoma, the defect was repaired with PTFE [polytetrafluoroethylene] (Fig 2), a patient with right upper lobe tumor involving posterior part of 2^{nd} ,3^{rd} ,4^{th} ribs, right upper lobectomy with chest wall resection was done(Fig 3), primary repair of posterior defect was done with soft tissue and skin (Fig 4), and a patient with chondrosarcoma of left 7^{th}, 8^{th} & 9^{th} ribs, reconstruction was done with TRAM flap after resection of tumor (Fig 5).

Nine patients (25%) had complications during their hospital stay (Table 6). The most common complications were basal atelectasis (4 patients 11%), pneumonia (2

patients, 5.5%), wound infection (2 patients, 5.5%), and atrial fibrillation (1 patient, 2.7%).

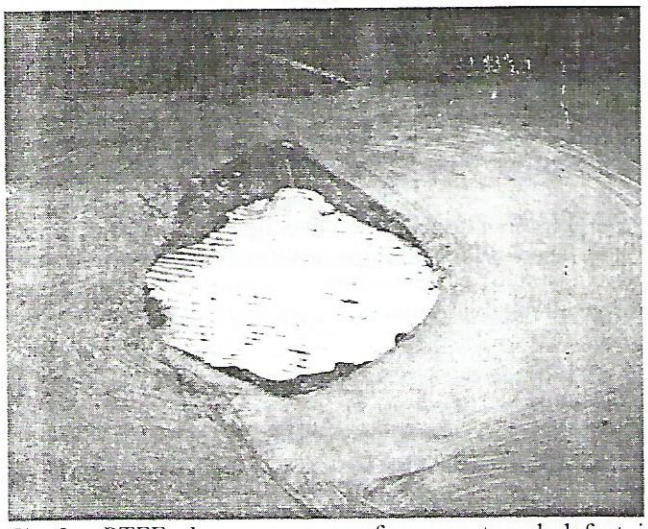

Fig 2. PTFE sheet coverage of upper sternal defect is shown

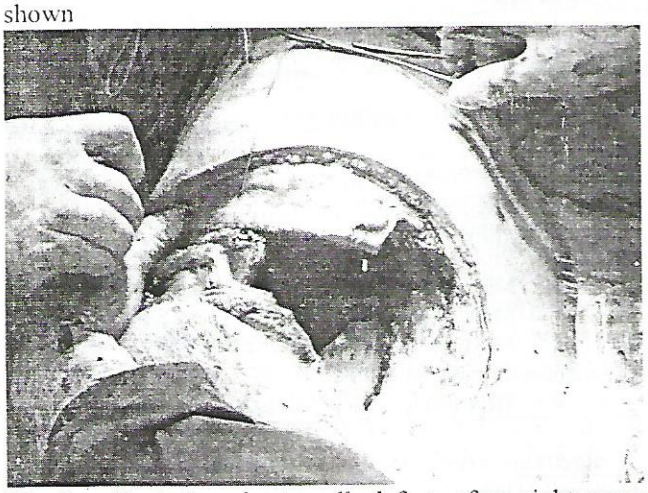

Fig 3. Posterior chest wall defect after right upper lobectomy and chest wall resection

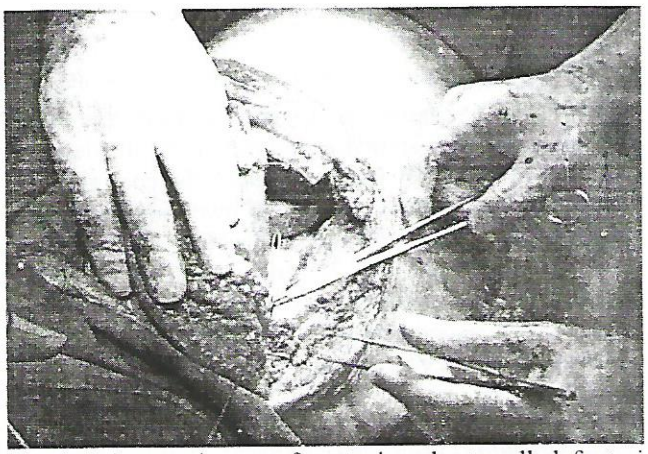

Fig 4. Primary closure of posterior chest wall defect is shown

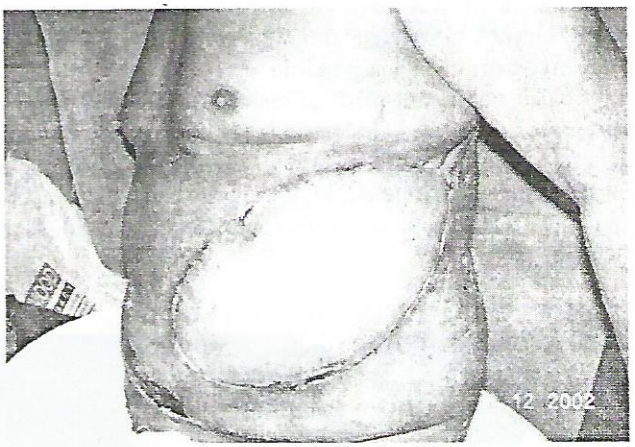

Fig 5. Postoperative TRAM Flap is shown

Table 6. Surgical complications

	n=	%age
Atelectasis	04	11.1
Pneumonia	02	5.5
Wound infection	02	5.5
Atrial fibrillation	01	2.7

Discussion

In the treatment of patients requiring chest wall resection, three tenets of surgical resection should be maintained[4]. First, a sufficient amount of tissue must be resected to dispose of all devitalized tissue. Second, in segments of large chest wall resections a replacement must be found to restore the rigid chest wall to prevent physiologic flail. Third, healthy soft-tissue coverage is essential to seal the pleural space, to protect the viscera and great vessels, and to prevent infection. As is evident by the current series, a combined multidisciplinary approach with plastic & reconstructive and thoracic surgeons affords acceptable functional and cosmetic results after chest wall resections.

Sternal resection and reconstruction is a major surgical technique incorporating a substantial undertaking which has been performed more commonly with the advent of mechanical positive-pressure ventilation, antibiotics, thoracic suction drainage, improved anesthesia and modern reconstructive techniques. The pulmonary status of the patient should be evaluated to anticipate postoperative complications, predict the need for ventilatory support, and maximize the patient's pulmonary capabilities. Although the majority of patients do not undergo concomitant lung resections and chest wall resections (5.5% in the current series), the loss in ventilatory capacity in those with a preexisting marginal respiratory function may lead to prolonged respiratory support and pulmonary complications in the postoperative period. In the current series the no such complication occurred. The postoperative pneumonia rate in these 36 patients subpopulation was low (2 of 36 patients, 5.5%). Despite of postoperative pneumonia, the overall, postoperative, and intensive care unit length of stay was

not significantly increased. After careful preoperative screening and as indicated, we do not hesitate to perform concomitant pulmonary resections with chest wall resections.

A basic tenet prior to the initiation of chest wall reconstruction is an appropriate and thorough chest wall resection that leaves healthy, viable margins to which materials and tissues used in a reconstruction may be anchored securely. Careful preoperative assessment for the extent of disease in patients with primary or metastatic malignancies is necessary prior to chest wall resection or reconstruction[5]. This is particularly important in patients with lung cancer locally invading the chest wall and in patients with metastatic disease to the ribs.

For patients in whom combined pulmonary and chest wall resection may be required we agree with Pairolero[6] that if the mediastinal lymph nodes are not positive, an en bloc resection is warranted as the 5-year mortality is more associated with the extent of the pulmonary cancer than with the extent of chest wall resection. In contrast Magdeleinat and colleagues[7] do not consider N2 disease a contraindication to en bloc resection and have recently reported an actuarial 5-year survival after complete en bloc resection of lung cancer invading the chest wall at 25% in T3NO patients, 20% in T3N1, and 21% in T3N2. Although nodal status (NO-1 versus N2) and the number of ribs resected (fewer than 2 versus more than 2) were long-term survival predictors in an univariate analyses, Chapelier and colleagues[8] found that only histologic differentiation (well versus poorly differentiated) and the depth of chest wall invasion (parietal pleura versus other) were independent predictors of long-term survival in multivariate analyses. Chest wall resection for local failure provides palliation for pain and removal of an ulcerated, occasionally pungent mass, thus potentially improving quality of life. Moreover it may give the best opportunity for local control when combined with adjuvant chemotherapy and radiation therapy. However, careful preoperative selection should be exercised in patients with recurrent local tumor owing to their high mortality rate[9]. In the era of superb technologic advances in radiation and chemotherapy and if no distant metastatic disease is present we believe that chest wall resection and reconstruction after or before chemoradiation should be the standard of care in patients with chest wall tumors regardless of the cell type.

Persisting or recurring chest wall involvement with breast carcinoma after local excision and radiation therapy may require chest wall resection to achieve local control[9,10,11]. Chest wall recurrences were found in 1% to 2% of stage I and in 10% to 12% of stage II breast carcinomas surgically treated with an extremely variable disease-free interval[12].

With modern surgical technique a wide range of reconstructive options are at the surgeon's disposal and hence it is imperative that the appropriate procedure be selected in a given patient. For small defects (less than 5cm) or those located posteriorly under the scapula above the fourth rib (after resection of Pancoast tumors) the skeletal component can be ignored and the defect closed with only soft tissue. For patients undergoing large chest wall defects or pulmonary collapse, stabilization of the chest wall defect may be indicated. LeRoux and Shama[13] have set forth the ideal characteristics of a prosthetic material: rigidity to abolish paradoxical chest motion, inertness to allow in-growth of fibrous tissue and decrease the likelihood of infection, malleability so that it can be fashioned to the appropriate shape at the time of operation, and radiolucency to allow radiographic follow-up of the underlying problem.

Historically, bone, diced cartilage, metal sheets, super-structures with autogenous rib graft, fascia lata, Teflon, and numerous other substances were used with minimal success[4]. Although no substance has been found to fulfill all criteria, synthetic or alloplastic materials (e.g., Prolene and Marlex mesh) are satisfactory if the condition of rigidity is not considered, the defect is medium sized, and all contaminated tissue is resected. While some authors advocate Prolene or Marlex mesh, others [14] advocate the use of polytetrafluroethylene (Gore-Tex) soft tissue patch reconstruction of all defects. For the most part, the choice of prosthetic material is based on surgeon's preference, as Deschamps and associates[15] have shown that no significant difference in the rate of postoperative outcome or complications exists between the use of Prolene mesh or PTFE soft tissue patch for chest wall reconstruction.

In cases where structural integrity is necessary for preventing chest wall collapse, methyl methacrylate sandwich, silicone, Teflon, or acrylic materials have been utilized[3]. While it is still unclear of the importance of rigidity in chest wall reconstruction, observations of chest wall trauma give much significance to the presence of paradoxic motion of the chest wall. However, this uncoordinated motion during respiration is seen in almost every major resection of the chest wall but it is not associated with pulmonary insufficiency, which is seen with its traumatic counterpart, flail chest. We and others[4,16] have used methyl methacrylate sandwich (with Prolene or Marlex mesh) with excellent physiologic and aesthetic success. Although a variety of synthetic materials can be used to reconstruct the chest wall defect, there is no consensus on the most physiologic or efficacious material.

Once the chest wall has been stabilized soft tissue coverage can be utilized to complete the reconstruction of complex thoracic defects. Although reports of transposition of the latissimus dorsi muscle for chest wall coverage had been described in 1896 by Tansini[17], it was not until the rediscovery of the musculocutaneous concept in 1977 by Jurkiewicz and associates[18] that stimulated the resurgence of the muscle and musculo-cutaneous flap approach to thoracic reconstruction. Whereas superficial

defects of the chest wall are easily closed with local flaps or skin grafts, full thickness defects are more challenging and often require close interaction between the thoracic and plastic surgeons. The indications for soft tissue free or pedicled muscle reconstruction are to provide vascularized tissue to cover a thoracic wound, control infection, obliterate dead space, and to potentially provide coverage of synthetic mesh used to stabilize the chest wall. The availability of numerous reconstructive techniques with well-vascularized tissue enables the extirpative surgeon then to take the wide and appropriate resections to ensure successful long-term management.

The numerous advances in chest reconstruction over the years with the introduction of muscle and musculocutaneous flaps have made them the mainstay in chest wall reconstruction[4,9,14,19]. The thoracic trunk is well suited for vascularized coverage given the many local muscle flaps (e.g. latissimus dorsi, pectoralis major, rectus abdominis, trapezius, or deltoid muscles) or greater omentum (used alone or in combination as options for wound coverage)[14,20,21]. With the bountiful methods of pedicled muscle transfer and uncommon pedicled muscle flap loss, the necessity for free flap in the reconstruction of the thoracic wall defect is minimal. In the rare situation of pedicled muscle flap loss, the pedicled omental flap has been useful as a salvage procedure in those instances. Free muscle flap failure generally requires a repeat free flap as pedicled muscle flaps would be unavailable.

In conclusion, the key to a successful outcome in these complex cases is the coordinated effort by the surgical teams in individualizing the care of these patients utilizing total resection of the disease process, reconstruction of the chest wall integrity, and soft tissue coverage of the defect. The team of surgeons should be well trained in chest wall reconstruction utilizing prosthetic materials and free or pedicled muscle flaps and must plan and work together to achieve optimal results.

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