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Research Article

Adequate Chest Wall Reconstruction for Composite Defects Achieved by Soft Tissue Flap + Mesh Only

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Abstract

Background: Chest wall tumor resechious create large defects requiring composite reconstruction.

Objective: The objective of our study is to evaluate the outcomes of patient undergoing bony stabilization with poly propylene mesh and soft tissue coverage with pedicled flaps.

Methodology: Comparative cross sectional study was done at Shifa hospital, Islamabad. 4 years period. All patients who underwent composite chest wall reconstructions after tumor resections were included bony stabilization was done with polypropylene mesh and soft tissue coverage was done with pedicles latissimuss dorsi or transverse rectus abdominis. Variables assessed included tumor type, location and resected ribs and flap used. Duration of hospital stay and any major or minor complications were noted.

Results: Total of 17 patients were included in the study. 11 (64.7%) were females and 6(35.3%) were males. The causes were primary chest wall tumors in 12 (70.6%) and breast carcinoma in 5 (29.4%). Ribs along with sternum were resected in 1 case and ribs only in 16 patients. The average number of ribs resected were 3.3. The average chest wall defect was 161.1cm^2 (ranging from 88cm -228 cm^2). Mean postoperative hospital stay was 7.41 days. There was no perioperative mortality.

Conclusion: Synthetic polypropylene mesh alone can be used for composite chest wall defects as it has less infection rate than rigid prosthesis, is easy to use, safe and cost effective.

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Introduction

Primary chest wall tumors are considered a rare entity and represent 5% of all thoracic neoplasms, approximately 50-80% are malignant. Among them chondrosarcomas are the most common.[1] In the era of modern surgical and technological advancements, extensive resections of malignant chest wall tumors have become possible but, the reconstruction of composite defects remain challenging.[2]

Most recent studies show that chest wall defects less than or equal to 5 cm in the greatest dimension do not require reconstruction.[3,4] The anterolateral chest wall has weak and thin layer of muscles due to which any defect >5 cm including 4 or more ribs should be reconstructed due to high risk of lung herniation and respiratory compromise due to paradoxical breathing[4]. In contrast defects <10 cm in apico-posterior chest wall do not require bony reconstruction due to strong musculature and presence of scapula and shoulder girdle.[5,8]

The goals of chest wall reconstruction are to guard intrathoracic organs, maintain cardiac and pulmonary functions and provide soft tissue coverage to resist infections, facilitate radiotherapy if needed and achieve aesthetically pleasing appearance.[6] Different metallic, synthetic and biological materials have been developed to restore chest wall stability, but their usage is arguable as there are no established guidelines, therefore it is usually based on surgeons' preference and experience.[5,7] The purpose of this

study is to evaluate the results of composite chest wall reconstruction in which bony restoration was done with polypropylene mesh and soft tissue coverage with pedicled musculocutaneous flaps after resection of malignant tumors.

Methodology

This study was approved by institutional review board (IRB# 184-24) and conducted in the department of plastic surgery, Islamabad over a period of 4 years from 1st January 2020 to 31st December 2023. It included a total of 17 patients who had undergone composite chest wall resections and reconstruction. This is a cross-sectional study in which patient's demographics such as age, gender, type of tumor, site of tumor, defect size, number of ribs resected, flap type, hospital stay, immediate postoperative complications were recorded.

The inclusion criteria was patients with malignant chest wall tumors in which reconstruction of bony defects was done with polypropylene mesh and soft tissue reconstruction was done with pedicled flaps after resection of malignant chest wall tumors. Exclusion criteria was benign tumors of chest wall, infected sternal wounds, trauma cases and those chest wall resection patients in which less than 3 ribs were resected or reconstruction was done for soft tissue coverage only with pedicle flaps.

Computed tomography or magnetic resonance imaging was performed in all cases to evaluate the extent of disease and suspected distant metastasis after which histological diagnosis was made through biopsy. Patients were discussed in multidisciplinary meeting by a thoracic and plastic surgeon, oncologist, radiologist and histopathologist. The patients were also evaluated by ICU specialist and pulmonologist prior to surgery.

Wide local excision was performed in all the cases taking a 4-5cm margin and specimen were sent for frozen section intraoperatively. The defect size was assessed, and bony reconstruction was done by polypropylene mesh by doubling it on itself and anchoring under slight tension to the cut edges of ribs for achieving skeletal stabilization. For soft tissue defect pedicled latissimus dorsi or transverse rectus abdominis flaps were used. Chest tube was instituted. Drains were placed under the flap and in the donor area. Postoperatively patients were kept in ICU for monitoring. Follow-up for any minor or major complications were done for a year in postoperative period.

Results

A total of 17 patients in our institution underwent composite chest wall reconstruction. Table 1 departs the clinical details of all patients. There were 64.7% females (11/17) and 35.3%males (6/17). Mean age was 40.2 years (ranging from 14 -65 years). The causes of composite chest wall defect were 12 (70.6%) primary chest wall tumors and 5 (29.4%) advance breast carcinoma. Pathological diagnosis was Chondrosarcoma [N=5] (29.4%), Ewing sarcoma [N=4] (23.5%), Leiomyosarcoma [N=1](5.9%) , Synovial sarcoma[N=1](5.9%) & Liposarcoma [N=1](5.9%).

After wide local excision the location of defect was anterolateral in 8 patients (47%), anterior in 7(41.1%), lateral in 1(5.9%) and central in 1(5.9%) case. There were no posterior defects in our study. Ribs along with lower part of sternum was resected in 1 case and ribs only in 16 patients. The average number of ribs resected were 3.3 (ranging from 3-5). The average chest wall defect after wide resection was 161.1cm^2 (ranging from 88cm -228 cm^2). Polypropylene mesh was used for skeletal reconstruction in all patients and for soft tissue coverage pedicled musculocutaneous latissimus dorsi (LD) flap was used in 12 patients (70.6%) and Pedicled Transverse rectus abdominis flap (TRAM) based on superior epigastric pedicle was used in 5 patients (29.4%). Figure 1 shows a patient who underwent resection of liposarcoma and coverage with LD flap. Figure2 shoes a patient who underwent TRAM flap resection of invasive breast cancer. Donor site was closed primarily in all TRAM flaps and in 7 LD flap patients, whereas split thickness skin grafting was used for donor sites of remaining 5 LD flap patients.

Postoperatively none of our patients had paradoxical respiratory movements. Mean postoperative hospital stay was 7.41 days (range 5-12 days). No perioperative mortality was seen. Post-operative complications seen during routine follow-ups after discharge included wound infection with negative cultures in 1 patient that was managed conservatively, LD donor site seroma in 3 patients, which was

aspirated and subsided eventually. Flap site wound dehiscence in 2 patients which was managed conservatively with repeated dressings. The mean follow-up period was 5.5 months (range 3-12 months).

3 patients received adjuvant chemotherapy, 9 patients were given radiotherapy and 5 received chemo-radiation. Two patients lost follow-up after 3 months. Two patients had recurrence at 5th and 7th month for which second surgery for re-excision and coverage with free anterolateral thigh flap was done. Rest of the patients had satisfactory results.

Assessment of the chest wall integrity was done once the chest tube was removed and surgical wounds were healed, by MRI (magnetic resonance imaging) that revealed concordant chest wall movements during respiration without any signs of paradoxical movements or displacement of mesh. There was no physical deformity on clinical examination and the patients were satisfied with overall postoperative results as there was no complain of limitations in routine activities.

Table 1: *Summary of Patients*

#	AGE/ SEX	TYPE OF TUMOR	SITE OF TUMOR ON CHEST	DEFECT SIZE (cm)	AVERAGE SURFACE AREA (cm)	SKELETAL RESECTION	Stay (no.of days)	SKELETAL STABILIZATION	TYPE OF PEDICLED FLAP	COMPLICATIONS
1	51/F	Advanced breast CA	Antero-lateral	16x11	176	4 ribs	9	Mesh	TRAM	SEROMA
2	33/F	Ewing sarcoma Chemo	Anterior	13x11	143	3 ribs	7	Mesh	LD	None
3	35/M	Chondro-sarcoma	Central	18x12	216	Sternum+ bilateral 5 Costocho-ndral ribs	11	Mesh	LD	None
4	65/M	Liposarcoma	Anterior	14x11	154	3 ribs	6	Mesh	LD	None
5	60/F	Advanced breast CA	Anterior	14x10	140	3 ribs	7	Mesh	TRAM	None
6	35 /F	Synovial sarcoma	Antero-lateral	11x8	88	3 ribs	5	Mesh	LD	None
7	52/F	Chondro-sarcoma	Antero-lateral	19x12	228	5 ribs	8	Mesh	TRAM	None
8	65/F	Advanced breast ca	Antero-lateral	16x10	160	4 ribs	6	Mesh	LD	Wound dehiscence
9	21/M	Chondro-sarcoma	Anterior	16x13	208	3 ribs	8	Mesh	LD	Infection
10	14/F	Ewing sarcoma	Lateral	13x10	130	3 ribs	7	Mesh	LD	None
11	57/M	Chondro-sarcoma	Antero-lateral	17x12	204	4 ribs	12	Mesh	LD	Infection
12	25/F	Ewing sarcoma	Anterior	13x9	117	3 ribs	1 1	Mesh	LD	None
13	16/M	Leiomyo-sarcoma	Antero-lateral	15x12	180	3 ribs	5	Mesh	LD	Seroma donor site
14	15/F	Ewing Sarcoma	Anterior	12x10	120	3 ribs	6	Mesh	LD	None
15	26/M	Chondro-sarcoma	Anterior	14x10	140	3 ribs	5	Mesh	LD	None
16	54/F	Advanced breast ca	Antero- lateral	14x13	182	3 ribs	7	Mesh	TRAM	None
17	61/F	Advanced breast ca	Antero-lateral	14x11	154	3 ribs	6	Mesh	TRAM	None

Abbreviations: *CA=carcinoma, LD= latissimus dorsi, TRAM= transverse rectus abdominis musculocutaneous*

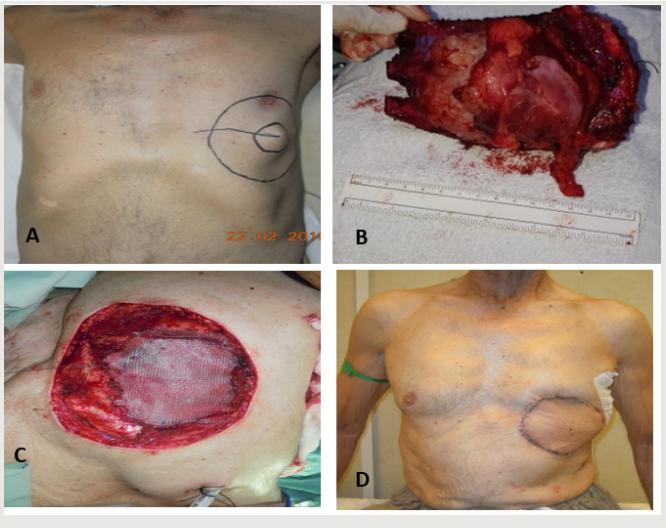

Figure 1: *A) liposarcoma of left chest wall. B) resected specimen showing 3 ribs. C) defect showing mesh placement. D) coverage with pedicled LD flap. D) follow-up picture at 3 weeks.*

Figure 2: *A) Invasive right breast CA. B) resected specimen showing 5 ribs. C) mesh placement over defect. D) TRAM flap for inset. E) early follow-up at 2 weeks.*

Discussion

The common indications of chest wall reconstruction are malignant tumors (primary and secondary), congenital anomalies, infection, trauma, and osteoradionecrosis.[2] In our study cases of only primary malignant chest wall tumors and advanced breast carcinomas were included. The patients falling in the age range of our study is comparable to others.[2] The planning for composite chest wall tumor resection and reconstruction should always have a multidisciplinary approach[10-14] as done in our study. En bloc surgical extirpation with approximately 4cms of clear margin is recommended to avoid recurrence as suggested by following studies.[2,3,10,14] In our study, we also followed the recommended margins of 4cm. Our study has mean chest wall defect of 161.1 cm^2 which is comparable to other studies.[4,9] The mean number of ribs resected in the present study was 3.3, which is comparable to Finckh et al [5] (3 ribs) and Hameed et al[12] (3.5 ribs).

An ideal prosthesis is firm enough to avoid abnormal motion, bio compliant in promotion of tissue ingrowth, moldable, radiolucent, resist infection, durable and affordable.[3,10-14] Many different rigid materials are available for reconstruction such as methyl methacrylate, titanium plates and silicone.[13,14] Non-rigid mesh and patches are further subdivided into synthetic mesh such as (polypropylene, marlex, vicryl, polyglactin, PTFE)[3] and biological mesh (porcine, bovine, human).[6] Recently 3D printed customized prosthesis[4,7,10,19] have become available. In our centre, polypropylene mesh was used for all chest wall defects and none of our patients showed signs of chest wall instability or flail chest. Alexander et al in his study of 34 cases showed excellent results using polypropylene mesh for ventral chest wall reconstruction without the use of metallic or biological implants regardless of the extent of chest wall resection.[5] Hameed et al had average bony defect of 16.5x13 cm for which they used polypropylene mesh and found it to be safe and effective [12]. Malathi et al in their series of 32 patients required skeletal stabilization in 13 cases for which they used mesh alone in 11 cases and rib grafts for other 2 central defects[2] whereas we used mesh for central defects as well. Another study of 146 patients showed comparison between synthetic mesh and ADM for skeletal reconstruction and concluded that ADM has less surgical site complication than synthetic mesh i.e., 32.6% vs 15.7%[9] but due to high cost of ADM, present study doesn't suggest it. Chang et al has suggested an algorithm in which a mesh only reconstruction is applied in a defect <4 ribs, however when 4 or more ribs or sternum is involved mesh with methyl methacrylate is used.[13] Spicer et al reviewed 427 patients with 82 rigid prostheses and 345 non rigid prostheses and claims no significant difference.[16]

In our study soft tissue coverage with pedicled flaps

was performed immediately after mesh placement in a single stage. The torso provides options of many vascularized flaps such as pectoralis major, rectus abdominis, serratus, external oblique, trapezius and latissimus dorsi.[11,17]However, the pedicled myocutaneous latissimus dorsi flap has stood the test in time. It was first reported by Italian surgeon Tansini after radical mastectomy in 1896.[11] Due to its large arc of rotation and reliable pedicle when latissimus dorsi is mobilized adequately leaving just the insertion intact, it can reach any part of the thorax such as lateral, anterior or midline easily.[12] We have used LD flap in 70% of our patients with no flap loss which is similar to Hameed et al[12] who used LD flap for all 20 cases in their study. For large anterolateral defects TRAM flap based on superior epigastric artery is a reliable option. It can easily cover defects up to 40 cm.[18,19] In our study 30% patients underwent coverage with TRAM flap. Omentum flap is considered as a salvage flap for large defects with small volumes in times of infection, irradiation, and flap failure.[17-19] Free flaps due to their long operative time are restricted only when regional flaps are deficient, irradiated or failed earlier.[12,17,20] Free anterolateral thigh flaps were used as a secondary procedure in 2 recurrent cases. Our study has a shorter period of hospital stay as compared to others.[8,13,21]

The limitation of the study are it's a retrospective study and that the sample size is small. A larger multi centric study can be planned in the future for more definitive assessment.

Conclusion

Despite availability of different rigid, non-rigid material and modification in flap techniques, composite chest wall reconstruction is still considered challenging. A multidisciplinary collaboration between thoracic and plastic surgeons makes it possible to achieve one stage tumor resection and appropriate chest wall reconstruction, providing maximal oncological results with minimal patient complications. Synthetic polypropylene mesh alone can be used for complex full thickness chest wall defects as it has less infection rate than rigid prosthesis is easy to use, is cost effective and most importantly is safe for the patient.

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Conflict of Interest: None

Author's Contribution

Fatima Askari: Data collection, Data analysis and interpretation, conception and design of the study, Final approval of the version to be published and accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Saad-ur-Rehman: Substantial contribution to acquisition of data, concept and design and final approval of the version to be published

M. Ibrahim Khan: Concept and design, substantial contribution to acquisition of data, critical review and final approval of the study.

Rafiya Masud: Conception and design of the study, critical revision of the article and final approval of the article to be published.

Shahrukh Mohmand: Data analysis, concept and design and final approval of the version to be published

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