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Chest Wall Resection: A 7-Years Single Centre Experience



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ABSTRACT

Background: Chest wall resection and reconstruction are performed for a range of pathologies such as primary chest wall tumors, locally invasive primary lung cancers, metastatic cancers, as well as infections. After such resections, reconstruction may be required to cover the defects resulting from the resection to preserve the chest wall integrity. This study aims to retrospectively review our 7-year experience in chest wall resection and reconstruction, adequacy of our resection, rates of recurrence, and survival outcomes. **Patients & Methods:** A retrospective review was performed from our available database of all patients who underwent chest wall resection and reconstruction at Castle Hill Hospital between April 2013 to April 2020. We retrieved data on the patient's demographics, Indications for resection, histology of the tumors, number of ribs resected, the extent of resection, resection margins as defined by the histology report, type of reconstruction performed, complications, and survival outcomes. Patients who had chest wall reconstruction due to trauma were excluded from the study. The data were statistically analyzed and P-value 0.05. **Results:** 49 patients were included in the study over this period. 51% were males and 49% were females with a mean age of 61 years (Range: 20 - 79 years). The commonest indication for resection was malignant tumors (77%) which comprised mostly primary chest wall tumors and infiltrating primary lung cancers. R0 resection was achieved in 61% of the resections and 43% of patients had some form of reconstruction. The most common complication was pneumonia/atelectasis followed by persistent air leaks and flap necrosis. There was one perioperative mortality. 10 patients had a recurrence of their cancers. Mean overall survival was 5.1+/- 0.44 years. In patients with malignant tumors, the survival was 73% and 23% at 1 year and 5 years respectively (p-value 0.0004). There was a significant difference in survival between patients with benign tumors vs malignant tumors (p=0.003). However, there was no significant correlation between patients who had R0 and R1 resections in respect to survival (p= 0.643). **Conclusion:** Primary chest wall malignancies along with infiltrating primary lung cancers continue to be the commonest indication for chest wall resections. Chest wall resections and reconstruction requires a multidisciplinary approach in pre-operative planning and reconstruction to improve operative outcomes.



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BACKGROUND

Chest wall resection and reconstruction are performed for a range of pathologies such as primary chest wall tumors, locally invasive primary lung cancers, metastatic cancers, as well as infections. Chest wall resection involves the removal of a portion of the chest wall, which may include the muscle, ribs, sternum, vertebra with or without the skin. The common indications for chest wall resections include metastatic and primary chest wall tumors, locally invasive tumors from surrounding tissues, congenital defects, Infections etc. [1]. After such resections, reconstruction may be required to cover the defects resulting from the resection to preserve the chest wall integrity. Reconstruction depends on the extent of resection and this could range from just soft tissue cover to more extensive rigid reconstruction. A variety of options and techniques are available for use for reconstruction some of which involves primary closure of the defect with muscle and skin, the use of musculocutaneous flaps: pedicled or free flaps, Omental flaps, and also the use of synthetic materials such as Polypropylene mesh, titanium bars, and methyl methacrylate sandwich to achieve a rigid chest wall reconstruction. This study aims to retrospectively review our 7-year experience in chest wall resection and reconstruction, adequacy of our resection, rates of recurrence, and survival outcomes.

PATIENTS/METHOD

A retrospective review was performed from our available database of all patients who underwent chest wall resection and reconstruction at Castle Hill Hospital between April 2013 to April 2020. This study period was selected as it represents the onset of our new thoracic database system. We retrieved data on the patient's demographics, Indications for resection, histology of the tumors, number of ribs resected, the extent of resection, resection margins as defined by the histology report, type of reconstruction performed, complications, and survival outcomes. Patients who had chest wall reconstruction due to trauma were excluded from the study as they did not require chest wall resection. The data were statistically analyzed and P-value 0.05.

RESULTS

51 patients were identified who underwent chest wall resection and reconstruction, however. Two patients' data were incomplete and therefore excluded from the study. The total number of patients in this study was 49patients. There were 25 (51%) male patients and 24 (49%) female

patients. The mean age was 61years with an age range of 20 years – 79 years. 49% (24) of the patients were ex-smokers, whilst 12% (6) were current smokers, with an average pack-year of 34 years.

Table 1: Histology of Resected Chest Wall Tumours

| Histology | N |
|--|-----------|
| Adenocarcinoma Lung | 7 |
| Squamous cell Carcinoma Lung NSCLC | 8 |
| Adenosquamous Lung cancer | 1 |
| Metastatic Renal Cell Carcinoma | 4 |
| Metastatic Colonic Adenocarcinoma | 2 |
| Schwannoma | 4 |
| Primary chest wall Sarcomas | 7 |
| Osteochondroma | 2 |
| Metastatic Prostate Adenocarcinoma | 1 |
| Small Cell Lung Cancer | 1 |
| Chronic Inflammation/Infections | 2 |
| Invasive Ductal Ca | 2 |
| Fibromatosis | 1 |
| Ganglioneuroma | 1 |
| Paravertebral mass (Bronchogenic cyst) | 1 |
| Metastatic Endometrial Cancer | 1 |
| Fibrous dysplasia | 1 |
| Pancoast Tumour | 1 |
| Solitary Fibrous Tumour | 1 |
| Poorly differentiated Carcinoma | 1 |
| Total | 49 |

The indications for resection were tumors 47 (96%) and chronic infection 2 (4%). Amongst tumors; malignant tumors made up 77% (36) of cases whilst benign tumors were 23% (11).

Distant metastatic cancers made up about 28% (13) of the resected tumors whilst primary chest wall tumors and infiltrating primary lung cancers made up the remaining 72% (34).

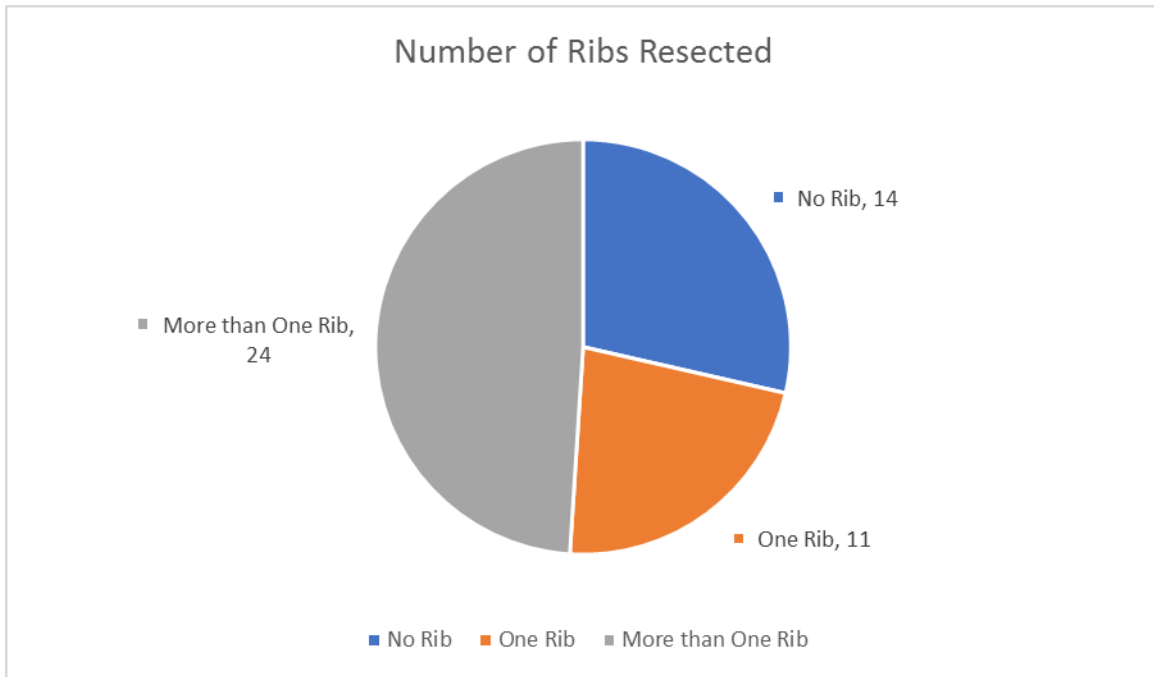


Figure 1: Number of Ribs Resected

35 (71%) patients had ribs resected as part of the tumor resection. In addition to the numbers of ribs resected, concomitant lung resection was performed in 22 patients (45%), these lung resections varied from wedge resections, Lobectomies, bi-lobectomies, and one pneumonectomy. 7 (14%) Patients had more extensive resections involving the first rib, clavicle, sternum, manubrium, vertebrae and diaphragm. R0 resection was achieved in 30 (61%) of the patients, R1 in 18 (37%) and R2 1 (2%) of the patients.

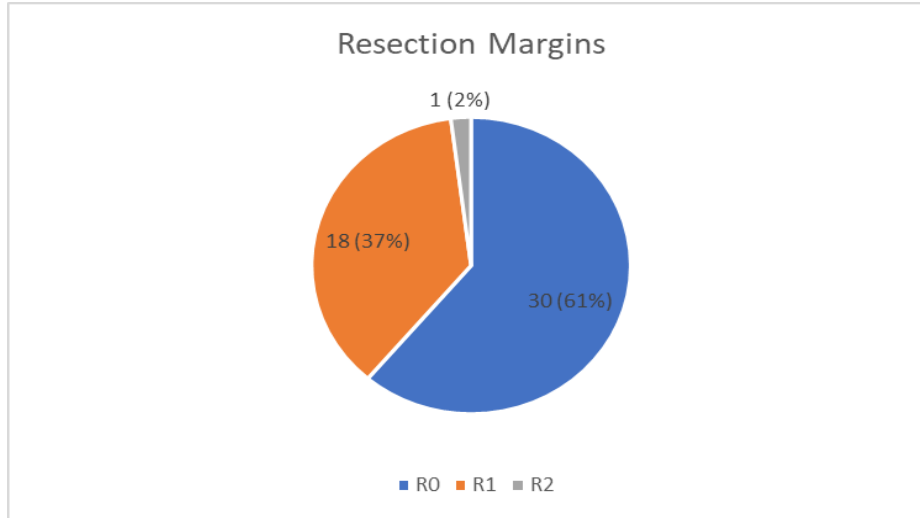


Figure 2: Resection Margins

43% (21) of patients had some form of reconstruction following resection whilst 57% (28) had a primary repair. Amongst those who had reconstruction, 13 patients had reconstruction using mesh, 7 patients with latissimus dorsi flaps, 2 patients had free flaps from the thigh and 6 patients had reconstruction using metallic bars (Titanium). Most patients had a combination of methods of reconstruction.

Table 2: Post Operative Complications

| Post Operative Complications | N (%) |
|------------------------------------|----------|
| Pneumonia/Atelectasis | 7 (32%) |
| Persistent Airleaks | 6 (27%) |
| Flap Necrosis (partial + Complete) | 1+1 (9%) |
| Atrial Fibrillation | 2 (9%) |
| Wound Infection | 1 (4.6%) |
| Pleural Effusion | 1 (4.6%) |
| Acute Kidney Injury | 1 (4.6%) |
| Urinary Retention | 1 (4.6%) |
| Hoarseness of Voice | 1 (4.6%) |

Complications occurred in 18 patients (36%), with some patients having more than one complication. The variety of complications is highlighted in Table 2. There was one perioperative death (2%). 10 (20%) had a recurrence of the tumor, of which 60% (6) occurred in patients with R1 resection and 40% (4) in R0 resection.

Mean follow-up was 38 months with a range of 7-88months. Mean overall survival was 5.1+/- 0.44 years. Overall survival at 1 year was 81% and overall survival at 5 years was 50%. In patients with malignant tumors, the survival was 73% and 23% and 1 year and 5 years respectively ($p=0.0004$) whereas in patients with benign tumors survival was 100% at 1 year and 5 years. There was a significant difference in survival between patients with benign tumors vs malignant tumours ($p=0.003$), figure 4. However, there was no significant difference between patients who had R0 and R1 resections in respect to overall survival ($p=0.643$). Further analysis revealed no statistical difference in survival between primary lung cancers and other malignancies ($p=0.007$), also no difference in survival was found between metastatic tumours and primary malignant chest tumors ($p=0.365$), figure 5.

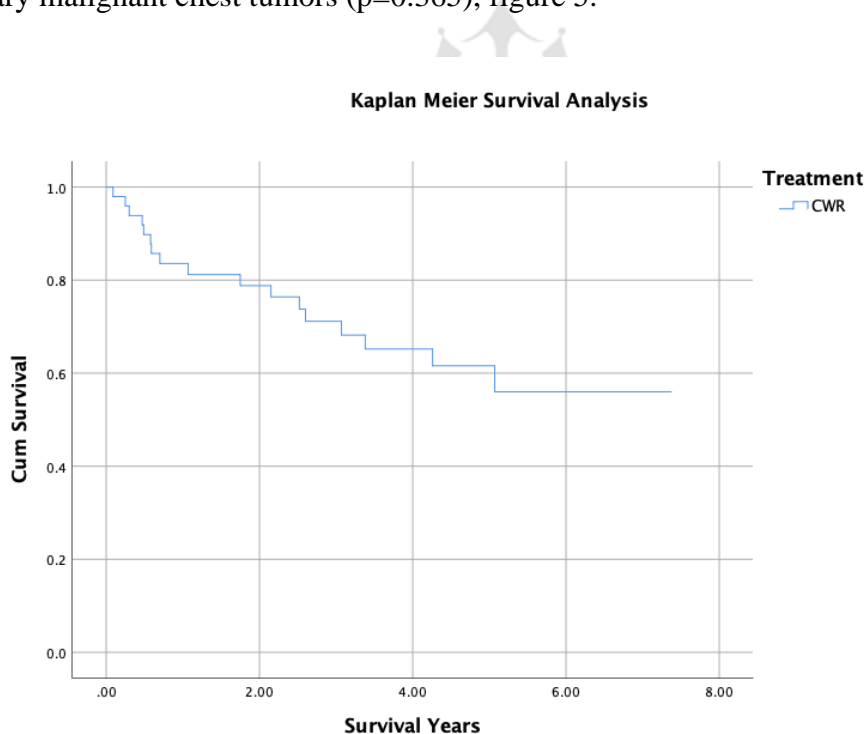


Figure 3: Cumulative Survival Analysis

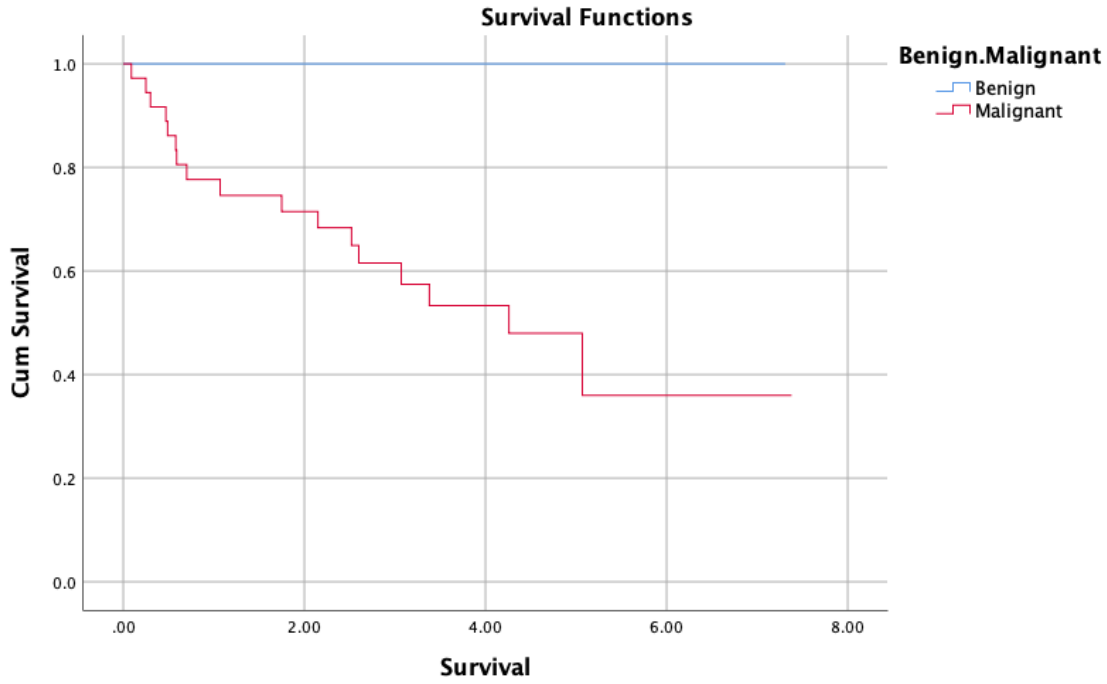


Figure 4: Survival analysis Benign vs Malignant

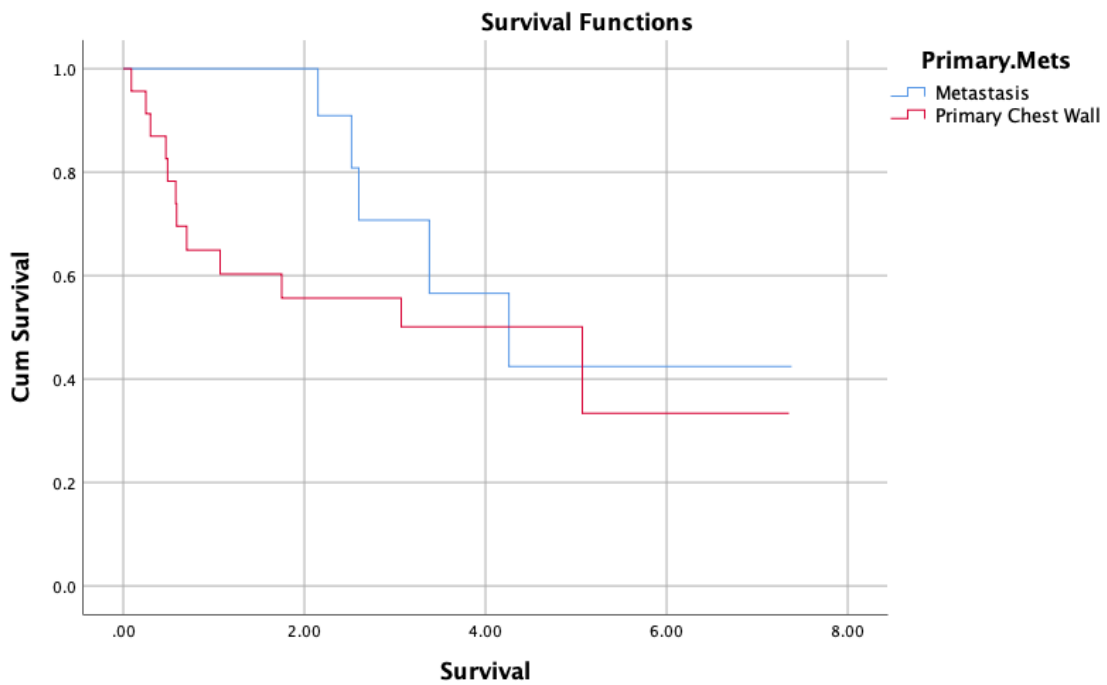


Figure 5: Survival between Metastatic tumors and Primary malignant chest tumors

DISCUSSION

The guiding principles of chest wall resection have been described. First, a sufficient amount of tissue must be resected to remove the tumor/devitalized tissue with adequate margins. Second, in segments of large chest wall resections, replacements must be found to restore the rigid chest wall to prevent a physiological flail. Third, healthy soft tissue coverage is essential to seal the pleural space, protect the viscera and prevent infection [2]. In addition, aesthetic concerns should be considered [3]. To achieve this multidisciplinary approach comprising of the Thoracic surgeon, Plastic surgeon, Respiratory physician, physiotherapist, and oncologist is essential for best results.

In our study, most patients were males 51% with a median age of 61 years, this is in tandem with a similar study by Weyant et al from the Memorial Sloan Kettering Cancer Centre, New York. The most common indication for resection is tumors (96%), with Non-small-cell Lung cancer infiltrating the chest wall making up the majority of cases 18 (37%) followed by Primary chest wall tumours 15 (31%), this pattern has been noted in studies in the United States [1,4] but in contrast to a study from Iran where primary chest wall tumors made up most of the cases [5].

A significant number of patients 70% had ribs resected en-bloc with the tumor, the number of ribs varied from one rib resected to up to 5 ribs resected. A few patients required more extensive resection involving the partial resection of the manubrium, sternum, vertebrae, and diaphragm. Resections were carried out to ensure adequate margins of resection and achieve an R0. Some of these resections required a frozen section to ensure clear margins. 18 (37%) patients had R1 and 1 (2%) had R2 resection, despite ensuring a wide margin of resection, this is unfortunate as it is known that incomplete resections result in early recurrence and thus poor prognosis, there may be a need for frozen section to be mandatory in chest wall resections. In our experience, the frozen section takes about an hour and a half of the operating time (reason being that pathology is off-site) and in a few cases this was not performed, and macroscopic tumor-free margins were relied on, however, some of these resections were deemed incomplete after pathological analysis. Although our study had a significant number of patients with incomplete resection, this did not affect survival when compared to patients who had R0 resection ($p=0.643$).

Of note, about 45% of the patients had concomitant lung resection which is particularly high compared to the study by Leuzzi et al where the concomitant lung resection was performed in 15.4% of patients [6] but at par with findings by Weyant et al [4]. The more complex resections requiring more than 3 ribs resection and extensive soft tissue resection/reconstruction were performed in conjunction with the plastic surgeons who guided the incision making because of subsequent reconstruction, this is to avoid damage to the vascular supply of the proposed flap and was involved in performing the musculocutaneous flap reconstruction.

There is no consensus on when to reconstruct the chest wall following a resection. However, a basic principle exists. The decision not to reconstruct the skeleton depends on the size and location of the defect. Defects less than 5 cm in greatest diameter anywhere on the thorax are usually not reconstructed. Posterior defects less than 10 cm likewise do not require reconstruction because the overlying scapula provides support unless they are located at the tip of the scapula where entrapment of the scapula can occur during movement of the arm [7]. 21 (43%) of patients had chest wall reconstruction, the most common form of reconstruction was the use of mesh (13 patients), whilst Latissimus dorsi flap, Anterior lateral flap flaps, free flaps, titanium bars also used to reconstruct the chest. In some patient's various techniques were combined, as some patients received a mesh + flap, metallic bars + flap, and so on. All the procedures requiring a flap were performed by the plastic surgeons as a joint procedure.

Most patients with inadequate resection and large tumours were referred to adjuvant therapies (chemotherapy, immunotherapy and radiotherapy) for locoregional and systemic control guided by the multidisciplinary team decisions.

Complications occurred in 36% of the patients, with respiratory complications most common, this is not unusual as 45% of patients had concomitant lung resections which varied from lobectomy, lobectomy and wedge resections. There was one patient death in the perioperative period, this patient had a right upper lobectomy with associated resection of the manubrium, he underwent reconstruction using polypropylene mesh and anterior lateral thigh flap for a T3N0M0 Poorly differentiated Carcinoma. He subsequently developed flap necrosis requiring re-operation with debridement and a pedicled latissimus dorsi flap reconstruction. He developed a chest infection and died following multiple organ failures.

Overall survival at 1 year was 81%, whilst 5-year survival was 50%. Amongst the patient group who had malignant aetiologies, the survival was 73% and 23% at 1 year and 5 years respectively, this was found to be statistically significant ($p=0.0004$), although there was a statistical difference in survival between benign chest wall tumors and malignant chest wall tumors ($p=0.003$).

CONCLUSION

Primary chest wall malignancies along with infiltrating primary lung cancers continue to be the commonest indication for chest wall resections. Survival outcomes following resection are satisfactory, however, the intraoperative frozen section is of paramount value to achieve complete resection and prevent a recurrence. A multidisciplinary team approach in pre-operative planning and reconstruction is imperative to improve operative outcomes.

Conflicting Interest: None Declared

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