Original Article

Contributing factors to the outcome of primary malignant chest wall tumors

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Background: Primary malignant chest-wall tumors (PMCWTs) are a heterogeneous group of tumors. They require a special experience in designing resection and reconstruction. They account for less than 1% of all primary malignant tumors. This study is designed to clarify different factors contributing to the outcome of patients with PMCWTs in our institution.

Methods: A retrospective study included 98 patients with pathology proven PMCWTs, treated at the National Cancer Institute (NCI), Cairo University, Egypt, during the past 10 years. Used variables were: age, sex, forced expiratory volume in the 1st second (FEV1), site, size, multiplicity, pathologic subtype, tumor grade, safety margin (SM), excised ribs, complications, estimated blood loss (EBL), neo-adjuvant and adjuvant treatments, Overall and disease free survival (DFS) were obtained using Kaplan-Meier method and compared using Log rank test. Cox regression was used to identify DFS predictors.

Results: PMCWTs represented 10.5% of all thoracic malignancies in our institution. There were 51 females (52%). The median age was 39 years [interquartile range (IQR) =25–52.3)] years. Chondrosarcoma was the commonest tumor histology (20.4%). The median tumor size was 8 cm (IQR =5–14). Tumor multiplicity was found in 18.4% of patients. Bone resection was performed in 76 patients (78.3%), ribs resection was performed in 59 patients and the median number of resected ribs per patient was 3 (IQR =1–3) ribs. Sternal resection was done in 7 (7.1%) cases. R0 resection was achieved in 62.2% of patients. There was one operative related mortality (1.02%) and 17.3% patients suffered procedure related complications. Local recurrence developed in 35 (35.7%) patients. The overall survival (OS) at 1, 3 and 5 years was 73.9%, 45.6% and 34.6% respectively and the median OS was 33 months (95% CI, 21.8–44.2), while median DFS was 24 months (95% CI, 19.6–28.4). Predictors of better DFS were –ve SM (P<0.001), tumors <5 cm (P=0.039), low grade (P=0.033), lower EBL (P=0.003) and absence of adjuvant therapy (P=0.007); however, on multivariate analysis, only –ve SM was the only predictor (HR =0.54; 95% CI, 0.29–0.97, P=0.041).

Conclusions: In primary malignant CWTs (PMCWTs) achievement of wide resection margins is of great importance to minimize the local tumor recurrence that will have an adverse impact on long-term survival.

Keywords: Chest wall tumors; local recurrence; sternal resection; reconstruction; complications; estimated blood loss (EBL); neo-adjuvant and adjuvant treatments

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Introduction

Primary malignant chest wall tumors are a heterogeneous group of tumors that originate from thoracic soft tissue and skeletal structures (1,2).

They may be asymptomatic and slowly growing with pain development during their extension (3). They need broad tumor-free margins that often lead to complex chest wall resection and reconstruction techniques, especially when the tumor is large in diameter or located posteriorly adjacent to the vertebrae or involves the sternum. Consequently, an early diagnosis of a small tumor increases the possibility of a curative therapy and decreasing the need for extended resections (4).

Extensive chest wall defects that involve soft and skeletal tissues may be the end result of chest wall resection of those tumors with 2 available method for reconstruction of such defects; prosthetic or biologic mesh and/or flaps with their blood supply (3,5-7). Recent advances in the techniques of skeletal and musculocutaneous reconstructions have facilitated the treatment of these tumors so that tumor size is not a contraindication to radical excision (8).

They require special experience in designing resection and reconstruction. This study aimed to clarify different factors contributing to the outcome of patients with PMCWTs in our institution.

Methods

Patients and data collection

This study was approved by institutional ethics committee/ethics board of National Cancer Institute (NCI)/Cairo University (No. IRB00004025). We retrospectively reviewed pathologically proven PMCWTs that were treated surgically at the NCI, Cairo University, Egypt, during the past 10 years.

Different possible prognostic variables were used as age, sex, forced expiratory volume in the 1st second (FEV1), site, size, multiplicity, pathologic subtype, tumor grade, safety margin (SM; length, whether the least SM was bone or soft tissue, and positivity), number of excised ribs, complications, intra-operative estimated blood loss (EBL), neo-adjuvant and adjuvant treatments, local and metastatic recurrence (MR).

Computed tomography (CT) of the chest and upper abdomen was the initial staging tool for all patients with magnetic resonance imaging requested only if indicated. In our institute, the commonest used biopsy methods were core needle biopsy with or without CT guidance. We reserve fine needle aspiration cytology (FNAC) for suspected recurrence. Surgical resection and reconstruction was designed according to the site and extent of the lesion resected. Adjuvant and neo-adjuvant therapy was given according to multi-disciplinary thoracic oncology team (MDT) decision.

Our cohort included 3 groups: (I) bony sarcomas as osteosarcomas, chondrosarcomas, and primitive neuro-ectodermal tumor (PNET)/Ewing's sarcoma; (II) soft tissue sarcoma as fibromatosis/fibrosarcoma, pleomorphic undifferentiated sarcoma previously named malignant fibrous histiocytoma, dermatofibrosarcoma protuberans, synovial sarcoma, angiosarcoma, myxofibrosarcoma, rhabdomyosarcoma , myxoliposarcoma; (III) others as carcinomas, solitary plasma cell myeloma and lymphoma that were initially diagnosed as liposarcoma (9-12).

Our institutional treatment policy for PMCWT is based on MDT decision. Regarding neoadjuvant/adjuvant treatment: (I) for PNET; the primary treatment is multi-agent chemotherapy: VAC/IE (Vincristine, Doxorubicin and Cyclophosphamide alternating with Ifosfamide and Etoposide) followed by local control therapy (either surgery or radiotherapy) followed by adjuvant chemotherapy to complete 54 weeks from the beginning of treatment (13,14); (II) for other chemo- and radio-resistant tumors as chondrosarcoma and fibrosarcoma the final decision will be based on MDT meeting opinion, however; we usually give postoperative radiotherapy in case of +ve surgical margin and high grade tumors that represent a poor prognostic criteria.

Defects less than 5 cm in diameter anywhere in the chest wall did not require skeletal reconstruction and could be closed with soft tissue only. Posterior superior defects less than 10 cm in diameter did not have to be reconstructed as they are covered with shoulder blades and large back muscles that provided adequate firmness and stability and did not disturb breathing mechanics.

Mesh with rigid reconstruction was adopted in sternal or ≥3 anterior, lateral or posterior ribs resection. Muscle reconstruction was adopted in <2 anterior ribs resection, while mesh reconstruction was done in <2 ribs resection located laterally or posteriorly similar to prior series (8). Sandwiched bone cement i.e., methyl methacrylate enclosed with Prolene mesh (MMM) was the most common method of rigid reconstruction in our institute (*Figure 1*). We usually fix the MMM with sutures placed either through drill holes in adjacent ribs or through peri-costal soft tissues and fix it to the surroundings using either PDS 0 or Prolene

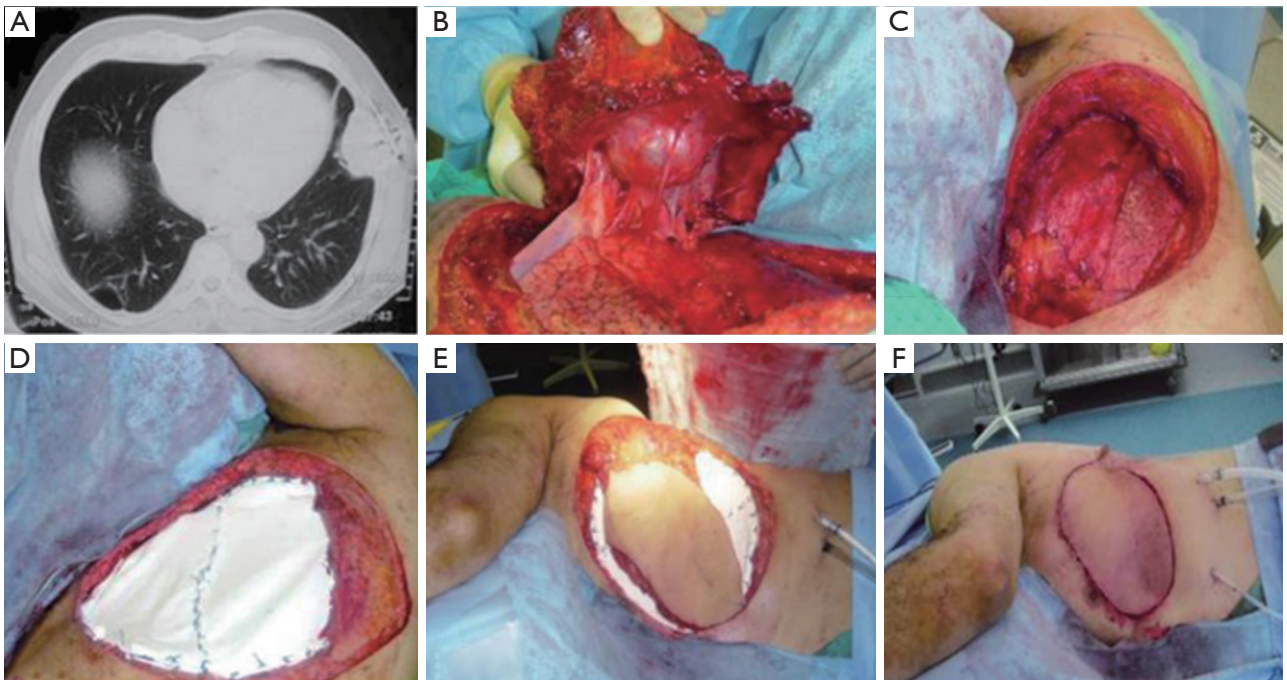


Figure 1 Left lateral chest wall chondrosarcoma. (A) Preoperative CT scan; (B) dissection of the tumor; (C) defect after resection, (D) defect closed with bone sandwich (MMM); (E) LD myocutaneous flap harvest; (F) final closure. CT, computed tomography; LD, latissimus dorsi.

1 sutures with a 2–3 cm overlapping margin between the mesh and chest wall to avoid pushing the mesh inside the defect with breathing

Survival and follow-up data

Overall survival (OS) is the time from date of surgery to date of death from cancer or other causes or date of last follow-up, while disease free survival (DFS) is the time from date of surgery to date of first recurrence, death from cancer or other causes or the date of last follow-up (12). Median follow-up was 36 months [interquartile range (IQR) =11.5–60] for the whole group.

Statistical analysis

The primary outcomes were to identify OS and DFS, that were analyzed using the Kaplan-Meier survival curves. Survival curves for significant variables in the multivariate analysis were compared using Log-rank test.

The secondary outcomes were to compare the clinico-pathological and survival data between the commonest 3 pathological subtypes among our cohort (chondrosarcoma, fibromatosis/fibrosarcoma and PNET/Ewing sarcoma.

Continuous variables were presented as a median and IQR and compared using Mann-Whitney U test. Categorical variables were reported as absolute numbers (frequency percentages) and compared using Pearson's Chi-square (χ^2) test. Analysis of variance (ANOVA) test was used to compare continuous variables in >2 groups. Cox regression was used to identify factors predicting DFS in both uni- and multivariate analyses. Kaplan-Meier survival curves with P value <0.05 was considered statistically significant. Hazard ratios (HR) and 95% confidence intervals (95% CI) were calculated. Statistical analyses were conducted using SPSS version 22.0 (IBM, Armonk, NY, USA).

Results

PMCWTs represented 10.5% of all thoracic malignancies in our institution. There were 51 females (52%). The median age was 39 years (IQR =25–52.3) years (*Table 1*).

Chondrosarcoma was the commonest tumor histology (20.4%) followed by fibromatosis/fibrosarcoma (19.4%) and PNET/Ewing sarcoma (16.3%) (*Table 2*). Other histopathological types were osteosarcoma in 9 (9.2%), pleomorphic undifferentiated sarcoma in 8 (8.2%), synovial sarcoma in 5 (5.1%), dermatofibrosarcoma in 3 (3.1%),

Table 1 Patients' characteristics among our cohort

Patients' characteristics	Median [IQR], frequency [%]
Age¶	39 [25–52.3]
Male gender	47 [48]
Pathology	
Bony	45 [45.9]
Soft tissue	44 [44.9]
Others	9 [9.2]
FEV1¶	2.29 [2.1–2.6]
Location (anterior only)	35 [35.7]
Left side tumors	47 [48]
Tumor size ≥5 cm	82 [83.7]
SM ≥2 cm	23 [23.5]
Least SM	0.1 [0.2–1.5]
+ve margin	37 [83.7]
Bony least SM	7 [7.1]
High grade [2–3]	48 [49]
Tumor size	8 [5–14]
Multiplicity	18 [18.4]
No. of excised rib	3 [1–3]
Lung resection	11 [11.2]
Additional lobectomy	3 [3.1]
No. of dissected nodes	12 [12.2]
+ve path N	1/12 (axillary)
Local recurrence (LR)	35 [35.7]
Time to LR (months, IQR)	14.5 [6–34.3]
Metastatic recurrence (MR)	21 [21.4]
Time to MR (months, IQR)	19 [8–36]
EBL¶	775 [500–1,400]
Complications	17 [17.3]
Neo-adjuvant treatment	28 [28.6]
Adjuvant treatment	67 [68.4]
Survival data; months	
Median OS (95% CI)	33 (21.8–44.2)
Median DFS (95% CI)	24 (19.6–28.4)
Median follow up (IQR)	36 (11.5–60)

IQR, interquartile range; FEV1, forced expiratory volume in the 1st second; SM, surgical margin; EBL, estimated blood loss; OS, overall survival; DFS, disease free survival. ¶, continuous variable.

2 (2%) for each of angiosarcoma, alveolar soft part sarcoma, myxofibrosarcoma, rhabdomyosarcoma, plasma cell myeloma, lymphoma, adenocarcinoma and 1 (1%) for each of myxoliposarcoma, metaplastic carcinoma, squamous cell carcinoma and undifferentiated carcinoma.

Pain was the most common symptom in PNET/Ewing's sarcoma (75%), osteosarcoma (57.1%), while mass was the most common symptom in chondrosarcoma (65%) and fibromatosis (60%).

The median tumor size was 8 cm (IQR =5–14). Tumor multiplicity was found in 18.4% of patients.

R0 resection was achieved in 62.2% of patients. Histopathologically, the least surgical margin was bone in 7 cases with 1 of them (14.3%) had +ve margin, while in the remaining 91 cases, 36 (39.6%) cases had positive margin (P=0.184).

Subgroup analysis regarding the clinico-pathological data between the commonest 3 pathological subtypes revealed higher prevalence of PNET in young age [24.5 years (20–30 years); P=0.004], higher prevalence of males in chondrosarcoma (70%; P=0.093) (*Table 2*). Higher SM ≥2 cm was more achievable in chondrosarcoma (35%) *vs.* 5.3% and 31.3% in fibromatosis/fibrosarcoma and PNET respectively (P=0.064). PNETs were likely to be of high grades (93.8%; P<0.001), develop metastatic potentials (M+ =37.5; P=0.008), especially lung metastasis (31.3%; P=0.042), receive neo-adjuvant (81.3%; P<0.001) and adjuvant treatments (87.5%, P=0.013) (*Table 2*).

Sternal and rib resection

Chest wall tumors were located anteriorly (35.7%), posteriorly (42.9%), laterally (5.1%) and in more than 1 location in the remaining.

Bone resection was performed in 76 patients (77.6%), ribs resection was performed in 59 patients and the median number of resected ribs per patient was 3 (IQR =1–3) ribs.

Sternal resection was done in 7 (7.1%) cases and their pathological diagnoses were 2 cases of chondrosarcoma, 2 rhabdomyosarcomata, 1 adenocarcinoma, 1 metaplastic carcinoma and 1 solitary plasma cell myeloma.

Among the 59 patients who had rib resection; 4 had sternal resection and 4 had vertebral resection as well. Among the remaining sternal resection cohort; 2 had sternal and clavicular resection and 1 had total sternectomy. Ten patients had scapulectomy, 2 had scapulectomy and clavicle resection, and 2 had clavicle resection

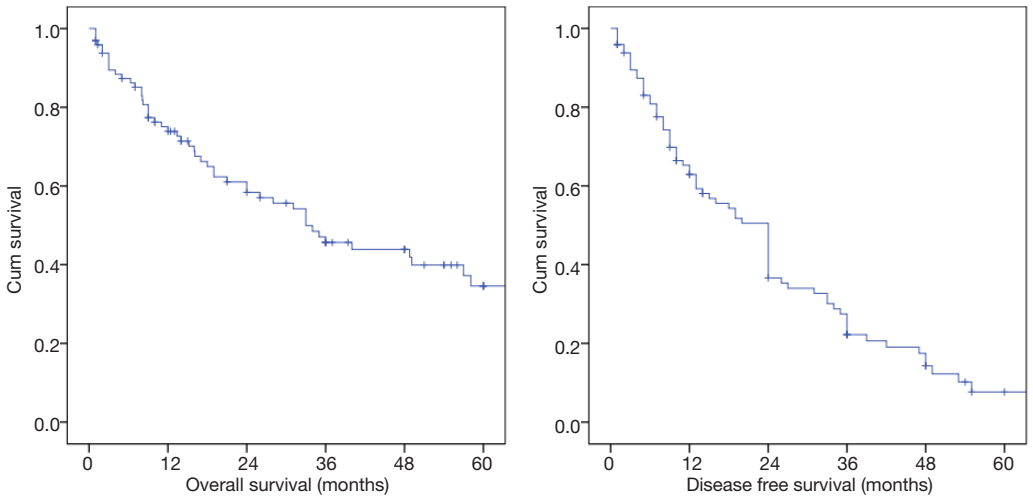
Table 2 Patients characteristics among the commonest 3 pathological subtypes

Patients characteristics	Median [%], interquartile range [IQR]			
	Chondrosarcoma (n=20)	Fibromatosis/fibrosarcoma (n=19)	PNET (n=16)	P value
Age¶	43.5 [30.25–56]	35 [29–58]	24.5 [20–30]	0.004
Male gender	14 [70]	7 [36.8]	7 [43.8]	0.093
Presenting symptom	Mass [65]	Mass [60]	Pain [75]	–
FEV1¶	2.35 [2.02–2.60]	2.45 [2.10–2.62]	2.20 [1.90–2.65]	0.850
Anterior only location	6 [30]	10 [52.6]	3 [18.8]	0.193
Tumor size ≥5 cm	18 [90]	15 [78.9]	13 [81.3]	0.618
SM ≥2 cm¶	7 [35]	1 [5.3]	5 [31.3]	0.064
Least SM¶	0.75 [0.10–3]	0.40 [0.10–1]	1.25 (0.28–2.38)	0.100
+ve margin	8 [40]	10 [52.6]	3 [18.8]	0.118
Bony least SM	3 [15]	1 [5.3]	0 [0]	0.208
High grade [2–3]	8 [40]	1 [5.3]	15 [93.8]	<0.001
Tumor size	8 [6.63–15.75]	8 [6–13]	7 [5–14.75]	0.608
Multiplicity	3 [15]	3 [15.8]	3 [18.8]	0.952
No. of excised rib¶	3 [0–3]	3 [1.5–3.75]	1 [0–2]	0.039
Lung resection	1 [5]	1 [5.3]	1 [6.3]	0.986
Metastatic recurrence (MR)	1 [5]	1 [5.3]	6 [37.5]	0.008
Lung MR*	1[5]	1 [5.3]	5 [31.3]	0.042
EBL¶	875 [500–1,650]	750 (500–1,612.5)	1,000 [500–1,200]	0.393
Complications	4 [20]	3 [15.8]	2 [12.5]	0.830
Neoadj treatment	1 [5]	1 [5.3]	13 [81.3]	<0.001
Adjuv. treatment	8 [40]	10 [52.6]	14 [87.5]	0.013
Survival data; months				
Median OS (95% CI)	57 (17.16–96.84)	58 (29.68–86.52)	10 (13.4–52.60)	C:F =0.561
				C:P =0.535
				F:P =0.121
Median DFS (95% CI)	24 (15.73–32.27)	36 (22.01–50)	24 (18.27–29.73)	C:F =0.057
				C:P =0.427
				F:P =0.173
Median follow up (IQR)	18 (2.73–52.50)	28.50 (12.80–58.78)	52.5 (39.75–68.40)	–

¶, P value obtained by ANOVA; C:F, chondrosarcoma *vs.* fibromatosis/fibrosarcoma P value; FEV1, forced expiratory volume in the 1st second; SM, surgical margin; EBL, estimated blood loss; OS, overall survival; CI, confidence interval; DFS, disease free survival.

Neoadjuvant/adjuvant therapy

Thirty-one (31.6%) patients had no adjuvant therapy. Adjuvant radiotherapy was given in 20 (20.4%) patients; 8 (40%) were fibromatosis/fibrosarcoma, 5 (25%) were chondrosarcoma, 3 (15%) were synovial sarcoma and 3 (15%) were dermatofibrosarcoma and 1 (1%) was osteosarcoma. Adjuvant chemotherapy was given in



Overall survival	0 months	12	24	36	48	60
PTs at risk (survival%)	98 (100)	64 (73.9)	46 (61)	32 (45.6)	25 (43.9)	13 (34.6)

Disease free survival	0 months	12	24	36	48	60
PTs at risk (survival%)	98 (100)	56 (65.2)	40 (50.5)	21 (27.5)	11 (17.5)	2 (7.7)

Figure 2 Kaplan Meier survival curves showing OS and DFS among the whole group. OS, overall survival; DFS, disease free survival.

26 (26.5%) patients; 10 (38.5%) were PNET, 6 (23.1%) were osteosarcoma, 2 (7.7%) were synovial sarcoma and 1 (3.8%) of each of the followings: rhabdomyosarcoma, pleomorphic undifferentiated sarcoma, chondrosarcoma, fibrosarcoma, alveolar soft part sarcoma, metaplastic carcinoma, adenocarcinoma and squamous cell carcinoma. Adjuvant chemoradiotherapy was given in 21 (21.4%) patients; 7 (33.3%) were pleomorphic undifferentiated sarcoma, 4 (19%) were PNET, 2 (9.5%) of each of the followings: chondrosarcoma, lymphoma and plasma cell myeloma and 1 (4.8%) of each of the followings fibromatosis, osteosarcoma, rhabdomyosarcoma and undifferentiated carcinoma.

Reconstruction

Primary closure was achieved in 52%of the cases. Forty-seven patients underwent reconstruction. Among them, MMM & pectoralis flap was achieved in 38.3%, Prolene mesh in 17%, MMM in 14.9%, split skin graft in 14.9%, attachment of the humeral head to the rest of clavicle in 6.4%, MMM & latissimus dorsi (LD) flap in 4.3% (*Figure 1*) and similarly Prolene mesh & pectoralis in 4.3%.

Morbidity, mortality and follow-up

Complications occurred in 17 (17.3%) patients; arrhythmia in 3 cases, bleeding in 3, both bleeding and arrhythmia in 1, chest infection in 6, effusion in 1 and wound infection in 3 cases.

There was one perioperative mortality (1.02%). The median follow-up was 36 months (IQR =11.5–60) for the whole group while it was 18 months (IQR =2.73–52.50) in Chondrosarcoma, 28.50 months (IQR =12.80–58.78) in fibromatosis/fibrosarcoma and 52.5 months (IQR =39.75–68.40) in PNET. Local recurrence (LR) developed in 35.7% of patients with median time to LR of 14.50 (6–34.25), while MR developed in 21.4% of patients (metastasis to the lungs in 13 cases, bone in 3, chest wall in 2, liver in 1, >1 site in 2 cases) with median time to MR of 19 (IQR =8–36) (*Table 1*).

The OS for the whole group at 1, 3 and 5 years was 73.9%, 45.6% and 34.6 % respectively and the median OS time was 33 months (95% CI, 21.8–44.2), while the median DFS was 24 months (95% CI, 19.6–28.4) (*Figure 2*).

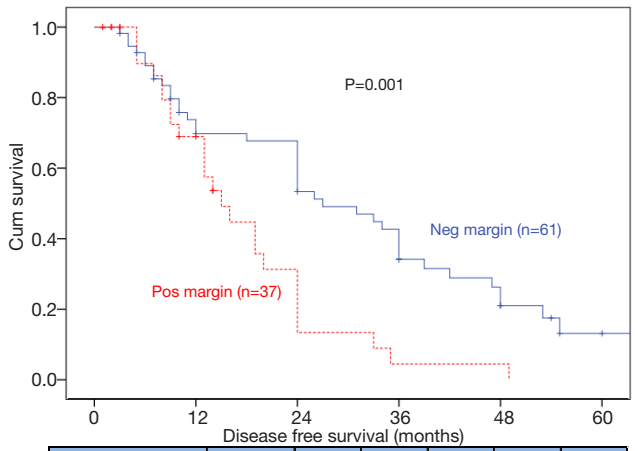
Predictors of DFS in univariate Cox regression analysis were –ve SM (HR =0.64, 95% CI, 0.50–0.82, P<0.001), tumor size ≥5 cm (HR =2.03; 95% CI, 1.04–3.98, P=0.039), high grade tumor (HR =1.66; 95% CI, 1.04–2.63, P=0.033), higher EBL (HR =1.0001; CI, 1.0001–1.001, P=0.003) and adjuvant treatment (HR =2.16; CI, 1.24–3.76, P=0.007); however, on multivariate analysis, the only independent predictor of DFS was the –ve SM (HR =0.54; 95% CI, 0.29–0.97, P=0.041) (*Table 3*).

The median DFS for +ve SM was 15 (10.5–19.5) *vs.* 27 (17.9–36.1) months for –ve SM (P=0.001; *Figure 3*).

Table 3 DFS predictors among our cohort (n=98)

Independents variables	Univariate predictors		Multivariate predictors	
	HR (95% CI)	P value	HR (95% CI)	P value
Age (continuous variable)	01.01 (0.99–1.02)	0.260		
Gender				
Female (n=51)	Reference			
Male (n=47)	1.05 (0.66–1.66)	0.837		
SM status				
Positive SM (n=37)	Reference		Reference	
Negative SM (n=61)	0.64 (0.50–0.82)	<0.001	0.54 (0.29–0.97)	0.041
Tumor size				
<5 cm (n=16)	Reference		Reference	
≥5 cm (n=82)	2.03 (1.04–3.98)	0.039	1.45 (0.67–3.18)	0.349
Tumor multiplicity				
Single (n=80)	Reference			
Multiple (n=18)	1.18 (0.89–1.57)	0.256		
FEV% (continuous variable)	0.80 (0.40–1.59)	0.521		
Lesion laterality				
Rt side (n=45)	Reference			
Lt side/midline (n=53)	0.99 (0.62–1.57)	0.948		
Grade				
Low (NA/G1; n=50)	Reference		Reference	
High (G2/G3; n=48)	1.66 (1.04–2.63)	0.033	1.56 (0.87–2.78)	0.135
Pathology				
Soft tissue (n=44)	Reference			
Bony (n=45)	1.12 (0.69–1.83)	0.645		
Others (n=9)	1.63 (0.77–3.43)	0.199		
Complications				
No (n=81)	Reference			
Yes (n=17)	0.94 (0.50–1.80)	0.860		
Lung resection				
No (n=87)	Reference			
Yes (n=11)	1.04 (0.50–2.17)	0.923		
EBL (continuous variable)	1.0001 (1.0001–1.001)	0.003	1.0002 (0.9998–1.001)	0.201
Adjuvant treatment				
No (n=31)	Reference		Reference	
Yes (n=67)	2.16 (1.24–3.76)	0.007	1.30 (0.63–2.68)	0.475

Note: variables with P value less or equal to 0.10 in univariate analysis were involved in MVA. DFS, disease free survival; SM, safety margin; FEV, forced expiratory volume; EBL, estimated blood loss; NA, not applicable grading as fibromatosis.



PTs at risk (survival%)	0 months	12	24	36	48	60
Negative margin	61 (100)	38 (73.8)	34 (67.7)	20 (42.7)	10 (26.3)	2 (12.1)
Positive margin	37 (100)	19 (69)	7 (31.3)	1 (4.5)	1 (4.5)	0 (0)

Figure 3 Kaplan Meier survival curves showing DFS among negative and positive surgical margin. DFS, disease free survival.

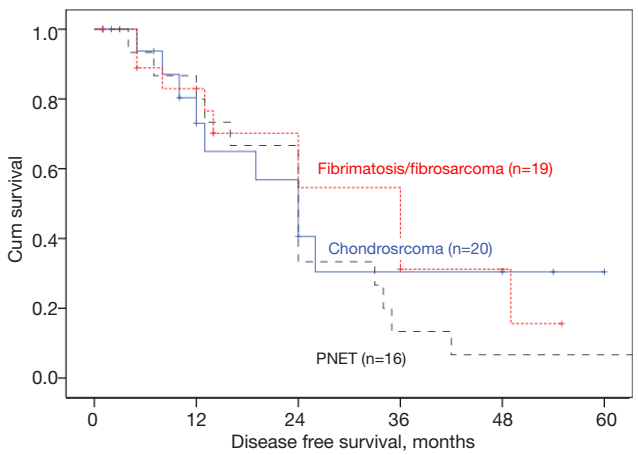


Figure 4 Kaplan Meier survival curves showing DFS among the commonest pathological subtypes in our cohort [the only nearly significant P value (P=0.057) between chondrosarcoma (n=20) and fibromatosis/ fibrosarcoma (n=19)]. DFS, disease free survival. PNET, primitive neuro-ectodermal tumor.

For Subgroup analysis, fibromatosis/fibrosarcoma had better median DFS of 36 (22.01–50) *vs.* 24 (15.73–32.27) months in chondrosarcoma (P=0.05, *Figure 4*), but no difference in OS (P=0.561) (*Table 2*).

Discussion

Chest wall tumors represent 5–20% of all thoracic malignancies in adult and children respectively. In children, Ewing's sarcoma is the most common chest wall tumor; while in adults chondrosarcoma predominates (2,15,16). In our study the figure for adult was confirmed and chondrosarcoma was found to be the most predominant pathological subtype.

There were 51 (52%) females among our series that is similar to that reported by Maeda *et al.* (17), but are slightly different than those reported by Hemmati *et al.* (18) who reported 41.77% were females, however his series main point was on resection of the chest wall metastasis.

Our cohort's median age of 39 (IQR =25–52.3) years was younger than most reported series that ranged from 49–64.8 years (17,19-22). The median age in Ewing's sarcoma was younger [24.5 years (20–30 years)] in comparison to the whole cohort to the prior series (15,23,24).

Pain was the most common symptom in PNET/Ewing's sarcoma (75%), osteosarcoma (57.1%), while mass was the most common symptom in chondrosarcoma (65%) and fibromatosis (60%). Similar to our results, Anderson and Burt found that the most common symptom for chondrosarcoma was mass, PNET/Ewing's sarcoma was pain, but they found that the most common symptoms for osteosarcoma were both mass and pain (3).

It is widely accepted that all tumors of the sternum should be considered as malignant until proved otherwise (25,26). In our series, seven cases underwent sternal resection; 2 were chondrosarcoma, 2 rhabdomyosarcomata, 1 adenocarcinoma, 1 metaplastic carcinoma and 1 solitary plasma cell myeloma.

Chest wall reconstruction is essential if there is resection of three ribs or more aiming for adequate stability and water and airtight closure of the chest cavity with acceptable cosmetic appearance. Bony reconstruction should be tailored to the extent of resection. Stabilization of the chest wall obviates the need for prolonged ventilation as patients are able to maintain their pulmonary function postoperatively (6,27). Muscle and musculocutaneous flaps are the tissues of choice to cover the wound, avoid or decrease the risk of infection, obliterate spaces and cover the synthetic mesh (28). In our study, chest wall reconstruction was done by the use of double layer Prolene mesh with or without bone cement that is covered either by rotational pedicle muscle flap (LD or serratus anterior) , that were chosen by proximity, knowing the arc of rotation and calculating the area of possible coverage, or covered by the local muscle flap (pectoralis major). In most cases, only a single muscle was transferred (27,29).

CWT resection is associated with a low major morbidity as long as reconstruction was done when indicated (1,8). Among our series, complication rate was 17.3% compared to 11–27% in the previous studies (1,30).

Resection of CWT has an acceptable risk of perioperative mortality from 0% to 7% (1,28,31-34), that was confirmed in our series with a perioperative mortality of 1.02%.

Prior reported series and meta-analysis in different cardiothoracic operations reported adverse survival with higher blood loss and intra-operative blood transfusion. In our series higher intra-operative EBL was associated with adverse DFS in univariate analysis but this was not sustained in the multivariate model (35-37).

Margin positivity (R1) was the most trivial and independent factor impacting survival in multivariate analysis. This runs in parallel to prior reported series in CWTs or other thoracic malignancies (30,38).

Conclusions

In primary malignant CWTs achievement of wide resection margins is of great importance to minimize the local tumor recurrence that will have an adverse impact on long-term survival.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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