ISSN 1669-9106 MEDICINA (Buenos Aires) 0000: 00: 00-00

Original article

OUTCOMES AFTER SURGICAL TREATMENT OF CHEST WALL SARCOMAS

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Received: 19-XI-2025
Accepted: 28-IV-2026

Abstract

Introduction: Chest wall sarcomas are very rare even within an already rare disease and can arise from soft tissue, cartilaginous, or osseous components of the thoracic wall. Various locations can be affected needing different types of oncologic and reconstructive surgeries. Hence, treatment is challenging and requires a multidisciplinary specialized team.

Materials and methods: All patients with diagnosis of localized chest wall sarcomas between January 2014 and June 2025 primarily operated at our center or referred after treatment elsewhere were included. Demographic data and tumor characteristics were evaluated (type of sarcoma, size, FNCLCC grade, neo/adjuvant treatment) as well as surgical outcomes (R classification). Overall survival (OS), local recurrence- (LRFS) and distant metastasis free survival (DMFS) were analyzed only for the chest wall soft tissue sarcoma (CWSTS) subgroup.

Results: A total of 17 patients with chest wall sarcomas underwent surgical resection, out of which 14 were primarily resected and 3 had previous resections elsewhere. Twelve patients (70%) had soft-tissue sarcomas (STS) and 5 (30%) bony sarcomas. All patients had macroscopic complete en bloc resections (94% R0 and 6% planned R1 margins). Four (24%) patients had superficial tumors and 13 (76%) had deep-seated sarcomas requiring 10 of them full-thickness resections. Median number of resected ribs per surgery was 3 (range, 1 – 3). For CWSTS subgroup, 5-years OS and LRFS were 81%.

Conclusion: In localized chest wall sarcomas, multidisciplinary en bloc surgical resection with clear margins by a specialized team is key and led to good rates of local control.

Key words: chest wall sarcoma, soft tissue sarcoma, surgical treatment, reference center.

Resumen

Resultados después del tratamiento quirúrgico de los sarcomas de la pared torácica

Introducción: Los sarcomas de pared torácica son muy raros. Pueden originarse de los tejidos blandos, cartilaginoso u óseo y afectar diversas localizaciones, requiriendo diferente abordaje quirúrgico y técnicas reconstructivas. Por consiguiente, el tratamiento es complejo y se beneficia de un equipo especializado.

Materiales y métodos: Se incluyeron pacientes con sarcomas de pared torácica operados entre enero-2014 y junio-2025. Se evaluaron datos demográficos y características del tumor (tipo de sarcoma, tamaño, grado FNCLCC, tratamiento neo/adyuvante), así como los resultados quirúrgicos (*R classification*). La supervivencia global (SG), la supervivencia libre de recidiva local (SLRL) y la supervivencia libre de metástasis a distancia (SLMD) se analizaron únicamente en el subgrupo de sarcoma de partes blandas (SPB).

Resultados: Diecisiete pacientes fueron operados; 14 presentaron lesiones primarias mientras que 3 habían sido resecados previamente en otro centro. Doce (70%) presentaron sarcomas de partes blandas y 5 (30%)

sarcomas óseos. En todos se realizaron resecciones macroscópicas completas (94% con márgenes R0 y 6% con margen R1 planeado). Cuatro pacientes (24%) presentaron tumores superficiales y 13 (76%) sarcomas profundos, 10 de ellos requirieron resecciones de espesor completo. La mediana de arcos costales resecados por cirugía fue de 3. Para el subgrupo de SPB, la SG y SLRL a 5 años fueron del 81%.

Conclusión: En los sarcomas localizados de pared torácica, la resección quirúrgica con márgenes libres por un equipo especializado es clave y conllevó una aceptable tasa de control local.

Palabras clave: sarcoma de pared torácica, sarcoma de partes blandas, tratamiento quirúrgico, centro de referencia

KEY POINTS
Current knowledge

- Chest wall sarcomas are very rare. Various locations can be affected, and different types of surgeries might be needed. Treatment by a specialized sarcoma team is mandatory for better oncologic outcomes.

Article contribution to current knowledge

- Chest wall sarcoma surgery is challenging and usually needed different types of complex reconstructive techniques with acceptable morbidities. For CWSTSs, we had good oncological outcomes after a prolonged follow-up. Individualized care with a multidisciplinary sarcoma team and collaboration between different specialties needs to be considered upfront the surgical plan.

Glossary of abbreviations

OS: Overall survival
LRFS: Local recurrence free survival
DMFS: Distant metastasis free survival
CWSTS: Chest wall soft tissue sarcoma
STS: Soft-tissue sarcomas
MDTB: Multidisciplinary tumour board
CPGs: Clinical practice guidelines

Primary chest wall sarcomas are uncommon (0.04% of newly diagnosed cancers) even within an already rare disease. These malignancies can arise from soft tissue, cartilaginous, or osseous components of the thoracic wall. Soft-tissue sarcomas (STS) account for 1% of all adult malignancies and there are more than 100 histological subtypes with different patterns of clinical behaviors[1]. More specifically, chest wall soft-tissue sarcomas (CWSTSs) represent only a few percentages of them. Clinically, they may present as painful masses or as slow-growing, painless lesions that can reach substantial size before detection[2, 3]. They represent an oncologic and surgical challenge.

Aggressive surgical en bloc resection with negative margins remains the cornerstone of treatment for localized disease, often requiring complex chest wall reconstructions. Depending on several factors, multimodal preoperative or postoperative approaches can be used to improve local control and long-term survival outcomes. Importantly, specialized multidisciplinary teams should carry out the treatment of sarcoma patients after multidisciplinary tumor board (MDTB) discussions preferably in reference centers. Different studies have already shown the benefits of this management[4-6].

The present study aims to analyze our institutional experience in managing primary and recurrent chest wall sarcomas. We sought to describe the surgical procedures performed as well as to describe the complex reconstruction methods if needed and morbidities associated. Secondarily, we analyzed the oncological outcomes of definitive surgery in terms of overall survival (OS) and local recurrence free survival (LRFS) in the CWSTSs subgroup.

Materials and methods

All adult (age ≥ 18 years) patients with confirmed localized soft tissue sarcomas of chest wall initially managed at our center or referred after surgical treatment elsewhere between January 2014 and June 2025 were included.

In the analysis, referred patients were included only if complete history (including surgical and pathologic reports) could be obtained. Trunk and extremities/girdle sarcomas, head and neck sarcomas, visceral sarcomas, retroperitoneal/pelvic sarcomas, spermatic cord/abdominal wall sarcomas with extension to thoracic wall and chest wall desmoid tumors were excluded. Data of initial tumor size was retrieved from pathologic report and was tabulated in cm. The R classification system was used to

define the quality of surgical margins throughout all patients of the study[7]. Macroscopically complete resection with no tumor cells in resection margins was considered R0. If microscopic tumor cells were identified at resection margin or at < 1 mm from inked surface was considered R1. Finally, R2 was considered as a macroscopic residual disease or tumor rupture in the first surgery. The histopathological grading was calculated using the French Federation of Cancer Centers Sarcoma Group (FNCLCC) grading[8]. All diagnosis of sarcoma performed outside were reviewed by our expert soft tissue pathologists.

As a specialized unit in the management of soft tissue sarcomas, all our patients are treated based on the recommendations of Clinical Practice Guidelines (CPGs) and after discussion in our sarcoma MDTB. Pre-operatory correct staging was defined if contrast-enhanced chest, abdomen and pelvis computed tomography (CT) and magnetic resonance imaging (MRI) of the affected site were performed. Re-excision surgery after inadequate margins outside a reference center is systematically considered and offered to patients (mainly if: high-grade [G2-3], deep and/or > 5 cm) after MDTB evaluation.

For survival analysis, the date of first surgery was considered the starting point. Local relapse free-survival (LRFS) was computed to the date of last follow-up (in person or telephone contact) or date of first local recurrence. Distant metastasis free-survival (DMFS) was computed to the date of last follow-up or date of systemic progression. Overall survival (OS) was considered to the date of last follow-up or death. Also, length of follow-up was calculated from the date of first surgery to last follow-up or death.

The primary end-point of our study evaluated the surgical and reconstructive procedures of all operated chest wall sarcomas and its postoperative morbidities. Secondarily, we sought to evaluate the outcomes after definitive surgery in terms of LRFS and OS in CWSTSs.

Statistical analysis

Statistical analysis was performed using Jamovi Computer Software (Version 2.4.12.0), Sydney, Australia. Continuous quantitative data are described using mean and standard deviation (SD) or median and interquartile range (IQR). Qualitative data described as absolute numbers with percentages. The Kaplan-Meier method was used for survival analysis.

Consent to participate: Due to the retrospective nature of this study, the Ethics Committee waived the requirement for written informed consent: however, all patients signed the surgical consent form.

Results

Demographics and tumor-related factors

During the study period, 14 (82%) patients with primary chest wall sarcomas were primarily resected and 3 (18%) patients had a re-resection after a previous resection with inadequate margins ('*whoops surgery*') performed elsewhere. We had a male dominance when distributed by sex (10:7, 58%), with a median age at presentation of 42 (range, 30.5 - 71) years. The majority (12/17, 70%) of the patients presented high-grade sarcomas. Twelve patients (70%) had soft-tissue sarcomas (STS) and 5 (30%) bony sarcomas. The most common soft-tissue histologic subtypes were myxofibrosarcomas (2/12, 16.5%), and undifferentiated pleomorphic sarcomas (2/12, 16.5%). The median tumor size was 6.7 (IQR, 3.25 - 10) cm. Baseline demographic and tumor characteristics are presented in *Table 1*.

Operative and perioperative outcomes

All patients underwent surgery with curative intent. Eight (8/17, 47%) patients had en bloc surgery associated with rib resection with a median of 3 (range, 1 – 3) resected ribs per surgery. Also, two patients required associated sternal resection, two patients underwent extended resection of diaphragm and one had a concomitant lung resection. Complex reconstructive procedures of the chest wall were performed in 11 (11/17, 65%) patients to cover large defects. Chest wall reconstructions were most commonly accomplished using permanent synthetic meshes (n = 7). In three cases, these were combined with bone cement (n = 3; methyl methacrylate placed between two mesh layers in a "sandwich" configuration). Finally, 2 cases required free flap reconstructions using anterolateral tight (ALT) flap to cover large soft tissue defects; in one patient also combined with rigid fixation with titanium bars.

Clear resection margins (R0 resection) were achieved in 13 (13/14, 92.8%) patients of the primary resection group and one patient had R1 resection. Of the patients with initial unplanned excisions ('*whoops surgery*'), residual disease was present in 33% (1/3) of the re-resection specimens. After re-resection surgery, final R-status was R0 for all patients (3/3). Only two (16.6%) patients with STSs received radiotherapy.

Tabla 1 | Demographic variables, tumor´s characteristics, treatment modalities and morbidities

	Chest wall sarcomas n = 17
Sex, n (%)	
Male	10 (58)
Female	7 (42)
Age, median (IQR)	42 (30-71)
Tumor size in cm, median (IQR)	6.7 (3.25-10)
Depth, n (%)	
Superficial	4 (24)
Deep	13 (76)
Histopathology, n (%)	
DDLPS	1 (6)
LMS	1 (6)
UPS	3 (17)
MFS	2 (12)
MPNST	1 (6)
DFSP	2 (12)
Others*	7 (41)
FNCLCC Grade, n (%)	
1	5 (29.5)
2	7 (41)
3	5 (29.5)
Perioperative treatments, n	
Posperative RT	3
Preoperative QT	1
Margins of definitive surgery, n (%)	
R0	16 (94)
R1	1 (6)
R2/Rupture	0
Complications (Clavien-Dindo), n (%)	
Total	3 (17.5)
IIIa	0
IIIb	1 (6)
IV	0

DDLPS: dedifferentiated liposarcoma; LMS: leiomyosarcoma; UPS: undifferentiated pleomorphic sarcoma; MFS: myxofibrosarcoma; MPNST: malignant peripheral nerve sheath tumor; DFSP: dermatofibrosarcoma protuberans; FNCLCC: French Federation of Cancer Centers Sarcoma Group; RT: radiotherap
**Others: chondrosarcoma (4), osteosarcoma (1), radio-induced angiosarcoma (1), myofibroblastic sarcoma (1)*

Two post-operative minor complications (2/17, 11.7%) were registered. One patient presented temporary vocal cord paralysis and another patient required optimization of analgesia due to poor pain management. We had one mayor complication (1/17, 6%) in a patient that presented surgical site infection and required surgical toilette and antibiotic therapy.

Long-term outcomes for chest wall soft-tissue sarcomas

Two patients (≥10 cm, T3 high-grade sarcomas) presented systemic pulmonary metastasis (one associated with bone metastasis) and died of their disease. Two (2/12, 16%) had a local recurrence: one after a complete R0 primary surgery and other after a clear margins re-resection surgery following an unplanned excision (having residual disease in the pathology report). In both patients a new surgery was performed achieving negative margins and received radiotherapy. Both are now disease free. With a median follow up of 60 (IQR, 26 – 76) months, the 5-year overall survival and local recurrence free survival was 81.8% and 81.8% (95%CI, 61.9%-100%), respectively (Figs. 1 and 2).

Discussion

In the present study we analyzed a series of operated chest wall sarcomas in a reference center. We had a predominance of CWSTSs with a 5-year LRFS and OS of 82% after a median follow-up of 60 months.

Chest wall sarcomas are very rare, comprise a wide variety of histological subtypes and various locations can be affected needing different types of oncologic and reconstructive surgeries. Available large cohort studies and review articles are scarce. Hence, data regarding incidence, prevalence and perioperative management is not clear. In our country there is no information published about CWSTSs.

Quality of initial surgery is the most important prognostic factor for local disease control in trunk and extremity soft tissue sarcomas[9-11]. The same core principle is applied for chest wall sarcomas being wide en bloc resection with negative margins the mainstay of treatment in patients with localized disease[12]. Chest wall sarcoma surgery usually includes resection of bony structures and occasionally can extend to other thoracic organs such as lung or diaphragm. In our study, 4 (24%) patients had superficial tumors while 13 (76%) had deep-seated sarcomas requiring 10 of them full-thickness resections to achieve negative margins. But other factors besides status of resection margins influence

Figure 1 | Overall survival (Kaplan-Meier) for chest wall soft tissue sarcoma (n = 12)

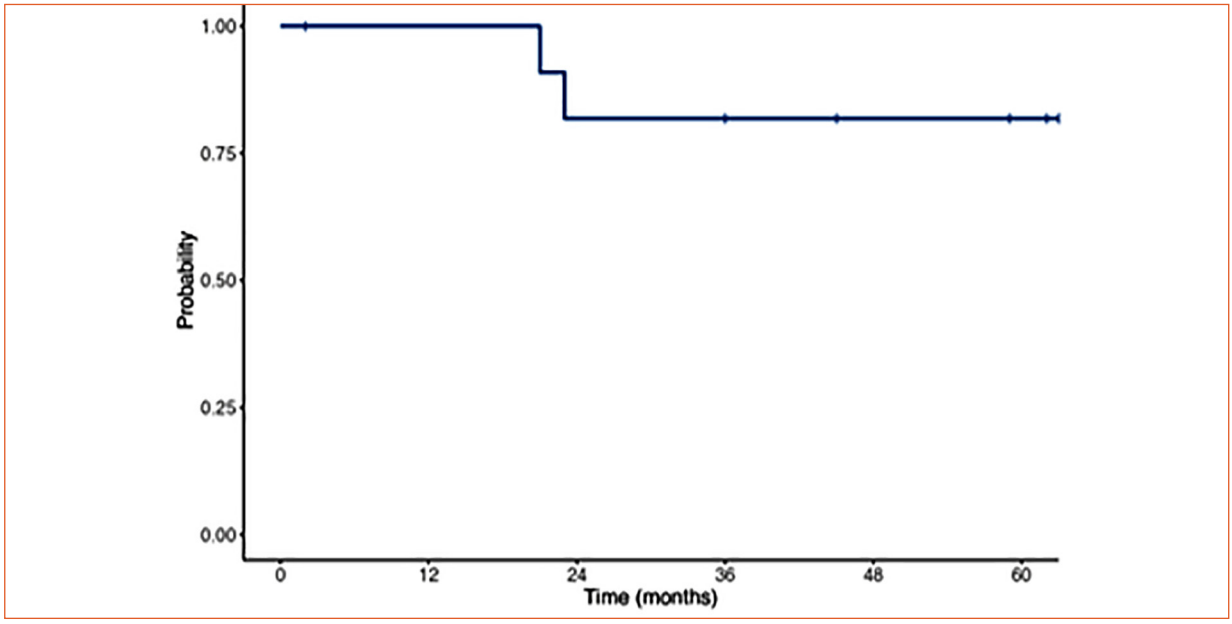
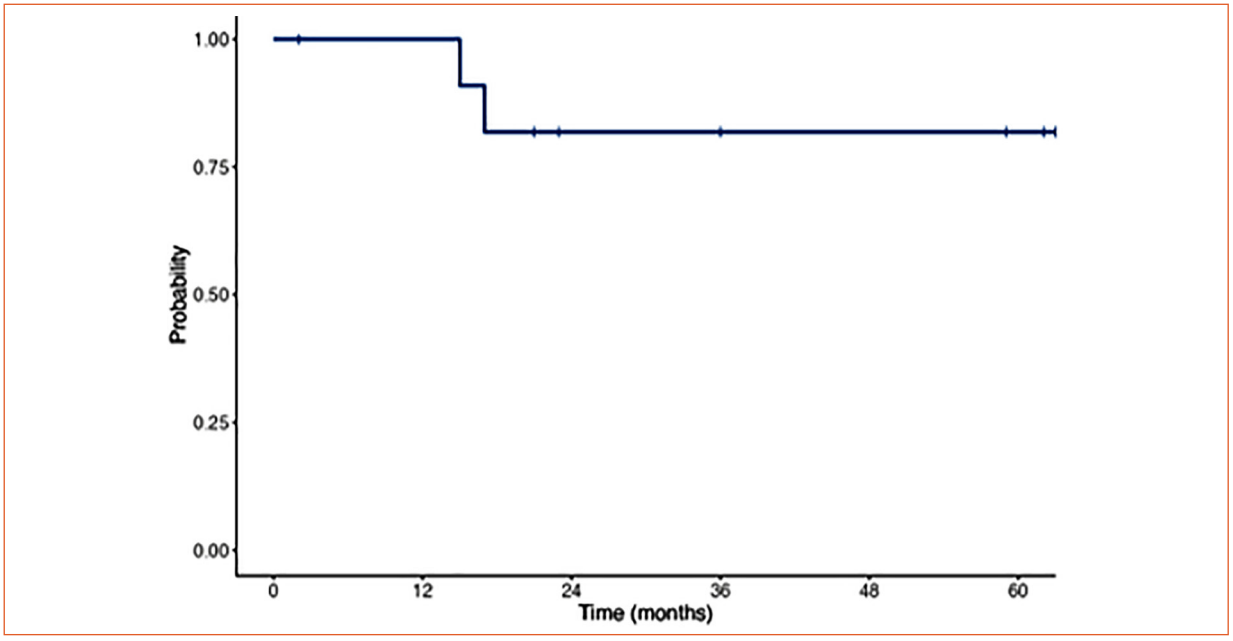


Figure 2 | Local recurrence free survival (Kaplan-Meier) for chest wall soft tissue sarcoma (n = 12)



survival, including histologic type and grade. Shewale et al., analyzed predictors of survival after 121 resections of primary chest wall sarcomas. The cohort analyzed included bone sarcomas (50.4%) and desmoid fibromatosis. The majority were high-grade sarcomas (63.6%) and R0 resection margins were achieved in 85% of patients. The 5-year overall survival rate was 60% and after multivariate analysis, high-grade and incomplete resections were associated with worse overall survival[13]. Similar results are described in other similar heterogeneous series that

included both bony and soft-tissue sarcomas[14, 15]. Nakahashi et al, analyzed the surgical outcomes of 38 patients with CWSTSs. With a 79% of R0 resections and 87% of high-grade sarcomas, they reported a 5-year OS of 45% and identified tumor size and surgical margins as predictors of survival in multivariate analysis [16]. In our study, most of the patients (92.8%) had clear R0 resection margins with 70% of high-grade sarcomas. That could possibly explain the better OS we report when compared with other series.

Despite the main treatment remains the complete surgical excision, multimodal strategies can have additional value. This is especially discussed in high-risk STS (when tumor malignancy grade is high, greater than 5 cm in size and deep to the investing fascia). But due to its rarity, CWSTSs are not included in validated prognostic tools that are used frequently for shared decision-making. Hence, recommendations are made based on extrapolated results of trunk and extremity sarcomas studies[17, 18]. Despite the morbidity differences already known between pre- and postoperative radiotherapy, equivalent oncologic outcomes have been demonstrated[19]. In our cohort, few patients (25%) received postoperative RT which was the team preference. However, we acknowledge that preoperative RT can offset the negative prognostic impact of a microscopically positive margin when is planned in advance on a critical structure. Systemic therapy (neo- or adjuvant) is not routinely indicated in localized chest wall soft tissue sarcomas and depends on MDTB discussion.

Complete surgical resection often results in large defects of the thoracic wall, either complete or partial in thickness and the exposition of intra-thoracic organs may become a main issue. Primary reconstruction should aim to protect structures bringing full soft tissue coverage and secure an adequate chest wall biomechanics of breathing. The treatment of sarcomas frequently needs a multidisciplinary experienced surgical team capable of not only complex resections but also reconstructions of both soft tissues and bony structures. It is reported that only a small part of chest wall sarcomas do not require full-thickness resections (in our study 34%). When performed, depending on size and location, different options can be chosen. After anterior or large lateral resections osteosynthesis materials or synthetic meshes are necessary to maintain chest wall stability. While to reconstruct soft tissue defects pedicled flaps (i.e fasciocutaneous, myocutaneous, muscular) or free flaps can be used. Reconstruction is a key point of sarcoma surgery and should be discussed upfront during the surgical planning for better oncological and functional results[20, 21].

Sarcoma care should be performed guided by CPGs to achieve better outcomes. Moreover, multidisciplinary treatment in high-volume reference centers is strongly advised and improves adhesion to CPGs[22-24]. Additionally, debate in MDTB is associated with better quality of surgery and relapse-free survival[5]. In our study, all patients were treated upon discussion within a specialized MDTB. Of note, of the 3 patients who had re-resection surgery after an unplanned excision, one underwent a full-thickness resection and two needed complex thoracic reconstructions. All three were T1 superficial sarcomas and can be hypothesized that a primary surgery in a specialized unit could have avoided this situation. Inexperience in primary care can lead to delayed referrals or inadequate excisions. As soon as sarcoma is suspected clinically, it is better that further diagnostics be made by a specialized sarcoma surgeon[25]. Individualized care in a reference sarcoma and thoracic surgery center is strongly advised in chest wall sarcomas[26].

This study has several limitations: it is a retrospective single-center study with a limited number of patients. Despite all this, to the best of our knowledge, this is the first national series to report the oncological results of chest wall sarcomas with an appropriate long-term follow-up by a specialized sarcoma team. We think our retrospective information brings valuable insight and encourages making collaborative efforts in this rare pathology.

Conflict of interest: None to declare

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