Surgical Management of Chest Wall Sarcoma: A Tertiary Cancer Center Experience

Sagar Khatiwada[1], Binay Thakur[1], Manoj Tiwari[1], Shachee Bhattarai[1], Srijana Thapa[1], Ashish Kharel[1], Mahesh Mani Adhikari[1], Sandeep Sapkota[1]

[1]Department of Surgical Oncology. BP Koirala Memorial Cancer Hospital, Bharatpur, Nepal.

Abstract

Background: Chest wall sarcoma is an uncommon condition, accounting for less than 5% of all thoracic neoplasms. It can arise from bone, cartilage, or soft tissues, depending on its tissue of origin. The most effective treatment approach is surgical resection with adequate margins. Recent research indicates that chemotherapy, whether administered as an adjuvant or neoadjuvant, may improve both overall survival and disease-free survival. This study focuses on examining common histological types, surgical approaches, post-surgical chemotherapy, reconstruction methods, and overall survival outcomes.

Methods: Our study included patients who had undergone surgical management for chest wall sarcoma at our center since 2005 to 2020. Data from 39 consecutive patients were collected and entered into the Statistical Package for the Social Sciences (SPSS 16) for analysis.

Results: Among 39 patients, the average age was 36 years, with 61% being male. 41% of patient presented delayed with mass size of >10 cm. While 46% underwent surgery alone, 54% received surgery combined with multimodal treatment (radiation and chemotherapy). The median survival was 89 months. Patients with low-grade sarcoma had a significantly better overall survival (Log rank, P<0.01). Although the Ewing's sarcoma group had the poorest mean survival at 74 months, and the overall median survival could not be determined for this group, no statistically significant difference in overall survival was observed among sarcomas of different tissue origins.

Conclusion: Chest wall sarcomas represent a varied group of tumors. In this study, chondrosarcoma and Ewing's sarcoma were the most frequent types but exhibited the lowest survival rates, primarily due to high grade tumors at diagnosis. Effective management necessitates a multidisciplinary approach, including aggressive surgical resection to achieve R0 margins. Chest wall reconstruction should aim to restore structural and functional integrity with minimal complications. High-grade tumors are associated with poorer survival, that require multidisciplinary team approach.

Keywords: Chest wall sarcoma, Chondrosarcoma, Ewing's sarcoma

Introduction

Chest wall sarcoma is a rare malignancy, accounting for less than 5% of all thoracic tumors.[1] It originates from bone, cartilage, or soft tissues, with chondrosarcoma being the most common subtype.[2-4] Prognostic factors such as age, sex, tumor histology, grade, resection margin status, and adjuvant treatment have been extensively studied.[5, 6] A phase III Italian trial demonstrated improved survival with chemotherapy in high-grade, large (>5 cm)

Corresponding Author:
Dr. Sagar Khatiwada , Department of surgical oncology (Thoracic unit), BP Koirala memorial cancer hospital Bharatpur, Nepal . Email: sagarkhatiwada2064@gmail.com, Phone: +977-9855016661

resectable or recurrent sarcomas, though overall survival impact remains debated.[7] Surgery with R0 resection is the primary and most durable treatment, with a recommended margin of 1.5 cm.[3] High-grade tumors and advanced-stage disease benefit from multimodal therapy, including radiation and chemotherapy, especially in cases of microscopically positive margins.[8-10]

Soft tissue sarcomas (STS) represent about 1% of adult malignancies, with over 70 subtypes, each influencing treatment and prognosis.[11] Undifferentiated pleomorphic sarcoma (UPS), previously termed malignant fibrous histiocytoma, accounts for 11–17% of STS and is rare in the chest wall.[12] Rhabdomyosarcoma, including embryonal and alveolar types, requires complete excision, with adjuvant chemo-radiotherapy for positive margins.[13]Post-resection, chest wall defects are reconstructed using prolene mesh, titanium plates, or muscle flaps to ensure functional stability and R0 resection. [14, 15]

Ewing's sarcoma is more responsive to both chemotherapy and radiation, making these treatments integral to its management, whereas osteosarcoma relies more heavily on surgical resection with chemotherapy as a supplementary approach.[16]

In Nepal, the prevalence of chest wall sarcoma is poorly documented, though BP Koirala Memorial Cancer Hospital, a central referral center, manages a significant number of cases. Data on treatment strategies, prognosis, surgical complications, demographic profiles, and survival outcomes are scarce. This study aims to address these gaps, standardize treatment approaches, and provide valuable insights into chest wall sarcoma management.

Methodology

This study was a single-center, hospital-based, retrospective observational study conducted at BP Koirala Memorial Cancer Hospital (BPKMCH). The study period spanned from 2005 to 2020, utilizing data from a prospectively maintained database in the Department of Thoracic Surgery. Approval was obtained from the Institutional Review Committee of BPKMCH prior to initiating the research. Informed consent was acquired from all participants in accordance with hospital protocols.

A total of 120 patients underwent chest wall resection due to primary chest wall tumors, metastatic tumors, or invasion of the chest wall by adjacent breast or lung cancers. Of these, 39 cases involving primary chest wall sarcomas were included in the study. Inclusion criteria comprised patients diagnosed with chest wall sarcoma who underwent surgical treatment at our department. Exclusion criteria included tumors of the breast, primary lung tumors, and patients lost to follow-up before 6 months.

Data reviewed encompassed demographic profiles, clinical presentations, treatment modalities (surgery, chemotherapy, and radiotherapy), techniques for chest wall reconstruction, surgical approaches, and postoperative outcomes. Outcome measures included histological types, tumor grading, resection margin status, and disease-free survival analysis.

Surgical principles adhered to a minimum resection margin of 2.5 cm for non-osseus lesion while 4 cm for osseus lesion. Reconstruction was not required if fewer than three ribs were resected. For bony defects larger than 5 cm in the anterior or anterolateral chest wall, Prolene mesh was used for reconstruction. In cases of posteriorly located tumors (anterior to the scapula), defects larger than 10 cm required Prolene mesh repair. When combined resection of the sternum and ribs was necessary, titanium plates were utilized.

For soft tissue coverage, a pedicled pectoralis major (PM) flap was employed for anterior or anterolateral defects. For larger defects of any size in lateral or posteriorly located lesions, a latissimus dorsi (LD) pedicled flap was used.

Statistical analysis was performed using SPSS version 16. Descriptive statistics were used to calculate medians and frequencies. Survival analysis was conducted using the Kaplan-Meier method, and univariate analysis of factors influencing survival was performed using the log-rank test. A p-value of <0.05 was considered statistically significant.

Results

In this study of 39 patients, the mean age was 36 years, with 61.5% being male. Soft tissue sarcoma accounted for 41% of cases, while the remaining 59% originated from bone or cartilage. Chondrosarcoma was the most prevalent histological type, observed in 28% of cases, followed by Ewing's sarcoma in 18%. The distribution of histological types is detailed in the accompanying table 2.

Histological grading revealed that 41% of cases were grade I, while 36% were grade III. On final histopathological evaluation, 97% of patients achieved an R0 resection margin.

For skeletal reconstruction, Prolene mesh was utilized in 51% of cases, while a titanium reconstruction plate was used in 5%. For soft tissue defects, the contralateral pectoralis muscle flap was the most commonly employed method for closure.

The median survival was 89 months. Survival outcomes are illustrated in Kaplan-Meier curves (Figure 2), depicting the impact of histological grade on overall survival. It showed statistically significant difference in overall survival of patient with grading of tumor evaluated by Log rank test with P-value of <0.001. Estimated mean survival of Grade I was 245 months, Grade II was 49 months and Grade III was of 29 moths respectively.

The Kaplan-Meier survival analysis of different histological types of tumor presented in Figure 3 revealed that soft tissue sarcoma and chondrosarcoma were associated with the longest mean survival times, at 135 and 125 months, respectively. Conversely, Ewing's sarcoma demonstrated the shortest mean survival duration (79 months) and failed to attain the median survival of 89 months. However, the log-rank test did not show a statistically significant difference among the groups, with a p-value of 0.821.

Regarding histological types, the median survival for soft tissue sarcoma was 50 months, while chondrosarcoma had a median survival of 89 months. Ewing's sarcoma and osteosarcoma exhibited poor overall survival, with median survival not reached for these subtypes.

Surgery alone was considered in 46.1% of cases while remaining patients received with multimodality treatment as detailed in subsequent table. Mean hospital stay was 12 days and intraoperative blood loss was 160 ml.

Discussion

Chest wall sarcomas can originate from bone (e.g., osteosarcoma, chondrosarcoma, Ewing's sarcoma) or soft tissue (e.g., liposarcoma, undifferentiated pleomorphic sarcoma, rhabdomyosarcoma, fibrosarcoma).[4] Chondrosarcoma, the most common bone sarcoma,[2-4] is primarily treated with surgery for non-metastatic cases due to its resistance to radiation. Radiotherapy is used for high-grade, de-differentiated, or mesenchymal variants, or with positive resection margins. Chemotherapy is generally ineffective for chondrosarcoma, except for mesenchymal subtypes.[17-19]

Table: 1 Demographic profile, surgical techniques, and postoperative complications of the participants N=39		
Mean age		36 years
Sex	Male	N=24 (61.5%)
	female	N=15 (38.5%)
Smoking		N=31 (79.6%)
Alcoholic		N=6 (15.4%)
Mean duration of mass		10.2 months
Clinical Presentation	Mass	N=35 (89.7%)
	Pain	N= 30 (76.9%)
	Cough	N=9 (23.1%)
Size of mass at Presentation	≤ 5 cm	N=11 (28.2%)
	6-10 cm	N=12 (30.8%)
	>10 cm	N= 16 (41%)
Origin of Mass	Soft tissue	N=18 (46.15 %)
	Ribs	N=16 (41.02%)
	Sternum	N= 4 (10.4%)
	clavicle	N=1 (2.56%)
Location of mass	sternal region	N= 6 (15.4%)
	anterior chest wall	N= 15 (38.5%)
	lateral chest wall	N= 16 (41%)
	posterior chest wall	N= 1 (2.6%)
	Paravertebral	N=1 (2.6%)
Treatment modality	Surgery alone	N=18 (46%)
	Surgery and ACT	N=11 (28.2%)
	Surgery and ART	N=2 (5.12%)
	Surgery and ACRT	N= 1 (2.56%)
	NACT-Surgery-ACT	N= 5 (12.8%)
	NACT-Surgery-ART	N= 1 (2.56%)
	NART-Surgery-ACT	N=1 (2.56%)
Reconstruction	None	N=6 (15.4%)
	Soft tissue flap	N= 10 (25.6%)
	Prolene only	N=6 (15.4%)
	Soft tissue and Prolene	N= 14 (35.9%)
	Reconstruction plate and soft tissue	N= 2 (5.1%)
	Autologous ribs and soft tissue	N=1 (2.56%)
Post operative complications	None	N=24 (61.53%)
	Wound complications (seroma, skin necrosis, wound gap)	N=12 (30.76%)
	Partial graft loss	N=1 (2.56%)
	Pneumonia	N=1(2.56%)
	Flail chest and death	N=1(2.56%)

NOTE: ACT= Adjuvant chemo therapy, ART = Adjuvant radiation therapy, NACT= Neoadjuvant chemotherapy, NART= Neoadjuvant radiotherapy, ACRT= Adjuvant chemotherapy and radiotherapy.

Table: 2 Final Histopathological characteristics of tumor		
Histological types	Chondrosarcoma	N=11 (28.2%)
	Fibrosarcoma	N= 4 (10.3%)
	Liposarcoma	N= 2 (5.1%)
	Ewing's Sarcoma	N=7 (17.9%)
	Osteosarcoma	N=4 (10.3%)
	Rhabdomyosarcoma	N= 5 (12.8%)
	Synovial sarcoma	N=1 (2.6%)
	Undifferentiated pleomorphic sarcoma (UPS)	N=3 (7.7%)
	Dermatofibrosarcoma Protuberens (DFSP)	N=2 (5.1%)
Histological grades	Grade I	N=16 (41%)
	Grade II	N=9 (23.1%)
	Grade III	N=14 (35.9%)
Resection Margin	R0	N= 38 (97.4%)
	R1	N=1 (2.56%)

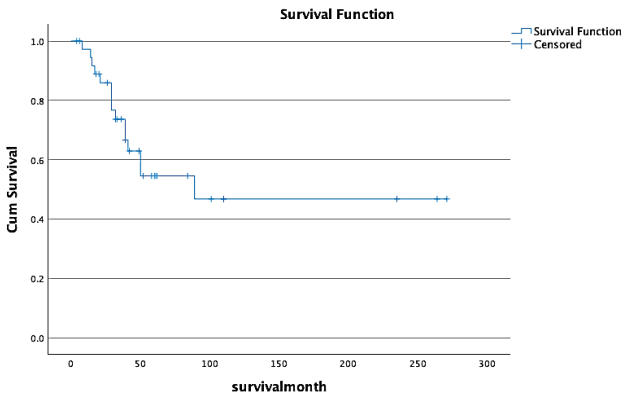

Figure 1: Kaplan Meier Survival curve shows median overall survival of 89 months.

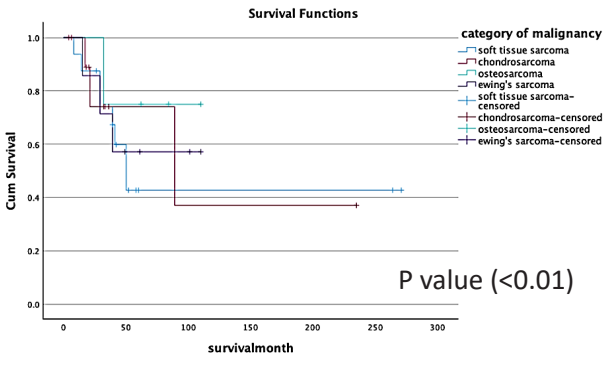

Figure 2: Kaplan Meier curve showing overall survival of patient based upon tumor grade.

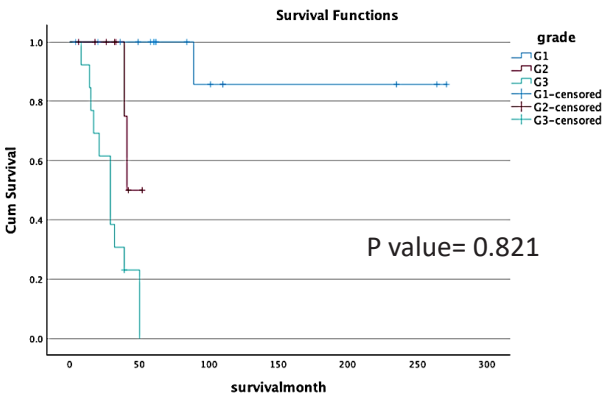

Figure 3: Kaplan-Meier Survival Curve by Histological Type of Sarcoma.

Osteosarcoma, arising from rapidly growing bones, responds well to chemotherapy, which targets microscopic deposits post-surgery.[20] Common subtypes include osteoblastic, fibroblastic, and chondroblastic. Despite surgery, 80% of osteosarcoma and Ewing's sarcoma patients develop metastases, but adjuvant chemotherapy has improved 5-year survival rates from 20% to 60%.[20] Neoadjuvant chemotherapy helps shrink tumors and guides personalized treatment usually considered in high grade tumor, or in cases where personalized implant preparation time is longer. Radiation is rarely used, reserved for cases with debility, positive margins, or small cell variants when chemotherapy fails.[20, 21]

Ewing's sarcoma is sensitive to both radiotherapy and chemotherapy, requiring multimodality treatment. Patients typically receive neoadjuvant chemotherapy, with resection if the tumor is resectable. Positive resection margins are followed by concurrent chemoradiotherapy and adjuvant chemotherapy. Unresectable cases are treated with definitive chemoradiotherapy.[16]

Prognostic factors for soft tissue sarcoma include tumor size and histological grade.[5, 6] Neoadjuvant chemotherapy is reserved for high-grade or recurrent tumors.[4, 5, 8, 19] Lymph node metastasis

is rare in adults (<5%), so lymphadenectomy is only considered for clinically or radiologically evident nodes >1 cm.[22, 23] Positive resection margins warrant re-resection if feasible; otherwise, radiotherapy is used.[23, 24] Only surgery is sufficient if sarcoma are Small (<5 cm), low-grade, superficial, or intramuscular tumors.[23]

Undifferentiated pleomorphic sarcoma (formerly malignant fibrous histiocytoma) is the most common soft tissue sarcoma variant, lacking specific differentiation. It has a high recurrence risk. En bloc resection with a 2 cm margin is standard, often after neoadjuvant chemoradiotherapy for high-grade or large (>10 cm) tumors. Adjuvant radiotherapy is used for positive margins, or invasion of nerves, bones, or vessels.[12]

Rhabdomyosarcoma (alveolar, pleomorphic, embryonal) is highly chemotherapy-sensitive. FOX-1 fusion status determines risk stratification. Radiation is used in all cases, with surgery as the primary treatment if complete resection is possible.[13]

Liposarcoma is primarily treated with surgical resection. Myxoid liposarcoma is highly radiosensitive, often showing significant response to preoperative radiotherapy.[6]

Surgery with microscopic negative margins (R0 resection) is the primary treatment for chest wall sarcoma, ensuring oncologically safe margins, functional skeletal stability, and soft tissue defect closure with functional and cosmetic acceptability.[4, 8, 25]

For sternal tumors, titanium reconstruction plates were utilized in 5.1% of cases, and autologous rib placement was used in one case, achieving acceptable functional stability. Polypropylene mesh was employed in 51.4% of cases for lateral chest wall defects requiring resection of more than three ribs. Soft tissue defects were reconstructed using latissimus dorsi or pectoralis muscle flaps as advocated in different studies.[14, 23] Crowley et al. advocated polypropylene mesh alone if ≤2 ribs excision, and if ≥3 ribs excised they advocated sandwich therapy with bone cement on polypropylene mesh.[14] Yang H et al. advocated titanium mesh for skeletal stability.[15]

In our series, most patients presented late, with 41% having tumors larger than 10 cm. Surgery alone was performed in 46% of cases, primarily for low-grade, small, superficial tumors without perineural or vascular invasion, achieving R0 resection.

Neoadjuvant chemotherapy (NACT) was administered in 15.38% of cases, including osteosarcoma and one Ewing's sarcoma with a large tumor size where effective radiation dosing was not feasible. Neoadjuvant radiotherapy was used in one case of Ewing's sarcoma due to its high sensitivity to radiation therapy. Similar recommendation is made by Van Roozendl et al.[8, 23]

Regarding postoperative complications, wound-related issues such as seroma occurred in 31% of cases. One patient who underwent large sternal excision with Prolene fixation died due to flail chest, prompting a recommendation for using reconstruction plates in all sternal resection cases.

Kaplan-Meier analysis revealed that higher tumor grades were associated with poorer overall survival, consistent with findings from other studies.[3-6, 8, 25] The median survival of 89% was achieved in chest wall sarcoma after multimodality treatment or surgery alone. Similarly study carried out by Greager et el. Showed 10 years disease free survival of 86%, Park et al. showed 5 years survival of 73% while Gangopadhyay et al. showed 2 years survival of 74.7%.[3, 4, 25] Ewings sarcoma had worst overall

survival of 79 months. Study carried out by Gangopadhyay et al. also showed Ewing's sarcoma having worst prognosis of survival.[4]

Conclusion

Chest wall sarcomas are rare, with poorly defined prevalence and clinical profiles. Surgical resection with safe margins is the mainstay of treatment, supplemented by skeletal stabilization (mesh/reconstruction plates) and soft tissue flaps for defects. High-grade and large tumors require multimodality therapy. Titanium plates are recommended for sternal resection to prevent flail chest. Immunohistochemistry is crucial for personalized treatment. Further large-scale studies are needed to establish clear management guidelines.

References

1. Waszczynskyi CH, Guimarães MD, Franco LF, Hochhegger B, Marchiori E. Primary undifferentiated sarcoma in the thorax: a rare diagnosis in young patients. Radiol Bras. 2016;49(6):409-10.
2. Friesenbichler J, Leithner A, Maurer-Ertl W, Szkandera J, Sadoghi P, Frings A, et al. Surgical therapy of primary malignant bone tumours and soft tissue sarcomas of the chest wall: a two-institutional experience. International Orthopaedics. 2014;38(6):1235-40.
3. Park I, Shin S, Kim HK, Choi YS, Kim J, Zo JI, et al. Primary Chest Wall Sarcoma: Surgical Outcomes and Prognostic Factors. J Chest Surg. 2019;52(5):360-7.
4. Gangopadhyay A, Nandy K, Puj K, Sharma M, Jayaprakash D, Salunke A, et al. Primary chest wall sarcoma; a single institution experience of 3 years. Cancer Treat Res Commun. 2021;27:100326.
5. Nakahashi N, Emori M, Tsuchie H, Nagasawa H, Sonoda T, Takada K, et al. Treatment outcome of chest wall soft tissue sarcomas: Analysis of prognostic factors. Journal of Surgical Oncology. 2019;120(7):1235-40.
6. Tsukushi S, Nishida Y, Sugiura H, Nakashima H, Ishiguro N. Soft Tissue Sarcomas of the Chest Wall. Journal of Thoracic Oncology. 2009;4(7):834-7.
7. Gronchi A, Ferrari S, Quagliuolo V, Broto JM, Pousa AL, Grignani G, et al. Histotype-tailored neoadjuvant chemotherapy versus standard chemotherapy in patients with high-risk soft-tissue sarcomas (ISG-STS 1001): an international, open-label, randomised, controlled, phase 3, multicentre trial. Lancet Oncol. 2017;18(6):812-22.
8. Van Roozendaal LM, Bosmans JWAM, Daemen JHT, Franssen AJPM, van Bastelaar J, Engelen SME, et al. Management of soft tissue sarcomas of the chest wall: a comprehensive overview. Journal of Thoracic Disease. 2024;16(5):3484-92.
9. Ozaniak A, Galova D, Benesova I, Lischke R, Ozaniak Strizova Z. Treatment approaches and outcomes of major chest wall resections and reconstructions in patients with soft tissue and bone sarcomas: a retrospective observational study. Journal of Thoracic Disease. 2024;16(10):6863-78.
10. Rehmani SS, Raad W, Weber J, Lazarev S, Ayub A, Al-Ayoubi AM, Bhora FY. Adjuvant Radiation Therapy for Thoracic Soft Tissue Sarcomas: A Population-Based Analysis. The Annals of Thoracic Surgery. 2020;109(1):203-10.
11. Gamboa AC, Gronchi A, Cardona K. Soft-tissue sarcoma in adults: An update on the current state of histiotype-specific management in an era of personalized medicine. CA: A Cancer Journal for Clinicians. 2020;70(3):200-29.
12. Bennett C, Bharadwaj S, Arndt A, Chawla A. A systematic review of undifferentiated pleomorphic sarcoma of the chest wall. Chin Clin Oncol. 2023;12(6):66.
13. Saenz NC, Ghavimi F, Gerald W, Gollamudi S, LaQuaglia MP. Chest wall rhabdomyosarcoma. Cancer. 1997;80(8):1513-7.
14. Crowley TP, Atkinson K, Bayliss CD, Barnard S, Milner RH, Ragbir M. The surgical management of sarcomas of the chest wall: A 13-year single institution experience. J Plast Reconstr Aesthet Surg. 2020;73(8):1448-55.
15. Yang H, Tantai J, Zhao H. Clinical experience with titanium mesh in reconstruction of massive chest wall defects following oncological resection. J Thorac Dis. 2015;7(7):1227-34.
16. Salimbene O, Viggiano D, Muratori F, Lo Piccolo R, Facchini F, Tamburini A, et al. Primary Chest Wall Ewing Sarcoma: Treatment and Long-Term Results. Life (Basel). 2024;14(6).
17. Rascoe PA, Reznik SI, Smythe WR. Chondrosarcoma

of the thorax. Sarcoma. 2011;2011:342879.
18. Ersöz E, Evman S, Alpay L, Akyıl M, Vayvada M, Gürer D, et al. Chondrosarcoma of the anterior chest wall: surgical resection and reconstruction with titanium mesh. J Thorac Dis. 2014;6(10):E230-3.
19. Hadj dahmane m, Zairi S, Zribi H, Abdennadher M, Ayedi A, Attia M, et al. Management of chest wall chondrosarcoma: report of 15 cases. European Respiratory Journal.58(suppl 65):PA1983.
20. Mesko NW, Bribriesco AC, Raymond DP. Surgical Management of Chest Wall Sarcoma. Surg Oncol Clin N Am. 2020;29(4):655-72.
21. Burt A, Berriochoa J, Korpak A, Rodler E, Jones RL, Weisstein J, Patel S. Treatment of chest wall sarcomas: a single-institution experience over 20 years. Am J Clin Oncol. 2015;38(1):80-6.
22. Fong Y, Coit DG, Woodruff JM, Brennan MF. Lymph node metastasis from soft tissue sarcoma in adults. Analysis of data from a prospective database of 1772 sarcoma patients. Ann Surg. 1993;217(1):72-7.
23. Wang L, Yan X, Zhao J, Chen C, Chen C, Chen J, et al. Expert consensus on resection of chest wall tumors and chest wall reconstruction. Translational Lung Cancer Research. 2021;10(11):4057-83.
24. Wouters MW, van Geel AN, Nieuwenhuis L, van Tinteren H, Verhoef C, van Coevorden F, Klomp HM. Outcome after surgical resections of recurrent chest wall sarcomas. J Clin Oncol. 2008;26(31):5113-8.
25. Greager JA, Patel MK, Briele HA, Walker MJ, Wood DK, Gupta TKD. Soft tissue sarcomas of the adult thoracic wall. Cancer. 1987;59(2):370-3.