

Contemporary outcomes of surgical resection for chest wall chondrosarcoma



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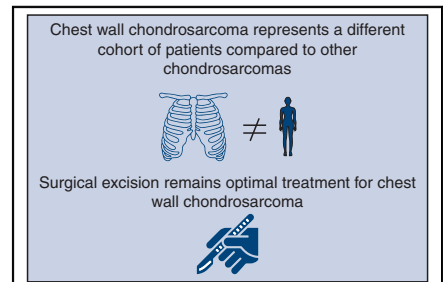
ABSTRACT

Objective: Chondrosarcoma is the most common primary malignant chest wall tumor and is historically associated with poor prognosis. Recommendations regarding surgical excision are on the basis of small, single-institution studies. We used a large national database to assess outcomes of surgery for chest wall chondrosarcoma (CWC) hypothesizing that surgical excision remains standard of care.

Methods: The National Cancer Databases for bone and soft tissue were merged to identify patients with chondrosarcoma from 2004 to 2018. Clinical and demographic characteristics of CWC were compared with chondrosarcoma from other sites. The primary outcome was overall survival described using Kaplan–Meier estimate. Univariable and multivariable Cox analysis was used to determine risk factors for poor survival among CWC patients who underwent surgery. Multivariable analysis of predictors of margin status was performed because of worse prognosis associated with positive margins.

Results: Among 11,925 patients with chondrosarcoma, 1934 (16.2%) had a CWC. Relative to other sites, CWC was associated with older age, male sex, White race, surgical resection, and care at a nonacademic institution. CWC was associated with 1-, 3-, 5-, and 10-year survival of 91.5%, 82.0%, 75.5%, and 62.7%, respectively. In univariable analysis, survival was associated with surgery (hazard ratio, 0.02; $P < .001$) and adversely affected by positive margins (hazard ratio, 2.66; $P < .001$). Multivariable analysis showed larger tumor size was independently associated with increased risk for positive margins (odds ratio, 1.04; 95% CI, 1.011–1.075).

Conclusions: CWC represents a different cohort of patients relative to chondrosarcoma from other sites. Surgical excision remains the optimal treatment, and positive margins are associated with poor prognosis. (JTCVS Open 2023;13:435–43)



Surgery is associated with improved survival for chest wall chondrosarcoma.

CENTRAL MESSAGE

Gold standard treatment of chest wall chondrosarcoma should include complete surgical resection with emphasis on obtaining negative surgical margins to improve patient survival.

PERSPECTIVE

Chondrosarcoma represents the most common primary malignant tumor of the chest wall. Treatment guidelines for CWC are largely on the basis of small, single-institution studies. In this study of a nationally representative database, surgical excision with negative margins was associated with significantly improved survival supporting current surgical recommendations for CWC.

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Although a rare entity, chondrosarcoma is the most common primary malignant tumor of the chest wall accounting for almost one-third of all primary chest wall malignancies.^{1,2} Chest wall chondrosarcomas (CWCs) typically present as a painful, slowly enlarging mass arising from either the ribs (80%) or sternum (20%).³ Most are solitary lesions that have been present for an average of 18 months before patients seek care.

Historically, CWCs have been associated with poor prognosis which is thought to be due to their aggressive biological behavior compared with chondrosarcomas originating from other locations of the body.⁴ Furthermore, treatment

Abbreviations and Acronyms

CoC	= Commission on Cancer
CWC	= chest wall chondrosarcoma
HR	= hazard ratio
NCDB	= National Cancer Database

for CWC remains challenging because these tumors are typically not responsive to radiation or chemotherapy. Because of this, treatment has remained primarily unchanged over time with radical surgical excision plus wide margins being the mainstay treatment for these patients.^{5,6}

Because of the rarity of CWCs, current surgical recommendations are on the basis of small series and single-institution studies which are subject to bias.^{1,7-10} In addition, margin recommendations for CWC are largely derived from data of sarcomas located in other areas of the body which might not be generalizable to tumors arising in the thoracic cavity. We believe that CWCs represent a clinical entity distinct from chondrosarcomas arising in other locations and therefore follow different treatment guidelines. The purpose of this study was to use a large, national database to assess the current trends and outcomes of surgery for CWC. We hypothesized that complete surgical excision with negative margins would continue to remain the standard of care for CWC.

METHODS

Data Source

The National Cancer Database (NCDB) is a joint project sponsored by the American College of Surgeons and the American Cancer Society. Data are collected from more than 1500 facilities accredited by the Commission on Cancer (CoC) and data on approximately 70% of all newly diagnosed cancer cases across the nation are captured.¹¹

The CoC NCDB and the hospitals participating in the CoC NCDB were the source of deidentified data used in this study. This registry includes data on patient demographic characteristics, the American Joint Committee on Cancer staging, tumor characteristics, surgical therapy, and neoadjuvant and adjuvant therapy. The CoC and participating hospitals in the CoC NCDB have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors. This study was determined to be exempt from institutional review board review because all of the data were deidentified.

Patient Selection

The 2018 NCDBs for bone and soft tissue were merged to identify all adult patients age older than 18 year old who were diagnosed with chondrosarcoma from 2004 to 2018. Patients were categorized into 2 groups on the basis of if they had a CWC or chondrosarcoma originating from another site. Clinical and demographic characteristics of patients with CWC were compared with chondrosarcoma from other sites. Patients were excluded for missing data regarding origin of tumor.

Outcome Measures

The primary outcome of interest was overall survival, which was defined from date of diagnosis to last follow-up or death. The secondary

outcome of interest was margin status among patients who underwent surgical resection. This was an exploratory analysis in light of findings in our study that positive margins were associated with worse survival. Negative margins were defined as all margins from the primary surgical site being grossly and microscopically negative for tumor on pathology report. Positive margins were defined as any margin with microscopic or macroscopic residual tumor or residual tumor not otherwise specified.

Statistical Analysis

The analysis involved comparison of all chondrosarcomas with other soft tissue and bone tumors, followed by the comparison of CWC with chondrosarcomas originating from other body regions. Statistical comparison between groups was performed using the Wilcoxon rank sum test for continuous variables and χ^2 for categorical variables. Demographic and clinical characteristics are described using median and interquartile range for continuous variables, and frequency and percentages for categorical variables.

Survival was estimated using the Kaplan–Meier method and compared using log rank test. Univariable and multivariable Cox proportional hazard analysis was used to assess factors associated with overall survival to control for confounding effects. A subgroup analysis using multivariable logistic regression analysis was performed to assess factors associated with worse survival among only patients with CWC who underwent surgical resection. A second multivariable logistic regression analysis was performed to determine factors associated with positive margins among CWC patients after surgical resection.

Statistical analysis was performed using STATA MP (version 16.0, StataCorp). Statistical significance was set as $\alpha \leq 0.05$, and because of the multiplicity of comparisons, we only treated findings with a *P*-value $< .016$ as statistically significant.

RESULTS

Among 146,727 patients with bone and soft tissue tumors, there were 11,925 (8.1%) patients diagnosed with chondrosarcoma in the NCDB from 2004 to 2018 compared with 134,802 (91.9%) other soft tissue or bone tumors. In [Table 1](#) the clinical and demographic characteristics of chondrosarcomas relative to all other bone and soft tissue tumors during the study period are compared.

Of the 11,925 chondrosarcomas, 1934 (16.2%) were classified as CWC. Among 1791 CWC patients, the median tumor size was 6 (4.2-9) cm. [Table 2](#) shows the clinical and demographic characteristics of CWC versus chondrosarcoma at other sites. Compared with chondrosarcomas at other locations, CWC was associated with older median age (59 vs 55 years, $P < .001$), male sex (61.7% vs 53.9%, $P < .001$), and White race (84.0% vs 79.0%, $P < .001$). Patients with CWC were also more likely to undergo surgical excision (87.4% vs 82.9%, $P < .001$) and less likely to receive their care at an academic institution (48.3% vs 63.4%, $P < .001$). For CWC patients who underwent surgical resection, the median hospitalization was 4 (interquartile range, 3-6) days with an unplanned 30-day readmission rate of 3.3% (52/1541) and positive margin rate of 12.1% (183/1512).

The median 1-, 3-, 5-, and 10-year survival for CWC was 91.5%, 82.0%, 75.5%, and 62.7%, respectively. With an a priori hypothesis that surgery was beneficial in the

TABLE 1. Demographic and clinical characteristics of chondrosarcoma tumors compared with other soft tissue/bone tumors in the National Cancer Database from 2004 to 2018

	Chondrosarcoma (n = 11,925)	Other soft tissue/bone tumor (n = 134,802)	P value
Age, years	56 (43-68)	60 (45-73)	<.001
Male sex (vs female)	6583 (55.2)	73,732 (54.5)	.14
Race			<.001
American Indian	47 (0.4)	465 (0.3)	
Asian	303 (2.5)	4305 (3.2)	
Black	908 (7.6)	15,084 (11.2)	
Hispanic	789 (6.6)	9438 (7.0)	
White	9519 (79.8)	102,137 (75.5)	
Other	359 (3.0)	3876 (2.9)	
Charlson–Deyo score			.06
0	9729 (81.6)	109,239 (81.0)	
1	1632 (13.7)	18,516 (13.8)	
≥2	564 (4.7)	7047 (5.2)	
Facility type			<.001
Academic program	5825 (60.9)	55,721 (50.6)	
Community cancer program	204 (2.1)	4986 (4.5)	
Comprehensive community cancer program	1882 (19.7)	30,262 (27.5)	
Integrated network cancer program	1658 (17.3)	19,086 (17.4)	
Private insurance (vs other)	6485 (54.4)	62,107 (45.9)	<.001
Median income (USD)			.02
<\$40,277	1764 (16.5)	21,386 (17.6)	
\$40,277-50,353	2411 (22.5)	26,439 (21.7)	
\$50,354-63,332	2466 (23.0)	28,166 (23.1)	
≥\$63,333	4,060 (37.9)	45,784 (37.6)	
Tumor size (cm)	7 (4.2-11)	7.5 (4-12.5)	<.001
Surgical excision (yes vs no)	8682 (83.7)	94,743 (76.2)	<.001
Type of surgical resection			<.001
Local excision	2287 (26.3)	33,556 (35.4)	
Partial resection	1235 (14.2)	9555 (10.1)	
Radical resection	5160 (59.4)	51,632 (54.5)	

Categorical variables are described as n (%) and continuous variables as median (interquartile range).

treatment of CWC, we performed an unadjusted comparison of survival among surgery and nonsurgery patients. The median 5-year survival for CWC patients who underwent surgery was 82.5% versus 37.5% for those who did not receive surgery ($P < .001$, [Figure 1](#)). In Cox proportional hazard analysis, overall survival was strongly associated with surgical excision (hazard ratio [HR], 0.02; $P < .001$) and adversely affected by positive margins among patients who underwent surgery (HR, 2.66; $P < .001$) (data not shown).

On the basis of this, a survival analysis was performed on the subset of patients who received surgery using multivariable Cox proportional hazard analysis to address potential confounding. Among patients with chondrosarcoma at any location who underwent surgical resection, patients who had a CWC compared with other chondrosarcoma was associated with better overall survival (HR, 0.74;

95% CI, 0.639-0.849) ([Table E1](#)). Tumor size (HR, 1.02; 95% CI, 1.011-1.020; $P < .001$), dedifferentiated histology (HR, 4.85; 95% CI, 4.248-5.530; $P < .001$), and positive margins (HR, 1.96; 95% CI, 1.725-2.232; $P < .001$) were associated with poor overall survival.

We subsequently performed a similar multivariable analysis of overall survival among the subgroup of CWC patients who underwent surgery ([Table 3](#)). This analysis also showed the adverse association of positive surgical margins (HR, 2.34; 95% CI, 1.726-3.183; $P < .001$), larger tumor size (HR, 1.03; 95% CI, 1.013-1.040; $P < .001$), and dedifferentiated histology (HR, 3.51; 95% CI, 2.362-5.220; $P < .001$).

Because of the poor prognosis associated with a positive surgical margin, overall survival was compared on the basis of margin status. The median 5-year survival for negative margins was 85.4% versus 62.5% for positive margins

TABLE 2. Demographic and clinical characteristics of all chondrosarcoma tumors in the National Cancer Database from 2004 to 2018 on the basis of tumor location (chest wall vs other location)

	Chest wall (n = 1934)	Other site (n = 9991)	P value
Age, years	59 (46-69)	55 (43-68)	<.001
Male sex (vs female)	1193 (61.7)	5390 (54.0)	<.001
Race			<.001
American Indian	5 (0.3)	42 (0.4)	
Asian	43 (2.2)	260 (2.6)	
Black	101 (5.2)	807 (8.1)	
Hispanic	109 (5.6)	680 (6.8)	
White	1625 (84.0)	7894 (79.0)	
Other	51 (2.6)	308 (3.1)	
Charlson–Deyo score			.001
0	1522 (78.7)	8207 (82.1)	
1	298 (15.4)	1334 (13.4)	
≥2	114 (5.9)	450 (4.5)	
Facility type			<.001
Academic program	782 (48.3)	5043 (63.4)	
Community cancer program	46 (2.8)	158 (2.0)	
Comprehensive community cancer program	475 (29.4)	1407 (17.7)	
Integrated network cancer program	315 (19.5)	1343 (16.9)	
Private insurance (vs other)	1038 (53.7)	5447 (54.5)	.49
Median income (USD)			.002
<\$40,277	248 (14.4)	1516 (16.9)	
\$40,277-50,353	362 (21.0)	2049 (22.8)	
\$50,354-63,332	395 (22.9)	2071 (23.1)	
≥\$63,333	719 (41.7)	3341 (37.2)	
Tumor size (cm)	6 (4.2-9)	7 (4.2-11.5)	<.001
Surgical excision (yes vs no)	1617 (87.4)	7065 (82.9)	<.001
Type of surgical resection			<.001
Local excision	424 (26.2)	1863 (26.4)	
Partial resection	295 (18.2)	940 (13.3)	
Radical resection	898 (55.5)	4262 (60.3)	

Categorical variables are described as n (%) and continuous variables as median (interquartile range).

($P < .001$; Figure 2). Multivariable logistic regression analysis was performed to determine factors associated with positive margin status after surgery among CWC patients (Table 4). The only factor independently associated with an increased likelihood of having a positive surgical margin was larger tumor size (HR, 1.02; 95% CI, 1.011-1.075; $P = .008$).

DISCUSSION

Although rare, chondrosarcoma is a locally aggressive disease with limited treatment options. During our 14-year study period, <10% of patients diagnosed with a soft tissue or bone tumor had a chondrosarcoma, and only 15% of those were classified as a CWC. Despite CWC representing the most common primary malignant tumor in the chest, data supporting surgical intervention are on the basis of small, single-institution experiences. This contemporary study of a nationally recognized database represents, to our

knowledge, the first large, multi-institution evaluation of surgical resection for CWC. Similar to previous studies, in our study surgical excision was associated with significantly improved survival for patients with CWC.

Because CWC is relatively uncommon, current guidelines and recommendations for the surgical management of CWC have largely been on the basis of data from chondrosarcomas originating at other body locations. In this study, significant differences in demographic and clinical characteristics of CWC and other chondrosarcomas suggest that CWC is a distinct clinical entity that should be managed and treated as such. Patients with CWC were more likely to undergo surgical resection, and when controlling for surgery, CWC was associated with improved survival compared with other chondrosarcomas. This information serves as an important tool for prognostication when discussing treatment options to provide an accurate prognosis to CWC patients.

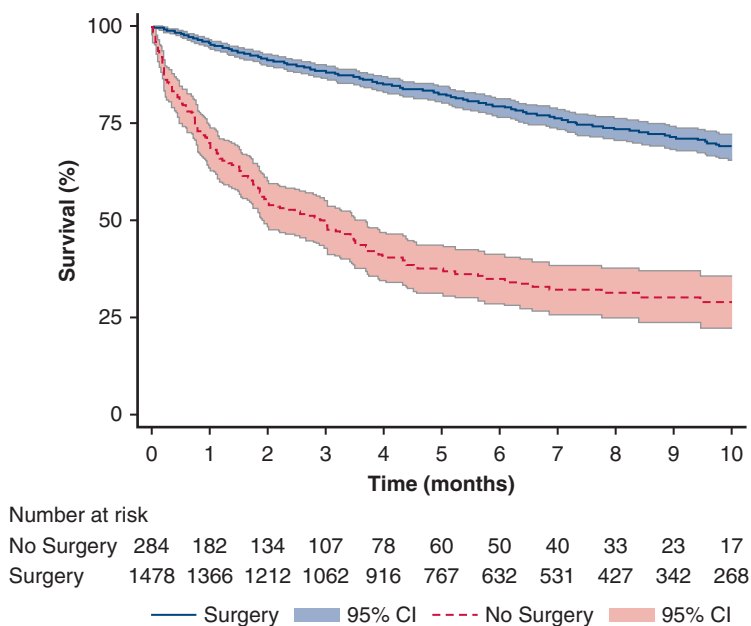
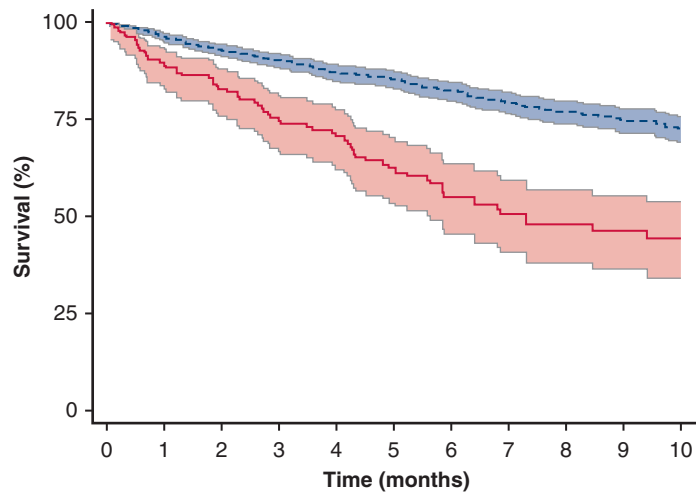


FIGURE 1. Kaplan–Meier curve showing survival in months for all patients with chest wall chondrosarcoma in the National Cancer Database from 2004 to 2018 on the basis of surgical intervention versus no surgical intervention. *CI*, Confidence interval.

TABLE 3. Subgroup analysis using multivariable Cox proportional hazard analysis of factors associated with overall survival among patients with chest wall chondrosarcoma who underwent surgical resection in the National Cancer Database from 2004 to 2018 (n = 1084)

	Hazard ratio (95% CI)	P value
Age per 1 year	1.04 (1.030-1.060)	<.001
Male sex	1.24 (0.953-1.619)	.11
Charlson–Deyo score		
0	Reference	
1	1.23 (0.915-1.650)	.17
≥2	1.21 (0.749-1.954)	.44
Facility type		
Academic program	Reference	
Community cancer program	1.00 (0.494-2.030)	1.00
Comprehensive community cancer program	1.01 (0.746-1.362)	.96
Integrated network cancer program	1.26 (0.922-1.732)	.15
Private insurance	0.73 (0.521-1.011)	.06
Tumor size (per 1 cm)	1.03 (1.013-1.040)	<.001
Histology		
Chondrosarcoma, NOS	Reference	
Juxtacortical chondrosarcoma	1.33 (0.584-3.025)	.50
Myxoid chondrosarcoma	1.02 (0.629-1.653)	.94
Mesenchymal chondrosarcoma	3.55 (1.096-11.479)	.04
Clear cell chondrosarcoma	1.63e ⁻¹⁴ (0.000-∞)	1.00
Dedifferentiated chondrosarcoma	3.51 (2.362-5.220)	<.001
Type of surgical resection		
Local excision	Ref	
Partial resection	0.94 (0.647-1.373)	.76
Radical excision	0.96 (0.713-1.285)	.77
Positive pathologic margins (vs negative)	2.34 (1.726-3.183)	<.001

CI, Confidence interval; *NOS*, not otherwise specified.



Number at risk
 Negative Margin 1220 1137 1010 893 762 641 530 450 362 292 227
 Positive Margin 159 136 120 95 83 65 51 40 34 25 20

--- Negative Margin 95% CI — Positive Margin 95% CI

FIGURE 2. Kaplan–Meier curve showing overall survival in months for all patients with chest wall chondrosarcoma who underwent surgical intervention in the National Cancer Database from 2004 to 2018 based on pathologic margin status. *CI*, Confidence interval.

TABLE 4. Multivariable logistic regression analysis of factors associated with positive pathologic margins among patients with chest wall chondrosarcoma who underwent surgical resection in the National Cancer Database from 2004 to 2018 (n = 1203)

	Odds ratio (95% CI)	P value
Age (per 1 year)	1.00 (0.982-1.019)	.97
Male sex	1.16 (0.794-1.682)	.45
Charlson–Deyo score		
0	Reference	
1	0.83 (0.512-1.350)	.45
≥2	0.97 (0.461-2.021)	.93
Facility type		
Academic program	Reference	
Community cancer program	0.92 (0.263-3.183)	.89
Comprehensive community cancer program	1.23 (0.814-1.863)	.33
Integrated network cancer program	0.83 (0.502-1.357)	.45
Private insurance	0.75 (0.489-1.154)	.19
Tumor size (per 1 cm)	1.04 (1.011-1.075)	.008
Histology		
Chondrosarcoma, NOS	Reference	
Juxtacortical chondrosarcoma	1.44 (0.407-5.113)	.57
Myxoid chondrosarcoma	1.23 (0.587-2.586)	.58
Mesenchymal chondrosarcoma	0.86 (0.107-6.974)	.89
Clear cell chondrosarcoma	0.87 (0.104-7.352)	.90
Dedifferentiated chondrosarcoma	1.61 (0.822-3.146)	.17
Type of surgical resection		
Local excision	Ref	
Partial resection	1.37 (0.838-2.255)	.21
Radical excision	0.68 (0.444-1.046)	.08

CI, Confidence interval; *NOS*, not otherwise specified.

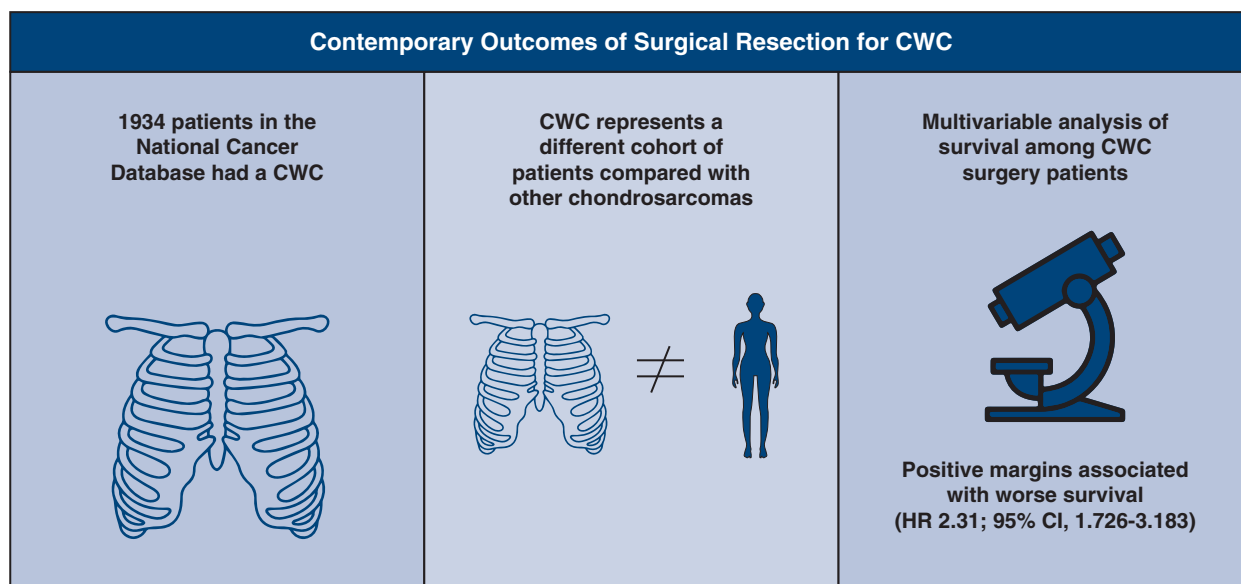


FIGURE 3. Patients with chest wall chondrosarcoma (CWC) who underwent surgical resection have improved overall survival compared with those who did not undergo surgery. Among surgical patients, negative margins are a predictor of better survival. *HR*, Hazard ratio; *CI*, confidence interval.

In addition to surgery patients having an improved median 5-year survival by 45% compared with nonsurgery patients, a subgroup analysis among CWC surgery patients showed that positive margin status was strongly associated with worse patient survival. These data support the findings from other studies in the literature. A recent case series of 38 patients diagnosed with primary soft tissue sarcomas involving the chest wall showed that tumor size and complete tumor excision with negative margins was associated with improved overall survival.¹² Another single-institution study of 121 patients with resected chest wall sarcoma showed that complete surgical resection and tumor grade were the most important predictive factors for survival.¹³ This suggests that negative pathologic margins should be considered a vital component of complete surgical resection of CWCs for curative intent.

Although our study emphasizes the importance of negative surgical margins, questions remain regarding if margin length matters for CWC. The current recommendations for surgical resection of chest wall sarcomas are on the basis of a single center, retrospective study by King and colleagues¹⁴ published in 1986 which showed improved 5-year survival with 4 cm margins (56%) compared with 2-cm margins (29%). On the basis of this, the generally accepted rule for margin length was created with 4-cm margins recommended for high-grade tumors and 2-cm margins for low-grade tumors.⁶ Since this landmark study, multiple other studies have shown the importance of an R0 resection for CWC.^{12,13,15} A more recent report that outlined consensus guidelines of 85 experts on the surgical management of chest wall tumors recommended wide excision with >2 cm margin distance to obtain an R0 resection.¹⁶

Although margin length is not measured within the NCDB, previous data on the basis of chondrosarcomas from other locations, such as pelvis and extremity, suggest that longer margin length might be important for decreasing local recurrence but might not necessarily affect disease-free survival.¹⁷

In our study, the only factor shown to be independently associated with CWC patients having an increased likelihood of positive surgical margins was larger tumor size. A hypothesis to this finding is that larger tumors likely have greater local invasion into surrounding structures, making it more difficult to obtain an R0 resection. Excision of large chest wall tumors poses a significant challenge for surgeons because chest wall reconstruction to protect vital organs and restore pulmonary mechanics and function is essential, but not easy.^{18,19} Tumor size might play an important role in determining which patients are ideal candidates for complete surgical resection with curative intent.

In addition to margin status, tumor histology was also shown to be an important factor associated with patient survival. Patients with mesenchymal and dedifferentiated histologic subtypes were 3.5 times more likely to die. Even those who underwent surgical resection still had a higher rate of mortality. This provides vital information for counseling and prognostication among patients with these more aggressive histologic subtypes of CWC. Other studies have shown that tumor grade is one of the most important factors affecting survival, which supports these findings from our study because histology is closely linked with tumor grade.¹³

Limitations of this study include that this was a retrospective analysis of a national database, which limits the ability to compare treatment groups. Although type of surgical

excision (local vs partial vs radical) was not associated with overall survival, this might be because of differences in subjective classification by the surgeon of type of resection. Furthermore, the NCDB lacks information regarding margin length, which could not be assessed in this study but might play an important role in survival outcomes. Other limitations include that patients were not excluded if they received chemotherapy or radiation which may have affected outcomes because these treatment modalities are typically used as adjuncts in patients with extensive disease or those not amenable to surgical resection. Last, although information regarding the general location of origin of chondrosarcoma was available, more granular detail such as location within the chest cavity or local extension of the tumor was not. Other studies have shown differences in outcomes for patients with CWCs originating from the ribs or sternum versus clavicle or scapula, which could not be addressed within this study.

CONCLUSIONS

This study of a nationally recognized database shows the unique characteristics and outcomes of CWC compared with chondrosarcomas originating from other locations of the body. Surgical resection with an emphasis on negative surgical margins should remain the gold standard treatment for patients with CWC (Figure 3). Although negative margins should be obtained for patients who undergo surgery for curative intent, further research is warranted to determine if margin length also plays a role in survival and patient outcomes.

Conflict of Interest Statement

C.W.T. reports that he is a consultant for Zimmer Biomet, Astra Zeneca, Atricure, and Medtronic and is a grant recipient for Zimmer Biomet. None of these relationships have affected this report or the accuracy of the data analysis. All other authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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Key Words: thoracic surgery, chondrosarcoma, chest wall chondrosarcoma, surgery

TABLE E1. Multivariable Cox proportional hazard analysis of factors associated with overall survival among patients with chondrosarcoma at any location who underwent surgical resection in the National Cancer Database from 2004 to 2018 (n = 4705)

	Hazard ratio (95% CI)	P value
Age	1.04 (1.034-1.046)	<.001
Male sex	1.33 (1.188-1.477)	<.001
Charlson–Deyo score		
0	Reference	
1	1.17 (1.020-1.333)	.02
≥2	1.71 (1.393-2.093)	<.001
Facility type		
Academic program	Ref	
Community cancer program	1.16 (0.761-1.758)	.50
Comprehensive community cancer program	1.21 (1.046-1.395)	.01
Integrated network cancer program	1.10 (0.957-1.268)	.18
Private insurance	0.77 (0.672-0.880)	<.001
Tumor size, cm	1.02 (1.011-1.020)	<.001
Histology		
Chondrosarcoma, NOS	Reference	
Juxtacortical chondrosarcoma	0.70 (0.365-1.362)	.30
Myxoid chondrosarcoma	0.81 (0.691-0.953)	.01
Mesenchymal chondrosarcoma	1.25 (0.806-1.929)	.32
Clear cell chondrosarcoma	0.74 (0.420-1.316)	.31
Dedifferentiated chondrosarcoma	4.85 (4.248-5.530)	<.001
Type of surgical resection		
Local excision	Ref	
Partial resection	0.94 (0.767-1.147)	.54
Radical excision	1.11 (0.956-1.281)	.18
Positive pathologic margins	1.96 (1.725-2.232)	<.001
Chest wall location (vs other)	0.74 (0.639-0.849)	<.001

CI, Confidence interval; NOS, not otherwise specified.