

# **Pediatric Axial Ewing Sarcoma: A Retrospective Population-Based Survival Analysis**

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## **INTRODUCTION:**

Ewing sarcoma is a malignant musculoskeletal tumor which can occur in both bone and soft tissue. While Ewing can occur in various anatomic locations, outcomes are especially poor for primary tumors of the axial skeleton. This study focuses on three primary anatomic locations: vertebral column, rib/sternum/clavicle/associated joints, and pelvis/sacrum/coccyx/associated joints. Previous publications have studied interventions for one specific disease presentation, the most prevalent being localized pelvic primary Ewing sarcoma. Literature on Ewing sarcoma of the axial skeleton is sparse, and this is the first study to address axial tumors in a pediatric population. The aim of this study is twofold. First, analyze the most common treatment regimens used to treat local and regional Ewing sarcoma by primary location. Second, compare the efficacy of treatment modalities across multiple presentations of Ewing sarcoma to identify which treatment modalities improve cancer specific survival and which have a detrimental effect on cancer specific survival.

## **METHODS:**

We queried the Surveillance, Epidemiology, and End Results (SEER) database from the years 2004 - 2019 for all cases of axial Ewing sarcoma in patients aged 1 - 19 years. A total of 310 patients were included for analysis. SEER is a population-based cancer database available from the National Cancer Institute covering about 30% of Americans. Axial presentation was defined as cancers of the vertebral column, rib/sternum/clavicle/associated joints, and pelvis/sacrum/coccyx/associated joints. Demographic and clinical information were collected, including race, age, sex, median household income, geographic density, primary site, treatment characteristics (receipt of surgery, radiation, chemotherapy, or any combination). Survival data for each patient were collected. Chi-squared test was used to compare associated frequencies in demographic and clinical characteristics, while the Kaplan-Meier test was used to assess univariate survival outcomes.

## **RESULTS:**

Incidence for each of the three primary tumor locations in this cohort showed significance in tumor stage, tumor size, surgery, radiation, surgery/chemo, surgery/radiation, and chemo/radiation. Patients with primary tumors of the pelvis/sacrum/coccyx/associated joints were significantly more likely to present with regional disease ( $p < 0.001$ ) as well as with tumors larger than 8 cm ( $p < 0.001$ ). Surgical treatment was most common in patients with primary tumors of the rib/sternum/clavicle/associated joints and least common in vertebral tumors ( $p < 0.001$ ). Radiation was most common in patients with primary tumors of the pelvis/sacrum/coccyx/associated joints ( $p < 0.001$ ). Surgery/chemo was used at a significantly lower rate in patients with vertebral tumors ( $p < 0.001$ ). Multimodal therapy with surgery/radiation was most common for patients with primary tumors of the pelvis/sacrum/coccyx/associated joints ( $p < 0.001$ ).

The study of specific surgical characteristics yielded a  $p$  value of  $< 0.001$  with three major findings of note. First, 71.6% of patients with primary tumors of the pelvis/sacrum/coccyx/associated joints didn't receive surgical treatment. Second, radical excisions/resections with limb salvage occurred in 55% of patients with primary tumors of the rib/sternum/clavicle/associated joints. Third, major amputations occurred in 94.1% of patients with primary tumors of the pelvis/sacrum/coccyx/associated joints.

Analysis of cancer specific survival yielded one result of statistical significance ( $p = 0.015$ ). Multimodal treatment with surgery/chemotherapy was found to be associated with improved cancer specific survival.

An additional analysis of cancer specific survival for this cohort showed a one-year survival of 99%, five-year survival of 90%, and a ten-year survival of 78%.

**DISCUSSION AND CONCLUSION:** The poor prognosis of axial Ewing sarcoma necessitates continued research on common treatments and their effect on patient survival. This analysis shows the low rate at which pelvic primary tumors are treated surgically as well as the high rate at which they are treated with chemo/radiation multimodal therapy. When tumors of the pelvis/sacrum/coccyx/associated joints are deemed to be amenable to surgical treatment, a major amputation is performed on most patients as it's the only way to remove the tumor in its entirety. The opposite tends to be true for primary tumors of the rib/sternum/clavicle/associated joints for which 55% of patients received a limb-sparing radical excision with only 5.9% receiving major amputations. Similarly, but to a lesser degree than pelvic tumors, vertebral tumors are also treated surgically with low frequency. While resection of the vertebral tumors is recognized as a positive prognostic factor, it is inherently quite risky and often impossible given the proximity of the spinal cord and other crucial neurovascular structures. The poor prognosis associated with pelvic Ewing sarcoma in this analysis is well documented in current literature. The consensus is that this is due to late diagnoses and the often-inoperable nature of this malignancy.

The positive correlation between surgery/chemo treatment and survival is understandable given that the “ideal” disease course consists of neoadjuvant chemotherapy followed by complete en bloc resection of the malignancy. This review reinforces the importance of early detection/treatment and provides surgeons with a detailed account of how axial Ewing sarcoma has been surgically treated since 2004.

Table 1: Surgical Characteristics	<i>p</i> <0.001		
	Vertebral Column	Rib, sternum, clavicle, and associated joints	Pelvic bones, sacrum, coccyx and associated joints
No surgery	21 (15.7%)	17 (12.7%)	96 (71.6%)
Local tumor destruction or excision	17 (47.2%)	11 (30.6%)	8 (22.2%)
Partial excision	18 (43.9%)	13 (31.7%)	10 (24.4%)
Radical excision or resection of lesion with limb salvage	10 (12.5%)	44 (55.0%)	26 (32.5%)
Major amputation	0 (0.0%)	1 (5.9%)	16 (94.1%)
Surgery, unknown procedure	1 (50.0%)	0 (0.0%)	1 (50.0%)