

## Introduction

Chondrosarcoma (CS) of the spine is a difficult lesion to treat given its invasive nature and proximity to the spinal cord. To date, only a limited number of case reports and case series exist reporting on these tumors. Investigators seek to gain a better understanding of this patient population and the types of surgical techniques used for treatment.

## Methods

A systematic literature search was performed in January 2018 querying several scientific databases, per PRISMA guidelines. Inclusion criteria specified all studies and case reports of patients with CS located in the spine for which all possible therapies, including spinal surgery, were considered and applied. Studies with other sarcoma subtypes, non-human populations, and no reported patient outcomes were excluded from the focused review. Surgery type was categorized into either en bloc, piecemeal excision, or Non-en bloc or piecemeal excision (NEP). Neurologic status was assessed using the modified Rankin Score (mRS); outcomes following surgery were dichotomized as either good (mRS 0-2) and poor (mRS 3-6).

## Results

In total 34 records and 3 patients from the senior authors were included in the systematic review yielding 87 patients with primary chondrosarcoma of the spine. The mean age was 41.5 years (Range 1-80), with the tumor most commonly arising in adult patients (90.8%, 79/87), the majority of which were males (66.7%, 58/87). En bloc (43.7%, 38/87) was the most common surgical method used, followed by piecemeal excision (34.5%, 30/87). Of the 35 patients with a mRS scores available, 20 were recorded as 'good' outcomes (57.1%).

Patients who underwent piecemeal excision exhibited the highest death rate (56.7%,  $p < 0.001$ ) and highest rate of recurrence (63.3%,  $p < 0.001$ ) compared to en bloc and NEP. The calculated reduced relative risk comparing en bloc to the other surgical techniques for recurrence and mortality was 78.8% (RR .21; 95% CI .08-.56;  $p$ -value= $<0.001$ ) and 80.7% (RR .19; 95% CI .06-.60;  $p$ -value= $<0.001$ ), respectively. Survival analysis revealed patients with a piecemeal excision had 9.4x hazards ratio for death compared to en bloc (95% CI 2.6 - 34,  $p$ -value=.001).

**Table 1**

Patient Summary	Number (%)
Number of Patients	87
Gender (Male)	58 (66.7)
Number of Adults	79 (90.8)
Mean Age (years)	41.5
Age Range (years)	1- 80
Location	
Cervical	16 (18.4)
Cervical+Thoracic	1 (1.2)
Thoracic	43 (49.4)
Lumbar	15 (17.2)
Sacral	6 (6.9)
Thoracic + Lumbar	3 (3.5)
Lumbar + Sacral	3 (3.5)
Lesions that Span More than Vertebral Level	25 (55.6)

**Patient Summary**

**Table 2**

Gender	Number (%)	Recurrence (%)	Ch1z	Death (%)	Ch1z
Male	58 (66.7)	19 (32.7)	.79	16 (27.6)	
Female	29 (33.3)	10 (35.7)		7 (24.1)	0.73
Age Group					
Pediatric	8 (9.2)	2 (25)	(Fisher)	0	(Fisher)
Adults	79 (90.8)	27 (34.6)	.71	23 (29.1)	0.1
Region					
Cervical	16 (18.4)	5 (31.3)		5 (31.3)	
Cervical + Thoracic	1 (1.2)	0		0	
Thoracic	43 (49.4)	14 (32.6)		12 (26.7)	
Lumbar	15 (17.2)	7 (50.0)	(Fisher)	4 (26.7)	(Fisher)
Sacral	6 (6.9)	2 (33.3)	0.80	1 (16.7)	.98
Thoracic + Lumbar	3 (3.5)	0		0	
Lumbar + Sacral	3 (3.5)	1 (33.3)		1 (33.3)	
Treatment					
En Bloc	38 (43.7)	4 (10.8)		3 (7.9)	
Piecemeal	30 (34.5)	19 (63.3)	(Fisher)	17 (56.7)	(Fisher)
NEP	19 (21.8)	6 (31.6)	<0.001	3 (15.8)	<0.001
Adjunct Therapy					
Surgery Only	23 (33.3)	6 (26.1)		5 (21.7)	
Chemotherapy	4 (6.1)	0	(Fisher)	0	(Fisher)
Radiation	33 (47.8)	16 (48.5)	0.14	15 (45.5)	.13
Chemotherapy and Radiation	9 (13.0)	4 (44.4)		2 (22.2)	

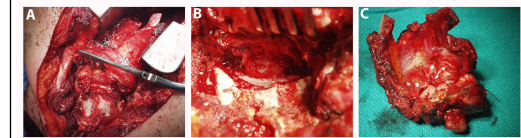
**Comparison of Recurrence and Death between Patient Groups**

**Figure 1**



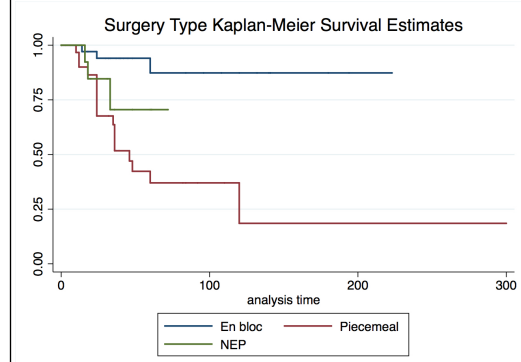
**Case Illustration of Primary Spinal Chondrosarcoma on CT Imaging**

**Figure 3**



**Case Illustration of Primary Spinal Chondrosarcoma Resection**

**Figure 2**



**Kaplan-Meier Survival Estimates by Surgery Type**

## Conclusions

CS is a rare lesion that most commonly presents in adult, male patients. En bloc surgical resection was associated with a significant decrease in recurrence, mortality, and increased survival compared to the other surgical techniques. Additionally, any surgical technique that involved entering the tumor capsule showed a significantly greater risk for recurrence and death.