



# Prognostic factors and outcomes of osseous chondrosarcoma after surgery: the 2004–2014 Surveillance, Epidemiology, and End Results database study

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**Background:** Chondrosarcoma is a major malignant tumor occurs at skeletal system, the prognostic factors and survival outcomes of osseous chondrosarcoma after surgery were still unclear.

**Methods:** The demographic information extracted include: age, gender, race, year of diagnosis, tumor sites, tumor size, grade, stages from the Surveillance, Epidemiology, and End Results (SEER) 18 registries research database [2004–2014]. The patients don't perform the surgery or the tumors sited at extraskeletal tissue are excluded. Multivariable Cox proportional hazard regression models are used to calculate the HRs with 95% CIs for chondrosarcoma cancer-specific survival (CCSS).

**Results:** Total of 1,630 osseous chondrosarcoma patients that performed surgery are included in present study. Multivariable Cox proportional hazard regression models find that the higher grade and stage, old age more than 75 years, and tumor size more than 20 cm have significant associated with the CCSS. But the gender, race, and tumor sites have no significant associated with CCSS.

**Conclusions:** We find grade, stage were independent prognostic factors for survival rate of osseous chondrosarcoma after surgery, and higher age more than 75 years, bigger tumor size more than 20 cm is also predicted poor outcomes.

**Keywords:** Prognostic factors; chondrosarcoma; survival; Surveillance, Epidemiology, and End Results (SEER)

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## Introduction

Chondrosarcoma is a slow-growing malignant tumor comprised of transformed cells producing a cartilaginous matrix (1,2), it occurs common at skeletal system, and also could be at extraskeletal sites (3,4). The prognostic factors

that affect the survival outcomes were inconsistent in previous studies (5-9) and still lack the data of patients with osseous chondrosarcoma after surgery.

In last 10 years, many osseous chondrosarcoma after surgery patients were registered to the Surveillance,

**Table 1** Characteristics of the study population from the Surveillance, Epidemiology, and End Results 18 registries research database, 2004–2014

Categories	Value
Number	1,630
Age at diagnosis, years	50.9±17.2
Gender, n (%)	
Male	865 (53.07)
Female	765 (46.93)
Race, n (%)	
White	1,433 (87.91)
Black	100 (6.13)
Other	79 (4.85)
Unknown	18 (1.10)
Tumor sites, n (%)	
Limbs	786 (48.22)
Vertebral column	68 (4.17)
Pelvis/sacroccocyx	257 (15.77)
Other bones	519 (31.84)
Tumor size, cm	
Mean	9.2
Median	6
Follow up term, months	
Mean ± SD	53.5±37.5
Median	47

Epidemiology, and End Results (SEER) database. Moreover, after 2004, the information of grade, American Joint Committee on Cancer (AJCC) staging system stage, tumor size were more completion than pervious (almost half information of the grade, tumor size and stage of osseous chondrosarcoma was unavailable before 2004).

The aim of present study is to use the 2004–2014 SEER databases to investigate the prognostic factors and survival outcomes of chondrosarcoma osseous chondrosarcoma after surgery.

## Methods

Patients diagnosed with chondrosarcoma (histological type ICD-O-3: “9220/3: Chondrosarcoma, not otherwise

specified”) are searched using the case-listing session protocol of the National Cancer Institute’s SEER 18 databases ([www.seer.cancer.gov](http://www.seer.cancer.gov)) (10). Only the patients registered at 2004–2014 are included in present study. The patients don’t perform the surgery or the tumors sited at extraskkeletal tissues are excluded.

We extract the demographic information include: age, gender, race, year of diagnosis, tumor sites, tumor size, grade, stages (AJCC staging system). The stages are classified to three types (11,12): (I) localized: tumor confined to cortex of bone or extension beyond cortex but confined within periosteum; (II) regional: extension beyond periosteum to surrounding tissues including adjacent skeletal muscle, adjacent bone/cartilage, or skin; or (III) distal metastasis. This article does not contain any identified human participants of the SEER database.

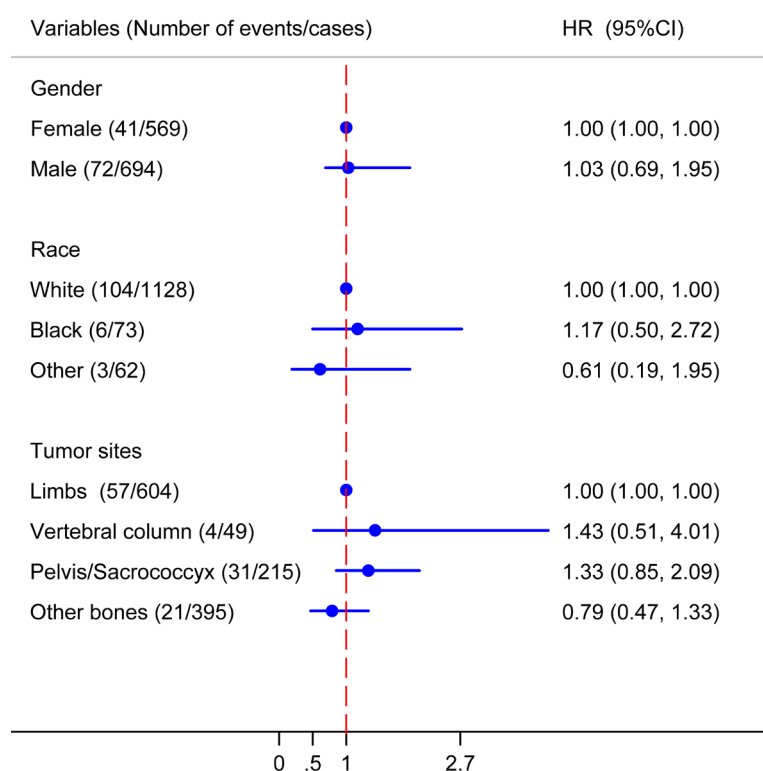
## Statistical analysis

The age is converted to a categorical variables of 0–44, 45–59, 60–74, ≥75 years old, Tumor sites are concluded into four of limbs, vertebral column, pelvis/sacroccocyx, and other bones (such as skull, rib, sternum, clavicle, and mandible). The grades of poorly differentiated and undifferentiated are combined by the similar type and small sample of undifferentiated. Multivariable Cox proportional hazard regression models are used to calculate the HRs with 95% CIs for chondrosarcoma cancer-specific survival (CCSS). The patients with lost data are excluded when perform the Multivariable Cox proportional hazard regression models. All statistical analysis is performed using STATA software (Version 14.2; Stata Corp, College Station, TX, USA).

## Results

Total of 1,630 osseous chondrosarcoma patients performed surgery are included in present study. The characteristics of included patients are summarized in *Table 1*. The age at the diagnosis is 50.9±17.2 years old. And the percentage of male is 53.07%, slight higher than the female (46.93%). Most of them are White population (87.91%), the Black and other race is 6.13% and 4.85%, respectively. The follow-up term is 53.5±37.5 months.

The Multivariable Cox proportional hazard regression models find the factors of gender, race and tumor sites have no significant associated with the CCSS (*Figure 1*). However, the grades of moderately differentiated, “poorly



**Figure 1** The forest plot shows that the multivariable Cox proportional hazard regression models find the factors of gender, race and tumor site had no significant associated with the chondrosarcoma cancer-specific survival. HR, hazard ratio; CI, confidence interval.

differentiated and undifferentiated” have poorer outcomes when the well differentiated osseous chondrosarcoma used as reference, with HR (95% CI) of 2.57 (1.46–4.53) and 5.36 (2.91–9.85), respectively. The stages of regional and metastasis also have poorer outcomes when the localized osseous chondrosarcoma used as reference, with HR (95% CI) of 2.35 (1.31–4.24) and 11.17 (5.59–22.32), respectively (Figure 2).

No significant difference are observed among the age categories of 0–44, 45–59, 60–74 years and tumor size categories of 0–10 and 10–20 cm by multivariable Cox proportional hazard regression models test. But patients have age  $\geq 75$  years, and tumor size  $\geq 20$  cm have poorer outcomes than categories (Figure 3).

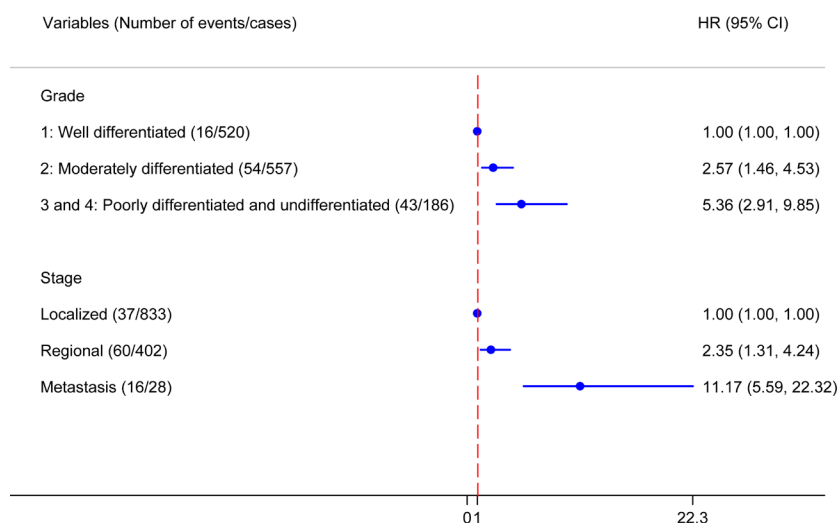
## Discussion

In present study, only the patients registered after 2004 are included. Because before the 2004, the most information of grade, tumor size, and stage of chondrosarcoma is lost and unavailable, it will influence the credible of results. After

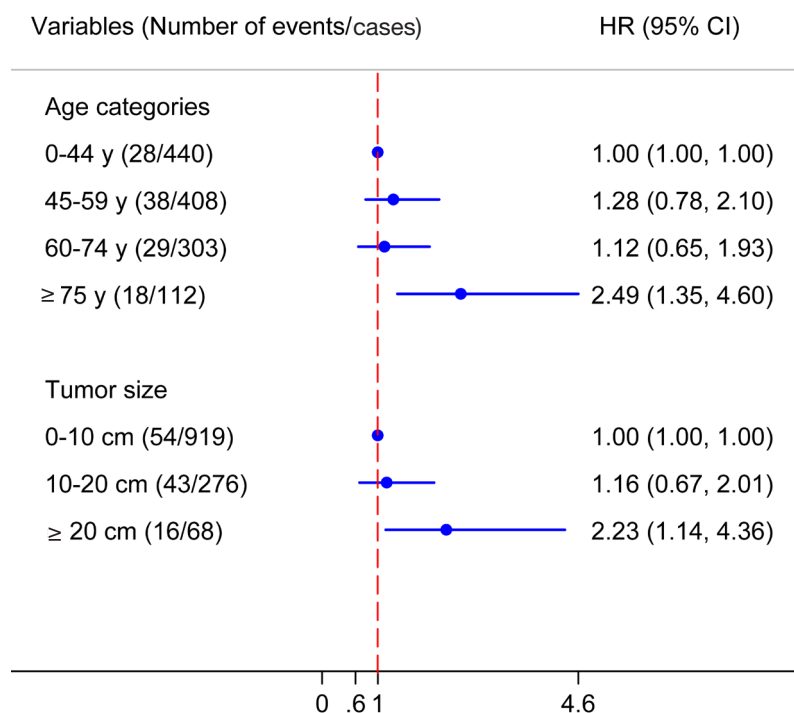
2004, the AJCC staging system 6th edition (13) is used at SEER, and information is more completion. Moreover, considering the surgical types are very varies before 2000, and have more consistent after then (14,15), therefore, we use the data after 2004.

Additional, compared to the previous study of Giuffrida *et al.* (9), only the osseous chondrosarcoma are included, because of the heterogonous sites of extraskeletal chondrosarcoma make the heterogonous survival rates (16). Some histological subtypes of chondrosarcoma, such as dedifferentiated (17) and mesenchymal (18) variants are generic term for a diverse group of skeletal sarcomas, also not included in this study. Only the histological type ICD-O-3: “9220/3: Chondrosarcoma, not otherwise specified” is included to make the consistent of single disease.

In studies of Marcove *et al.* (6), Gitelis *et al.* (7), and Lee *et al.* (8), only the grade was found as a prognostic factor for chondrosarcoma, but not the stage. In studies of Rizzo *et al.* (5), grade was also not found as a prognostic factor. The reason may the sample in their study is too small. In



**Figure 2** The grades of moderately differentiated, “poorly differentiated and undifferentiated”, the stages of regional and metastasis had poorer outcomes when the well differentiated and localized osseous chondrosarcoma used as reference. HR, hazard ratio; CI, confidence interval.



**Figure 3** No significant difference is observed among the age categories of 0–44, 45–59, 60–74 years and tumor size categories of 0–10 and 10–20 cm, however, patients’ age ≥75 years, and tumor size ≥20 cm have poorer outcomes, with HR (95% CI) of 2.49 (1.35–4.60) and 2.23 (1.14–4.36), respectively. HR, hazard ratio; CI, confidence interval.

our present study, most current 1,630 patients data find both the grade and stage are the independent prognostic factors. The higher grade and stage have significant poorer survival than the lower grade and stage, the HRs are increased ladder-like as the grade and stage increased (*Figure 2*).

We also classify the age to categories of 0–44, 45–59, 60–74,  $\geq 75$  years, and tumor size to categories of 0–10, 10–20 and  $\geq 20$  cm. We find the survival outcomes don't have line trends with age and tumor size. The patients with age less than 75 years have similar survival outcomes and only the patients  $\geq 75$  years have the poorer survival outcomes. Similar results are observed in tumor size, only patients with tumor size more than 20 cm have the poorer outcomes, which is not find in previous studies (5,6,8,9).

The strengths of our present study include: (I) most recently [2004–2014] and with large sample size of 1,630 cases; (II) the multivariable analysis of CCSS included variables of age, gender, race, year of diagnosis, tumor sites, tumor size, grade, stages; (III) the included patients are consistently.

There are some limitations of present study, the SEER database has its nature drawbacks of don't combine some detailed information of patient comorbidities and adjuvant treatments, lack of central radiologic and pathologic review by experts. And this is an observational study, may have some cofounders can't be included.

## Conclusions

We found grade, stage are independent prognostic factors for survival rate of osseous chondrosarcoma after surgery, and higher age more than 75 years, bigger tumor size more than 20 cm is also predicted poor outcomes.

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## Footnote

**Conflicts of Interest:** All authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/tcr.2018.03.14>). The authors have no conflicts of interest to declare.

**Ethical Statement:** The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Review by the institutional review board was not required for this study as the SEER database is publicly available without individually identifiable private information. Informed consent was waived.

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