

Constructing a Nomogram for Predicting Pelvic Osteosarcoma: A Retrospective Study Based on the SEER Database and a Chinese Cohort

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Abstract

Aims/Background Generally, pelvic osteosarcoma has a worse prognosis compared with limb osteosarcoma. This study aims to create and validate a new nomogram for predicting the prognosis of pelvic osteosarcoma.

Methods Clinical data of 62 patients derived from the Surveillance, Epidemiology, and End Results (SEER) database and 31 Chinese patients diagnosed with pelvic osteosarcoma were gathered. Kaplan-Meier survival analysis was utilized to calculate the median survival time for all variables. Univariate and multivariate Cox regression models were employed to identify the prognostic factors of pelvic osteosarcoma. A nomogram was constructed using data gleaned from the SEER cohort and verified using the receiver operating characteristic (ROC) curve and calibration plot in the Chinese cohort.

Results Kaplan-Meier analysis revealed that individuals of other races (Asians) (hazard ratio (HR) = 0.24, 95% confidence interval (CI): 0.1–0.57, $p = 0.001$), aged ≤ 51 years old (HR = 0.4, 95% CI: 0.22–0.73, $p = 0.003$), and with tumor size ≤ 160 mm (HR = 0.37, 95% CI: 0.2–0.71, $p = 0.03$) had better survival outcomes. Conversely, factors such as no primary surgery (HR = 3.6, 95% CI: 1.81–7.15, $p < 0.001$), lung metastasis (HR = 1.96, 95% CI: 1.17–3.28, $p = 0.010$), and radiotherapy (HR = 1.89, 95% CI: 1.10–3.25, $p = 0.021$) were associated with poorer survival. Multivariate Cox analysis indicated that lung metastasis (HR = 2.57, 95% CI: 1.29–5.13, $p = 0.008$), other races (Asians) (HR = 0.23, 95% CI: 0.07–0.75, $p = 0.015$), tumor size (HR = 0.28, 95% CI: 0.13–0.62, $p = 0.001$) and age (HR = 0.3, 95% CI: 0.16–0.59, $p < 0.001$) were independent prognostic factors for pelvic osteosarcoma. Univariate and multivariate Cox regression models identified three independent variables in the training cohort: age, lung metastasis, and tumor size. A predictive nomogram was developed based on the data from the SEER cohort and validated in the Chinese cohort. The areas under the curves (AUCs) that are used to predict 1-year, 2-year, and 3-year survival rates were 0.81 (95% CI: 0.68–0.94), 0.75 (95% CI: 0.63–0.86), and 0.80 (95% CI: 0.70–0.89) in the training cohort, and 0.67 (95% CI: 0.30–1.04), 0.66 (95% CI: 0.43–0.90) and 0.71 (95% CI: 0.50–0.93) in the validation cohort.

Conclusion The predictive nomogram constructed in this study facilitates accurate and effective prediction of the overall survival of patients with pelvic osteosarcoma and helps enhance the clinical decision-making process.

Key words: pelvic osteosarcoma; SEER; nomogram; Chinese cohort

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Introduction

Osteosarcoma, also known as osteogenic sarcoma, is a highly aggressive bone tumor that originates from mesenchymal cells and mainly affects adolescents and

children. Characterized by high rates of metastasis and malignancy, osteosarcoma poses a serious threat to patients' health and lives. Pelvic osteosarcoma, in particular, presents huge challenges for early detection due to the tumor being embedded deep within tissues and the complex anatomical structures surrounding the tumor. Thus, the tumor is often found large in size upon diagnosis, making radical surgical intervention challenging and raising the risk for postoperative complications and metastasis. This results in a poor prognosis with a 5-year survival rate of less than 30% (Brown et al, 2021).

Pelvic osteosarcoma is typically treated with a multifaceted approach that includes surgical resection, radiotherapy, and chemotherapy. Surgical intervention is the cornerstone of therapy, aiming to remove tumor tissue and preserve limb function as much as possible (Laitinen et al, 2023; Lee et al, 2022). Implementing surgery on pelvic osteosarcoma patients presents technical challenges, necessitating the development of personalized surgical plans based on the specific location and size of the tumor by experienced orthopedic oncology surgeons. Chemotherapy plays a crucial role in the comprehensive treatment of pelvic osteosarcoma by inhibiting the growth and spread of tumor cells and enhancing surgical outcomes and patient survival rates. On the other hand, radiation therapy is primarily employed as an adjuvant treatment to eliminate residual tumor cells or alleviate symptoms such as pain. Despite the advancements in surgical techniques and materials science, the growing experiences in pelvic osteosarcoma resection and construction in multiple medical centres (Shi et al, 2024), the limb salvage rate, survival rate, and functional recovery rate of patients with pelvic osteosarcoma after standardized treatment have yet to achieve the satisfactory thresholds.

The treatment of pelvic osteosarcoma, with a focus on restoring the patient's limb function, achieving long-term survival, and improving the clinical cure rate, is the gold-standard treatment for pelvic malignant tumors, becoming a hot research topic worldwide, and encouraging extensive follow-up studies. Multiple factors contribute to the prognosis of pelvic osteosarcoma, and the identification and resolution of these factors are currently the subject of intense research. In this study, we conducted a retrospective analysis of the diagnostic and therapeutic practices utilizing data obtained from Surveillance, Epidemiology, and End Results (SEER) databases and those from Hangzhou Third People's Hospital, aiming to identify potential prognostic indicators for pelvic osteosarcoma.

Methods

Patients

Clinical data were collected from the SEER database, which is supported by the National Cancer Institute (NCI) and contains data of nearly half of the U.S. population today. The SEER*Stat software (version 8.4.3) (<https://seer.cancer.gov/seerstat>) was used to extract clinical information. We applied the primary site codes C41.1 for pelvic bones, sacrum, coccyx and associated joints, and the International Classification of Diseases for Oncology, Third Edition (ICD-O-3) histologic codes like 9180/3 (osteosarcoma, not otherwise specified (NOS)), 9181/3 (chondroblastic

osteosarcoma), 9182/3 (fibroblastic osteosarcoma), 9183/3 (telangiectatic osteosarcoma), 9184/3 (osteosarcoma in Paget disease of bone), 9185/3 (small cell osteosarcoma), 9186/3 (central osteosarcoma), 9187/3 (intraosseous well-differentiated osteosarcoma), 9192/3 (parosteal osteosarcoma), 9193/3 (periosteal osteosarcoma), and 9194/3 (high-grade surface osteosarcoma). Patients without pathological diagnosis, surgical information, survival time, lung metastasis information, bone metastasis information, and tumor size information were excluded from the present study. Data of a range of clinical characteristics were extracted, including the year of diagnosis, age at diagnosis, race, primary site, metastatic site (including bone and lung), tumor size, chemotherapy, radiation, surgery of the primary tumor, surgery for metastatic lesions, survival months and vital status.

This study also retrospectively collected the clinical data of patients initially diagnosed with osteosarcoma at Hangzhou Third People's Hospital from January 2016 to December 2023, which served as an external validation cohort. The last follow-up time was on 16 May 2024. Patients with unknown age, tumor size, chemotherapy, radiotherapy information, surgical method, surgical method of metastasis, metastasis site information and no follow-up were excluded. This study was reviewed and approved by the Medical Ethics Committee of Hangzhou Third People's Hospital (Ethical reference number: 2024KA086). Given the nature of this research, the process of obtaining written informed consent was exempted by the Medical Ethics Committee of Hangzhou Third People's Hospital.

Statistical Analysis and Construction of Nomogram

Quantitative data are expressed as medians, while qualitative data are presented as counts and percentages. The normality and skewness of these variables were assessed using the Shapiro-Wilk test. Non-normally distributed data are presented as the median and interquartile range (M [P25, P75]), and inter-group comparison for these data was achieved using the Mann-Whitney U test. Comparisons between groups were performed using a *t*-test or analysis of variance for continuous variables. Categorical variables were compared using the Pearson's chi-square test, Fisher exact test and calibrated chi-square test. When the data is 2 rows and 2 columns, the Pearson's chi-square test is used for $T \geq 5$, the calibrated chi-square test is used for $1 \leq T < 5$, and the Fisher exact test is used for $T < 1$. When the data is 2 rows and 3 columns, the Pearson's chi-square test is used for less than 20% $T < 5$ and Fisher's exact test is used for above 20% $T < 5$ or $T < 1$.

The X-tile software (version 3.6.1, Yale University, New Haven, CT, USA) was utilized to determine the optimal cutoff value of continuous variables. The chi-square test was employed to compare clinicopathological parameters. For survival analysis, the Kaplan-Meier estimation method was conducted alongside the log-rank test to compare differences between groups. Univariate and multivariable Cox regression analyses were conducted to determine the predictive capability of significant parameters ($p < 0.05$).

A nomogram was developed to predict the 1-year, 2-year, and 3-year overall survival (OS). The discriminative ability of the nomogram was measured in terms of the area under the curve (AUC) and the receiver operating characteris-

tic (ROC). Calibration plots were constructed after 200 bootstrap resamplings, and the C-index score was calculated to evaluate the predictive power of the nomogram. Data processing and analysis were performed using R (version 4.2.3) (<https://www.r-project.org/>) and Zstats v0.90 (<https://www.medsta.cn/software>).

Results

Characteristics of the Population

The training cohort for this study was made up of 62 patients diagnosed with pelvic osteosarcoma selected from the SEER database. Separately, 31 patients recruited from the Hangzhou Third People's Hospital formed the validation cohort. The screening process for both cohorts is graphically represented in Fig. 1.

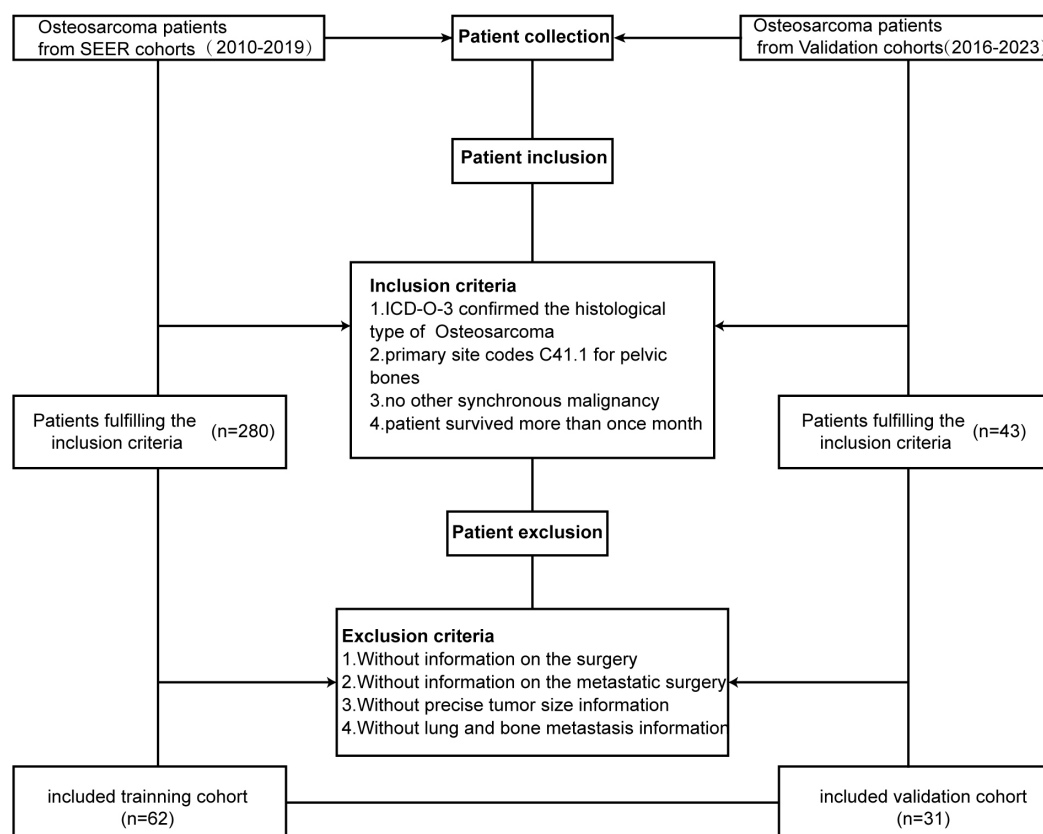


Fig. 1. Flowchart for patient selection and inclusion. SEER, Surveillance, Epidemiology, and End Results; ICD-O-3, International Classification of Diseases for Oncology, Third Edition.

The clinical characteristics of both cohorts are outlined in Table 1. In the training cohort, the median age of diagnosis was 34 years (14–82 years) and in the validation cohort, it was 27 years (11–69 years). The training cohort had a median survival time of 30 months (1–119 months), while the validation cohort had a median survival time of 17.5 months (6–96 months). The mean tumor sizes were 115 mm (20–199 mm) and 101 mm (25–206 mm) in the training cohort and the validation cohort, respectively.

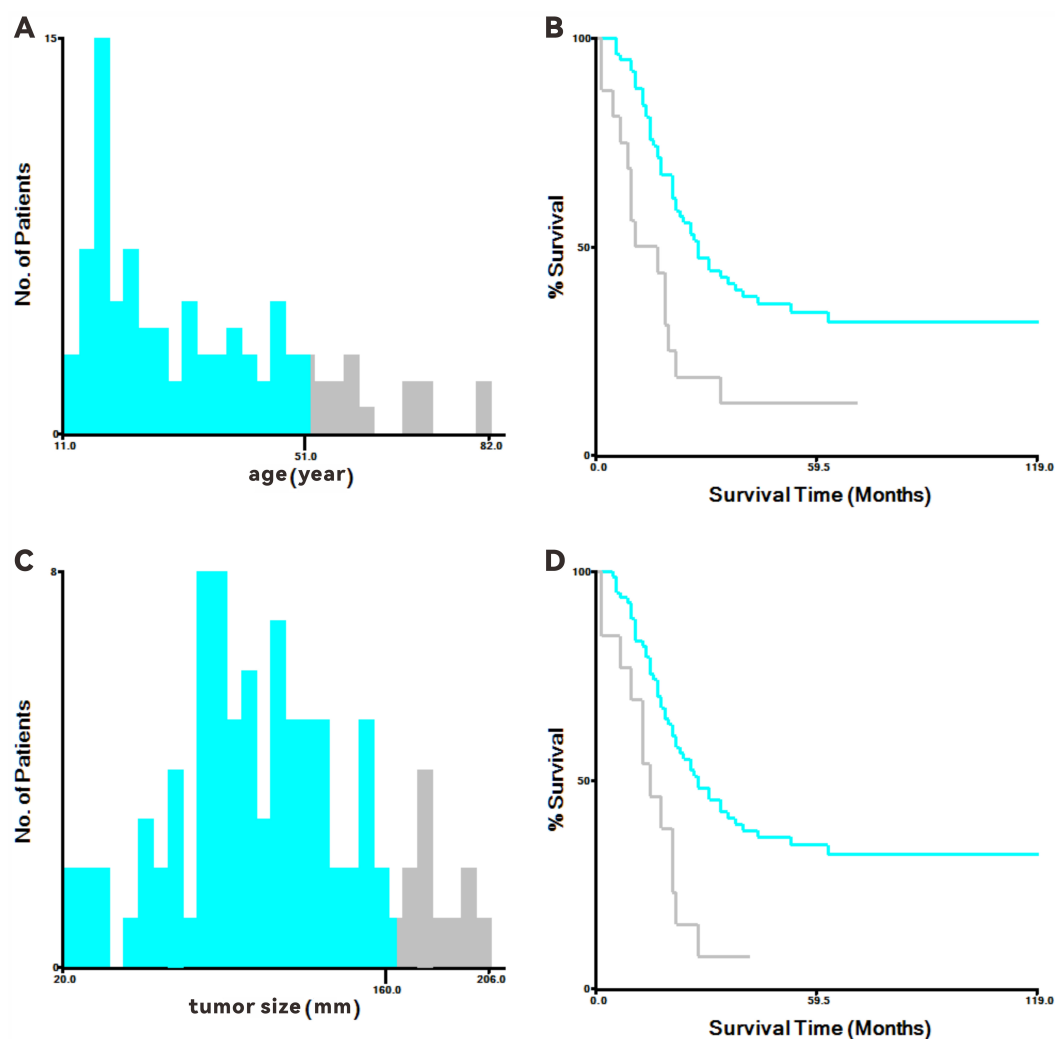


Fig. 2. The optimal cutoff value. (A,B) The optimal cutoff value of age is identified by an X-tile. (C,D) The optimal cutoff value of tumor size identified by X-tile.

In the training cohort, there were 33 female patients (53.23%) and 29 male patients (46.77%). Among them, tumors were found to be located in the left pelvis in 24 patients (38.71%) and the right pelvis in 25 cases (40.32%), whereas the tumor location was unspecified in 13 cases (20.97%). Additionally, 51 patients (82.26%) were white, 8 patients (12.90%) were black, and 3 patients (4.84%) were of other races. Among the 36 patients who received surgical treatment, 12 cases (19.35%) underwent major amputation, and 24 cases (38.71%) underwent partial or radical surgery. Seventeen patients experienced lung metastasis, and five patients had bone metastasis, but none of the screened patients had received metastatic surgery. Furthermore, 56 patients (90.32%) received chemotherapy and 17 patients (27.42%) were treated with radiotherapy. As of the follow-up deadline, 49 patients (79.03%) had died.

In the validation cohort, there were 11 female patients (35.48%) and 20 male patients (64.52%). Among the subjects in the validation cohort, tumors were found in the left pelvis for 11 patients (35.48%) and in the right pelvis for 19 cases (61.29%), but the location remains unclear for one case (3.23%). All patients received chemother-

apy. Out of the 30 patients who received surgical treatment, seven cases (22.58%) underwent major amputation while 23 cases (74.19%) underwent partial or radical surgery. Additionally, lung metastases were detected in 15 patients (48.39%), while bone metastases were observed in three patients (9.68%). Separately, three patients (9.68%) underwent metastatic surgery and five patients (16.13%) received radiotherapy. By the deadline of follow-up, 12 patients (38.70%) were reported deceased.

Table 1. Baseline characteristics of the training cohort and validation cohort.

Variables	Total (n = 93)	Training (n = 62)	Validation (n = 31)	Statistic	p-value
Survival time (months), median (Q ₁ , Q ₃)	21 (12, 14)	30 (19.5, 45)	17.5 (12, 36)	Z = -1.65	0.1
Tumor size (mm), mean ± SD	110.71 ± 43.17	115.16 ± 41.03	101.81 ± 46.57	t = -1.41	0.161
Age (years), median (Q ₁ , Q ₃)	29 (18, 46)	34 (17, 46)	27 (19, 46.75)	Z = -0.15	0.880
Sex, n (%)				$\chi^2 = 2.61$	0.106
Female	44 (47.31)	33 (53.23)	11 (35.48)		
Male	49 (52.69)	29 (46.77)	20 (64.52)		
Laterality, n (%)				$\chi^2 = 6.229$	0.043
Left	35 (37.63)	24 (38.71)	11 (35.48)		
Not a paired site	14 (15.05)	13 (20.97)	1 (3.23)		
Right	44 (47.31)	25 (40.32)	19 (61.29)		
Chemotherapy, n (%)				/	0.173
No	6 (6.45)	6 (9.68)	0 (0.00)		
Yes	87 (93.55)	56 (90.32)	31 (100.00)		
Bone metastasis, n (%)				$\chi^2 = 0.00$	1.000
No	85 (91.40)	57 (91.94)	28 (90.32)		
Yes	8 (8.60)	5 (8.06)	3 (9.68)		
Lung metastasis, n (%)				$\chi^2 = 4.03$	0.045
No	61 (65.59)	45 (72.58)	16 (51.61)		
Yes	32 (34.41)	17 (27.42)	15 (48.39)		
Surgery of other regional sites, n (%)				/	0.035
None	90 (96.77)	62 (100.00)	28 (90.32)		
Yes	3 (3.23)	0 (0.00)	3 (9.68)		
Surgery, n (%)				$\chi^2 = 15.921$	<0.001
Major amputation	19 (20.43)	12 (19.35)	7 (22.58)		
None	27 (29.03)	26 (41.94)	1 (3.23)		
Partial or radical surgery	47 (50.54)	24 (38.71)	23 (74.19)		
Radiation, n (%)				$\chi^2 = 1.46$	0.227
No	71 (76.34)	45 (72.58)	26 (83.87)		
Yes	22 (23.66)	17 (27.42)	5 (16.13)		
Race, n (%)				/	<0.001
Black	8 (8.60)	8 (12.90)	0 (0.00)		
Other	34 (36.56)	3 (4.84)	31 (100.00)		
White	51 (54.84)	51 (82.26)	0 (0.00)		

Risk Factors of Osteosarcoma

After analyzing 93 patients using X-tile software, the results showed that the optimal cutoff point for age was 51 years old, and the optimal cutoff point for tumor size was 160 mm (Fig. 2).

To further clarify prognostic factors, a Kaplan-Meier analysis of data gathered from 93 patients was conducted (Table 2). The study showed that patients of other races, age ≤ 51 , and tumor size ≤ 160 mm survived longer (Fig. 3), while those without surgery on the primary site, having lung metastasis, and who had received radiation therapy had shorter survival times (Supplementary Fig. 1).

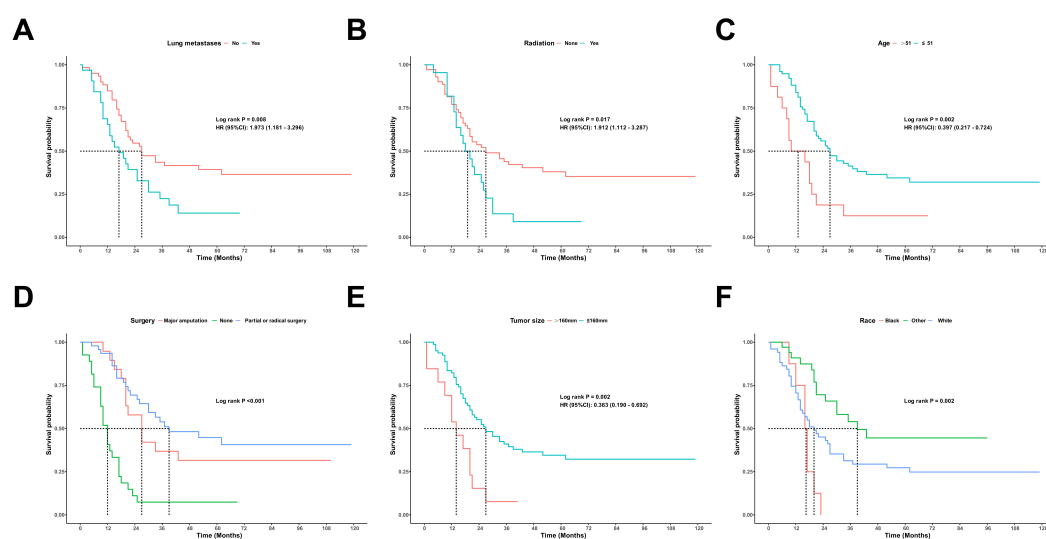


Fig. 3. Kaplan-Meier curves of overall survival for pelvic osteosarcoma. (A) Lung metastases. (B) Radiation. (C) Age. (D) Surgery. (E) Tumor size. (F) Race. HR, hazard ratio; CI, confidence interval.

Univariate regression analysis was used to assess the impact of clinicopathological variables on OS. The results indicated that lung metastasis, lack of surgical treatment, and radiation were all identified as risk factors for a poorer OS, while other races, tumor size ≤ 160 mm, and age ≤ 51 years were identified as risk factors for a better OS.

Lung metastasis, other races, tumor size ≤ 160 mm, and age ≤ 51 years were independent prognostic factors, as identified by multivariate analysis with Cox regression. Specifically, lung metastasis was highlighted as an independent predictor of a worse OS (hazard ratio (HR): 2.57; 95% confidence interval (CI): 1.29–5.13; $p = 0.008$), while in other races, tumor size ≤ 160 mm, and age ≤ 51 years were determined as independent predictors of improved OS (Table 3).

Univariate and Multivariate Cox Regression Analyses of Training Cohort Data

After analyzing the training cohort data using X-tile software, the results showed that the best cutoff point for age was 40 years old, and the best cutoff point for tumor size was 170 mm (Fig. 4).

Table 2. Median survival time of patients categorized based on different variables.

Variable	n	Median survival time (months)
Sex		
Female	44	23
Male	49	25
Laterality		
Left	35	20
Not a paired site	14	20
Right	44	27
Chemotherapy		
No	6	25.5
Yes	87	23
Bone metastasis		
No	85	25
Yes	8	22
Lung metastasis		
No	35	27
Yes	26	17
Surgery of other regional sites		
No	90	21
Yes	3	NA
Surgery		
Major amputation	19	27
None	27	12
Partial or radical surgery	47	39
Radiation		
No	71	27
Yes	22	19
Race		
Black	8	16.5
Other	15	39
White	38	20
Tumor size		
>160 mm	13	14
≤160 mm	80	27
Age		
>51 years	16	13
≤51 years	77	27

Univariate Cox regression analysis of the training cohort data revealed that five variables were closely related to the prognosis of pelvic osteosarcoma, including age, lung metastasis, primary tumor surgery, and tumor size ($p < 0.05$). The significant variables identified in the univariate Cox regression analysis were then included in a multivariate Cox regression analysis, which revealed that age, lung metastasis, and tumor size were independent risk factors for patients with pelvic osteosarcoma (Table 4).

Table 3. Univariate and multivariate Cox analyses of factors related to overall survival in pelvic osteosarcoma.

Variable	Univariate regression analysis			Cox regression analysis		
	HR	95% CI	<i>p</i> -value	HR	95% CI	<i>p</i> -value
Sex						
Female	ref					
Male	0.81	0.49–1.34	0.411			
Laterality						
Left	ref					
Not a paired site	1.24	0.62–2.48	0.550			
Right	0.73	0.42–1.28	0.277			
Chemotherapy						
No	ref					
Yes	0.78	0.31–1.96	0.602			
Bone metastasis						
No	ref					
Yes	1.41	0.64–3.11	0.392			
Lung metastasis						
No	ref			ref		
Yes	1.96	1.17–3.28	0.010	2.57	1.29–5.13	0.008
Surgery of other regional sites						
No	ref					
Yes	0.00	0.00–Inf	0.995			
Surgery						
Major amputation	ref					
None	3.60	1.81–7.15	<0.001	1.80	0.79–4.13	0.162
Partial or radical surgery	0.73	0.37–1.45	0.370	1.04	0.51–2.15	0.910
Radiation						
No	ref					
Yes	1.89	1.10–3.25	0.021	1.69	0.92–3.10	0.088
Race						
Black	ref			ref		
Other	0.24	0.10–0.57	0.001	0.23	0.07–0.75	0.015
White	0.47	0.21–1.03	0.059	0.73	0.30–1.76	0.486
Tumor size						
>160 mm	ref			ref		
≤160 mm	0.37	0.20–0.71	0.003	0.28	0.13–0.62	0.001
Age						
>51 years	ref			ref		
≤51 years	0.4	0.22–0.73	0.003	0.3	0.16–0.59	<0.001

Ref refers to reference, and inf refers to infimum. HR, hazard ratio; CI, confidence interval.

Nomogram Construction

Three risk factors identified from the multivariate Cox analysis for the training cohort data were integrated to predict the 1-year, 2-year, and 3-year OS probability (Fig. 5).

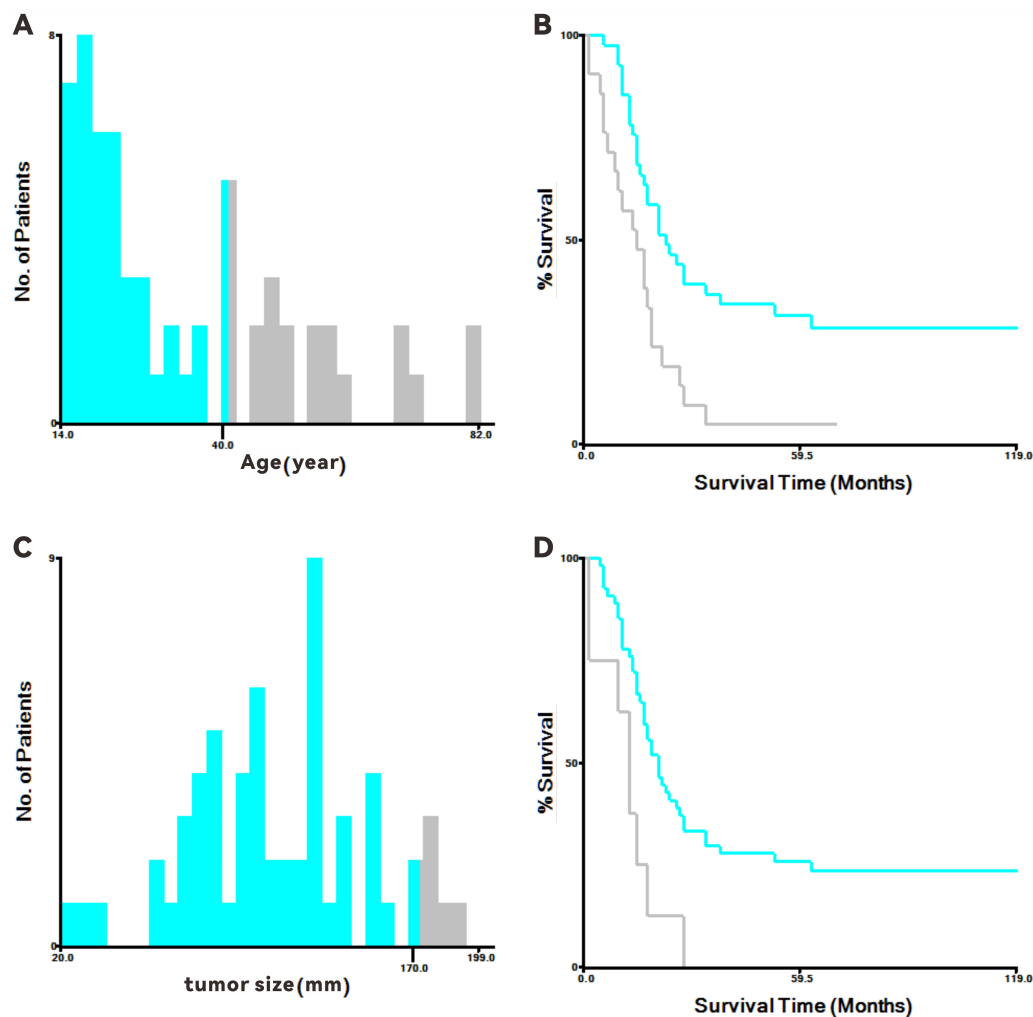


Fig. 4. The optimal cutoff value. (A,B) The optimal cutoff value of age in the training cohort was identified by X-tile software. (C,D) The optimal cutoff value of tumor size in the training cohort was also identified by X-tile software.

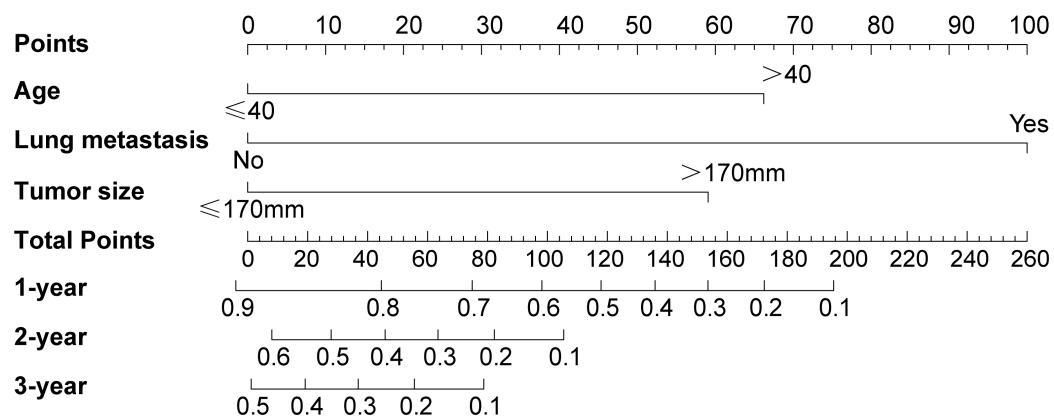


Fig. 5. Nomogram for predicting 1-year, 2-year and 3-year overall survival (OS).

The nomogram developed was internally and externally verified by evaluating its discriminative ability and calibration of the model. After bootstrap resampling of the training cohort, the bias-corrected C-index is 0.72 (95% CI: 0.65–0.79). The

Table 4. Univariate and multivariate Cox analyses of factors related to the overall survival in training cohort.

Variable	Univariate regression analysis			Cox regression analysis		
	HR	95% CI	<i>p</i> -value	HR	95% CI	<i>p</i> -value
Sex						
Female	ref					
Male	1.08	0.62–1.89	0.788			
Age						
>40	ref					
≤40	0.41	0.23–0.74	0.003	0.37	0.20–0.68	0.001
Laterality						
Left	ref					
Not a paired site	1.15	0.55–2.39	0.717			
Right	0.597	0.62–2.27	0.597			
Chemotherapy						
No	ref					
Yes	1.05	0.42–2.66	0.913			
Bone metastasis						
No	ref					
Yes	1.24	0.44–3.46	0.683			
Lung metastasis						
No	ref			ref		
Yes	3.44	1.82–6.49	<0.001	4.48	2.27–8.84	<0.001
Surgery						
Major amputation	ref					
None	2.43	1.15–5.15	0.021			
Partial or radical surgery	0.66	0.29–1.47	0.309			
Radiation						
No	ref					
Yes	1.70	0.92–3.13	0.090			
Race						
Black	ref					
Other	1.15	0.30–4.33	0.841			
White	0.51	0.23–1.13	0.097			
Tumor size						
>170 mm	ref			ref		
≤170 mm	0.35	0.16–0.77	0.009	0.42	0.19–0.93	0.033

AUCs for training cohort patients at 1-year, 2-year, and 3-year OS were 0.81 (95% CI: 0.68–0.94), 0.75 (95% CI: 0.63–0.86), 0.80 (95% CI: 0.70–0.89) (Fig. 6A–C). The validation cohort showed that the C-index of OS was 0.70 (95% CI: 0.53–0.87), and the AUCs of patients at 1-year, 2-year, and 3-year OS were 0.67 (95% CI: 0.30–1.04), 0.66 (95% CI: 0.43–0.90), 0.71 (95% CI: 0.50–0.93) (Fig. 6D–F). Fig. 7 displays the internal and external calibration plots. The calibration plots revealed the initial nomogram's poor accuracy for predicting 1-, 2-, and 3-year

survival rates. The quantity and quality differences between the SEER database and validation cohort, along with the small sample size, could influence the accuracy of the model.

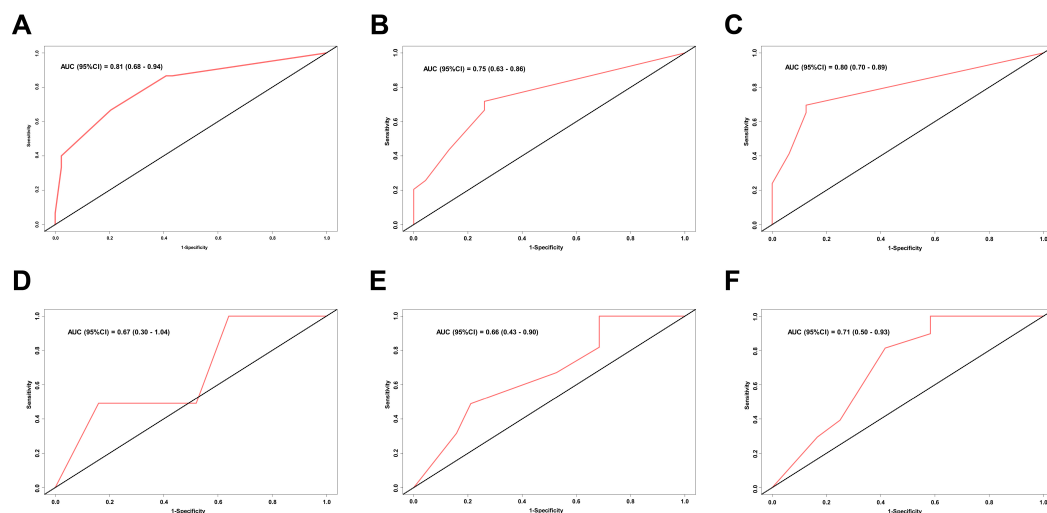


Fig. 6. The receiver operating characteristic (ROC) curves of 1-year, 2-year, and 3-year overall survival of (A–C) the training cohort and (D–F) the validation cohort. AUC, the area under the curve.

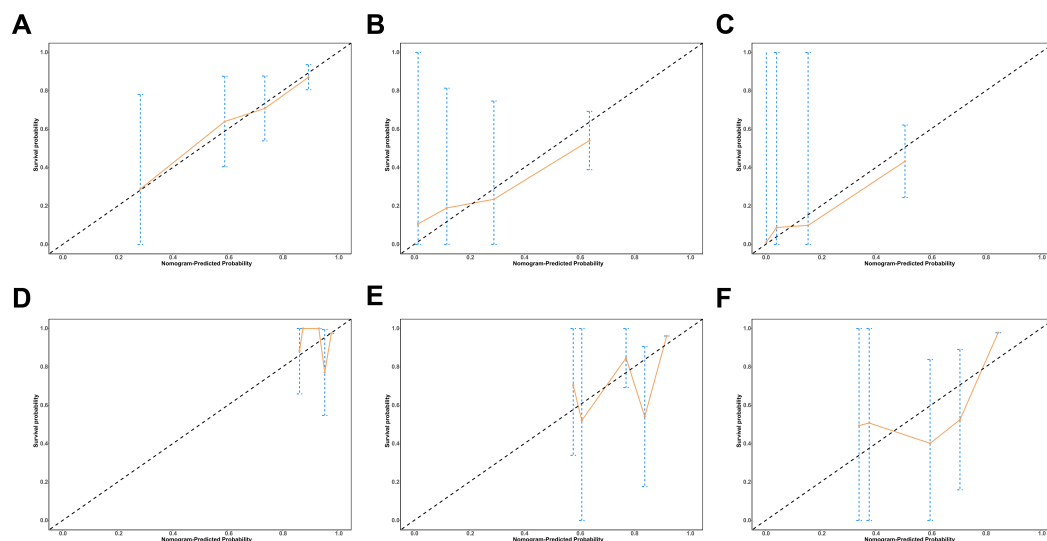


Fig. 7. Calibration curve of the nomogram for predicting 1-year, 2-year, and 3-year overall survival in (A–C) the training cohort and (D–F) the validation cohort.

Discussion

Pelvic osteosarcoma accounts for less than 10% of all osteosarcoma cases. A repertoire of independent factors associated with osteosarcoma in patients, including children and elderly individuals, have been identified in various studies. How-

ever, research concerning pelvic osteosarcoma was rarely reported in the literature. Through this research, we found that age, lung metastasis, and tumor size are significant independent prognostic indicators for pelvic osteosarcoma.

Typically, the incidence of cancer increases with age, but the incidence of osteosarcoma is recognized for its distinctive bimodal age distribution (Desai and Guddati, 2022). Several studies have shown that age is a common prognostic factor for osteosarcoma (Bacci et al, 2006; Sadykova et al, 2020; Wu et al, 2023). Patients over 40 years old have a lower survival rate, compared to adolescent patients, possibly due to their reduced ability to tolerate intensive therapy or the location of the tumor (Kim et al, 2023). At present, high-dose methotrexate, cisplatin, doxorubicin and ifosfamide are the predominant chemotherapy drugs. Elderly patients are vulnerable to the more adverse side effects attributed to these drugs, which can impact the final outcome. Additionally, the prognosis for axial tumors is poorer compared with that for limb tumors (Collins et al, 2013). Axial osteosarcoma typically occurs in adults and is associated with a later age at diagnosis (Ottesen et al, 2022), consistent with the findings of poor prognosis and older age at diagnosis reported by Takenaka et al (2021). Our results revealed that the median age of onset for pelvic osteosarcoma was approximately 34 years old, and younger age was a favourable prognostic factor for pelvic osteosarcoma.

The initial tumor size is a crucial prognostic factor for osteosarcoma that can be easily determined, playing a foundational role in designing risk-adapted therapy (Bieling et al, 1996). A retrospective analysis revealed that necrosis rates, tumor size ≥ 10 cm, and distant metastasis were significantly associated with low survival rates in osteosarcoma (Erdoğan et al, 2023). Pelvic osteosarcoma is typically unresectable, presenting a large tumor volume with a diameter of more than 10 cm at the time of diagnosis, presenting a challenge for local treatment (Chen et al, 2023). Tumor size is a determining factor in whether pelvic osteosarcoma can be completely treated, and complete surgical resection is essential for tumor treatment (Laitinen et al, 2023). Our results indicate that tumor size is an independent prognostic factor for pelvic osteosarcoma, with larger tumors associated with worse outcomes. The lung is the most common site of metastasis arising from osteosarcoma. The occurrence of lung metastasis signifies the onset of chemotherapy resistance. Unfortunately, it has been observed that poor prognosis is the likely outcome, regardless of whether radical chemotherapy is implemented before or after metastasis (Saraf et al, 2018). Our analysis supports these results and indicates that bone metastasis does not appear to affect the prognosis of pelvic osteosarcoma.

Kaplan-Meier analysis of the data of 93 patients revealed that primary tumor surgery is a potential prognostic factor, although it was not found to be significant in the multivariate Cox regression analysis. However, a study had shown that primary lesion resection may provide survival benefits for patients with metastatic chondrosarcoma, but not for those with metastatic pelvic osteosarcoma (Hu et al, 2023). Unfortunately, this external finding cannot be verified in this study, since the patients selected from the SEER database, we reviewed had never received surgery as a treatment for metastases. Additionally, we observed that race factor seems to impact the prognosis of pelvic osteosarcoma, with the individuals of other races

(Asians) living the longest while the black individuals having the shortest survival duration. Previous study had also noted significantly lower average survival times for black individuals with osteosarcoma of the extremities and lung metastasis (Liu et al, 2023). Furthermore, sacral involvement has been identified as a poor prognostic factor for patients with pelvic osteosarcoma. The complex pelvic anatomy and proximity of urogenital organs to the sacrum may significantly hamper surgical resection (Saab et al, 2005). It is important to note that according to our Kaplan-Meier analysis results, the survival period for individuals receiving radiotherapy was shorter, which does not align with real-world results. Future studies should include more treatment-related information and parameters for comprehensive research.

The current study showed that individuals of other races (Asians), aged ≤ 51 years old, and with a tumor size ≤ 160 mm were associated with longer survival times, according to the results from Kaplan-Meier survival analysis. Conversely, no primary tumor surgery, lung metastasis, and lack of radiotherapy were associated with shorter survival duration. The multivariate Cox proportional hazard model confirmed that age, lung metastasis, and tumor size were independent prognostic factors for pelvic osteosarcoma. In the analysis of the SEER data, we identified three independent variables: age, lung metastasis, and tumor size, which were utilized to develop a predictive nomogram validated in a Chinese cohort. The ROC curve analysis revealed that the AUCs for predicting 1-year, 2-year, and 3-year survival rates were 0.81, 0.75, and 0.80, respectively, in the training cohort, and 0.67, 0.66, and 0.71, respectively, in the validation cohort. These data indicated that the AUCs for predicting 1-year and 2-year survival rates in the validation cohort were less accurate. We speculate that this reduced accuracy may be caused by the inherent dataset differences between the datasets of the two cohorts, which has an impact on model construction. One prominent distinction between the training cohort (from the SEER database) and the validation cohort is their treatment profiles; for instance, all patients from the training cohort had never received metastatic surgery for treatment and did not have complete data on radiotherapy and chemotherapy, while all patients from the validation cohort had received chemotherapy.

Several limitations of this study should be highlighted. Firstly, in this retrospective analysis, there are certain differences between the validation group and the Training group. Secondly, both the training cohort and the validation cohort had small sample size attributed to the low incidence of pelvic osteosarcoma. Therefore, the findings of this study should be further validated through multicentre, large-sample prospective studies.

Conclusion

The present research unveils that age, tumor size, race, primary tumor surgery, lung metastasis, and radiation therapy may be associated with the survival time of osteosarcoma, whereas age, lung metastasis, and tumor size are independent prognostic factors for pelvic osteosarcoma. Based on these data, a predictive nomogram was constructed and validated in a Chinese cohort. To verify the findings of this

study and enhance the predictive ability of the nomogram constructed, large-sample prospective studies are warranted in future for further validation.

Key Points

- The prognosis of pelvic osteosarcoma is closely related to age, tumor size and lung metastasis.
- Race, primary tumor surgery, and radiotherapy may be related to the survival time of patients with pelvic osteosarcoma.
- Three independent prognostic factors identified from the training cohort (based on the SEER database) were utilized for constructing a nomogram, which was then validated in a Chinese cohort.
- The use of a nomogram can effectively predict the OS of patients with pelvic osteosarcoma and help facilitate clinical decision-making.

Availability of Data and Materials

All the data of this study are included in this article and supplementary files.

Author Contributions

YFX, QYY and JWY designed the research study. MC, JLC, YWY and YXL performed the research. YFX and QYY drafted the manuscript. All authors contributed to the important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

This study involved human subjects, which was reviewed and approved by the Medical Ethics Committee of Hangzhou Third People's Hospital (Ethical reference number: 2024KA086). This study was conducted in accordance with the Declaration of Helsinki. According to the requirements, this study can be exempted from written informed consent by the Medical Ethics Committee of Hangzhou Third People's Hospital.

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Conflict of Interest

The authors declare no conflict of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at <https://www.magonlinelibrary.com/doi/suppl/10.12968/hmed.2024.0339>.

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