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# Prognosis of solitary bone plasmacytoma of the extremities

## A SEER-based study

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**Abstract**

Due to the rarity of solitary bone plasmacytoma (SBP), few studies reported the prognosis and survival predictors of SBP, especially for patients with extremity SBP.

A total of 552 patients with extremity SBP were identified from the Surveillance Epidemiology and Ends Results (SEER) database between 1973 and 2016. In order to obtain independent predictors of survival, we performed both univariate and multivariate analysis via Cox proportional hazards model. Additionally, we used the Kaplan-Meier method to construct survival curves.

The mean and median age at diagnosis of all patients were 64 and 65 years, respectively. The ratio of male versus women was 1.3:1. Overall survival for this special population was 51.2% and 34.9% at 5 and 10 years, respectively. Cancer-specific survival (CSS) for this special population was 63.5% and 47.5% at 5 and 10 years, respectively. Age at diagnosis and radiotherapy treatment were found to be significant independent predictors of both overall survival and CSS. Additionally, multivariate analysis showed that year of diagnosis and marital status were significantly correlated with CSS.

This is the first study to identify prognostic factors of extremity SBP by using the SEER database. Our findings highlight that radiotherapy is the mainstream treatment for extremity SBP. Additionally, age, year of diagnosis, and marital status were significant independent predictors of survival. Knowledge of these survival predictors may help clinicians provide appropriate management for extremity SBP patients.

**Abbreviations:** CSS = cancer-specific survival, MM = multiple myeloma, OS = overall survival, SBP = solitary bone plasmacytoma, SEER = Surveillance, Epidemiology, and End Results, SP = solitary plasmacytoma.

**Keywords:** clinical features, extremity, prognosis, solitary bone plasmacytoma

## 1. Introduction

Solitary plasmacytoma (SP) is a monoclonal gamma globulin disease with unknown causes, which is characterized with locally proliferating plasma cell tumors and without systemic diseases.[1] According to the site of involvement, SP can be divided into 2 types: solitary bone plasmacytoma (SBP) and solitary extramedullary plasmacytoma (SEP). SBP accounts for about 70% of SP, and most commonly occurs in the axial skeleton.[2–4] The median age at diagnosis ranges from 55 to 60 years with male predominance.[5] Patients with SBP have a worse prognosis than SEP cases.[6] Additionally, patients with extremity SBP have a better prognosis than spinal SBP cases.[7]

Although there are many advanced treatment methods for SBP, radiotherapy remains the primary therapy.[8] Surgery is usually performed to treat SBP or prevent its complications.[9] However, the role of surgery in increasing survival remains unknown. Moreover, chemotherapy for treatment of SP is still controversial.[1] To our knowledge, few studies have reported prognosis and treatment methods of patients with extremity SBP due to its rarity. Therefore, this large-scale study is aimed to reveal the clinical features and explore the prognostic predictors among patients with extremity SBP.

## 2. Materials and methods

### 2.1. Patient population

We identified SBP cases by using the specific codes (9731/3) of the International Classification of Diseases for Oncology, 3rd edition from the publicly available Surveillance, Epidemiology, and End Results (SEER) database. The present study was conducted according to standard rules and approved by the Institutional Review Board of Taizhou Tumor Hospital. We only included SBP

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*The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.*

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cases located in the extremity. All cases were confirmed by histopathology. Patients with unknown variables were excluded. We extracted patients' data from the SEER database, including race, age at diagnosis, sex, year of diagnosis, marital status at diagnosis, surgery, radiotherapy, chemotherapy, vital status, death cause, and survival month. Cause-specific survival (CSS) was calculated as the duration from diagnosis to death due specifically to SBP.[10,11]

### 2.2. Statistical analysis

We used the IBM SPSS Statistics 22 software to perform statistical analyses. Both univariate and multivariate analyses were performed to obtain independent predictors of overall survival (OS) and CSS via the Cox proportional hazards model. Only variables with $P < .05$ from univariate Cox analysis were subsequently integrated into the multivariable analysis to confirm the independent predictors of survival. Survival curves were constructed by using the Kaplan-Meier method. A 2-tailed $P < .05$ was considered as statistically significant.

## 3. Results

### 3.1. Baseline information

The sociodemographic and clinical characteristics of 552 patients with extremity SBP were shown in Table 1. White people accounted for 81.3%. The mean and median age at diagnosis of all cases were 64 and 65 years, respectively. More than half of patients (60.9%) were aged >60 years. The ratio of male versus women was 1.3:1. Regarding the year of diagnosis, patients diagnosed before 2000 were 12.7%, patients diagnosed between 2000 to 2009 were 45.1%, and patients diagnosed after 2010 were 42.2%. Over half of the patients (62.9%) were married. Treatments included local radiotherapy (76.8%), local surgery (26.1%), and systemic chemotherapy (21.7%). OS for this special population was 51.2% and 34.9% at 5 and 10 years, respectively. CSS for this special population was 63.5% and 47.5% at 5 and 10 years, respectively.

**Table 1**

**Clinical characteristics of 552 patients with extremity SBP.**

| Variable | Value |
|---|---|
| *Race* | |
| White | 449 (81.3%) |
| Black | 78 (14.1%) |
| Others | 25 (4.5%) |
| *Age, y* | |
| ≤60 | 216 (39.1%) |
| >60 | 336 (60.9%) |
| *Sex* | |
| Female | 238 (43.1%) |
| Male | 314 (56.9%) |
| *Year of diagnosis* | |
| <2000 | 70 (12.7%) |
| 2000–2009 | 249 (45.1%) |
| ≥2010 | 233 (42.2%) |
| *Marital status at diagnosis* | |
| Married | 347 (62.9%) |
| Single | 65 (11.8%) |
| Other status | 140 (25.4%) |
| *Surgery* | |
| Yes | 144 (26.1%) |
| No | 408 (73.9%) |
| *Radiotherapy* | |
| Yes | 424 (76.8%) |
| No | 128 (23.2%) |
| *Chemotherapy* | |
| Yes | 120 (21.7%) |
| No | 432 (78.3%) |
| *Dead* | |
| Yes | 252 (45.7%) |
| No | 300 (54.3%) |
| *5-y OS rate* | 51.2% |
| *5-y CSS rate* | 63.5% |
| *10-y OS rate* | 34.9% |
| *10-y CSS rate* | 47.5% |

CSS = cancer-specific survival, OS = overall survival, SBP = solitary bone plasmacytoma.

### 3.2. Univariate survival analysis

Table 2 showed the results of univariate cox regression analysis of survival in detail. There were significant differences depending on age at diagnosis, sex, marital status at diagnosis, and radiotherapy in OS. Significant differences in CSS were found in terms of race, age at diagnosis, sex, year of diagnosis, marital status at diagnosis, and radiotherapy. Survival was worse for patients with age >60 compared to those with age ≤60 (Figure 1A and 2A). Patients diagnosed after 2010 experienced better CSS than others (Fig. 2B). Married patients exhibited a better CSS than other patients (Fig. 2C). Patients who did not receive radiotherapy had worse OS and CSS than those who received radiotherapy (Fig. 1B and 2D). Additionally, we observed no significant difference in OS and CSS in terms of chemotherapy or surgery.

### 3.3. Multivariate survival analysis

Based on the results of multivariate cox regression analysis (Table 3), age <60 years and radiotherapy performed were significantly associated with a better OS and CSS. Sex was not an independent predictor of either OS or CSS. Race had no effect on CSS. Additionally, year of diagnosis and marital status at diagnosis were significantly correlated with CSS.

## 4. Discussion

To date, there are no systematic clinical studies specifically analyzing patients with extremity SBP. Moreover, little is known about how to appropriately treat patients with extremity SBP and improve their prognosis. In this study, we first retrospectively analyzed the clinical characteristics and treatment methods of extremity SBP based on a large cohort of patients. Our study demonstrated that age at diagnosis and radiotherapy were significant independent predictors of both OS and CSS. Additionally, multivariate analysis showed that year of diagnosis and marital status at diagnosis were significantly correlated with CSS.

The median age at diagnosis of this special population was 65 years, which was in agreement with previous studies.[4,9,12] Multivariate analysis indicated that age ≤60 significantly predicted an improved OS and CSS among extremity SBP. Other studies on SP also revealed this finding.[12,13] Wang et al[12] reported that older age was a negative independent predictor of OS among patients with spinal SBP. Furthermore, age >60 years was associated with progression of plasmacytoma.[14] Sex was

**Table 2**

**Univariate Cox analysis of variables in patients with extremity SBP.**

| | OS | | CSS | |
|---|---|---|---|---|
| **Variable** | **Hazard ratio (95% CI)** | ***P*** | **Hazard ratio (95% CI)** | ***P*** |
| *Race* | | | | |
| White | 1 | | 1 | |
| Black | 0.603 (0.344–1.056) | .077 | 0.437 (0.192–0.994) | .048 |
| Others | 1.143 (0.606–2.155) | .679 | 0.916 (0.374–2.244) | .848 |
| *Age, y* | | | | |
| ≤60 | 1 | <.001 | 1 | <.001 |
| >60 | 2.680 (2.060–3.488) | | 2.701 (1.905–3.829) | |
| *Sex* | | .047 | | .011 |
| Female | 1 | | 1 | |
| Male | 0.794 (0.633–0.997) | .783 | 0.667 (0.488–0.913) | .116 |
| *Year of diagnosis* | | .119 | | .001 |
| <2000 | 1 | | 1 | |
| 2000–2009 | 0.958 (0.707–1.299) | .535 | 0.723 (0.483–1.083) | .804 |
| ≥2010 | 0.748 (0.519–1.078) | .001 | 0.427 (0.259–0.704) | <.001 |
| *Marital status at diagnosis* | | | | |
| Married | 1 | .612 | 1 | .621 |
| Single | 1.128 (0.770–1.654) | | 1.072 (0.620–1.853) | |
| Other status | 1.515 (1.179–1.948) | <.001 | 1.879 (1.337–2.641) | <.001 |
| *Surgery* | | | | |
| Yes | 1 | .249 | 1 | .161 |
| No | 1.068 (0.828–1.377) | | 1.094 (0.766–1.563) | |
| *Radiotherapy* | | | | |
| Yes | 1 | | 1 | |
| No | 1.977 (1.542–2.536) | | 2.124 (1.498–3.012) | |
| *Chemotherapy* | | | | |
| Yes | 1 | | 1 | |
| No | 0.852 (0.649–1.119) | | 0.770 (0.535–1.109) | |

CI = confidence interval, CSS = cancer-specific survival, OS = overall survival, SBP = solitary bone plasmacytoma.

not an independent predictor of OS or CSS. Additionally, predilection of males to females (1.3:1) is not obvious.

On multivariate analysis, we noted that marital status at diagnosis was significantly related to CSS. Married patients experienced favorable survival than single or other patients. Other types mainly include divorced, separated, widowed patients. Some studies also reported a survival benefit among married patients with malignant bone tumors.[15–17] Thus,

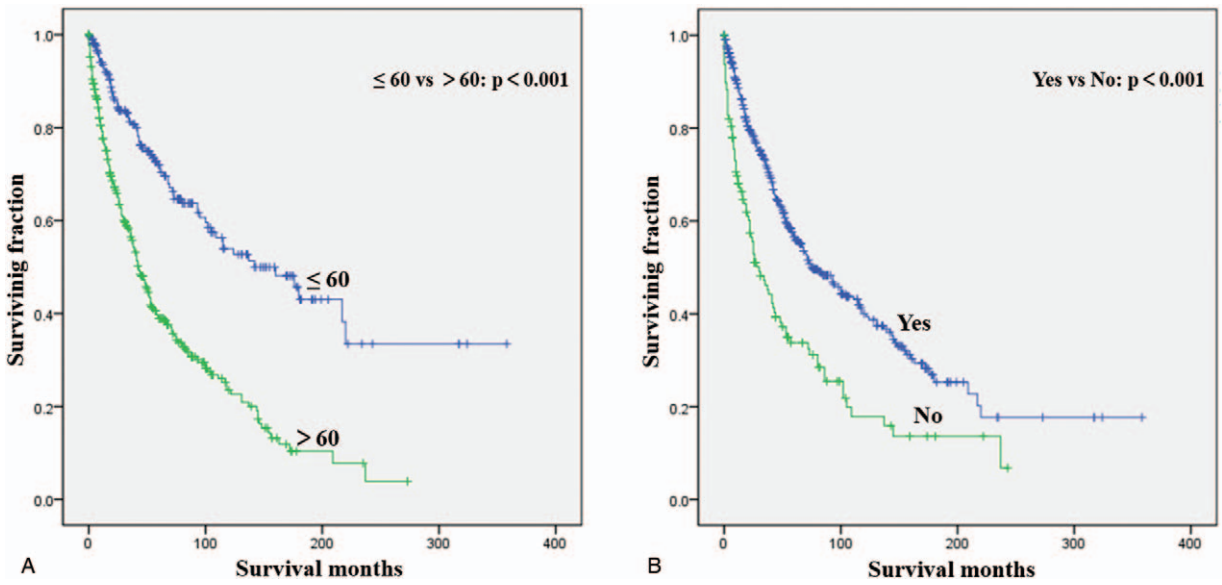


**Figure 1.** Kaplan-Meier method curves for OS in patients with extremity SPB stratified by (A) age at diagnosis and (B) radiotherapy. CSS = cancer-specific survival, OS = overall survival, SPB = solitary plasmacytoma of bone.

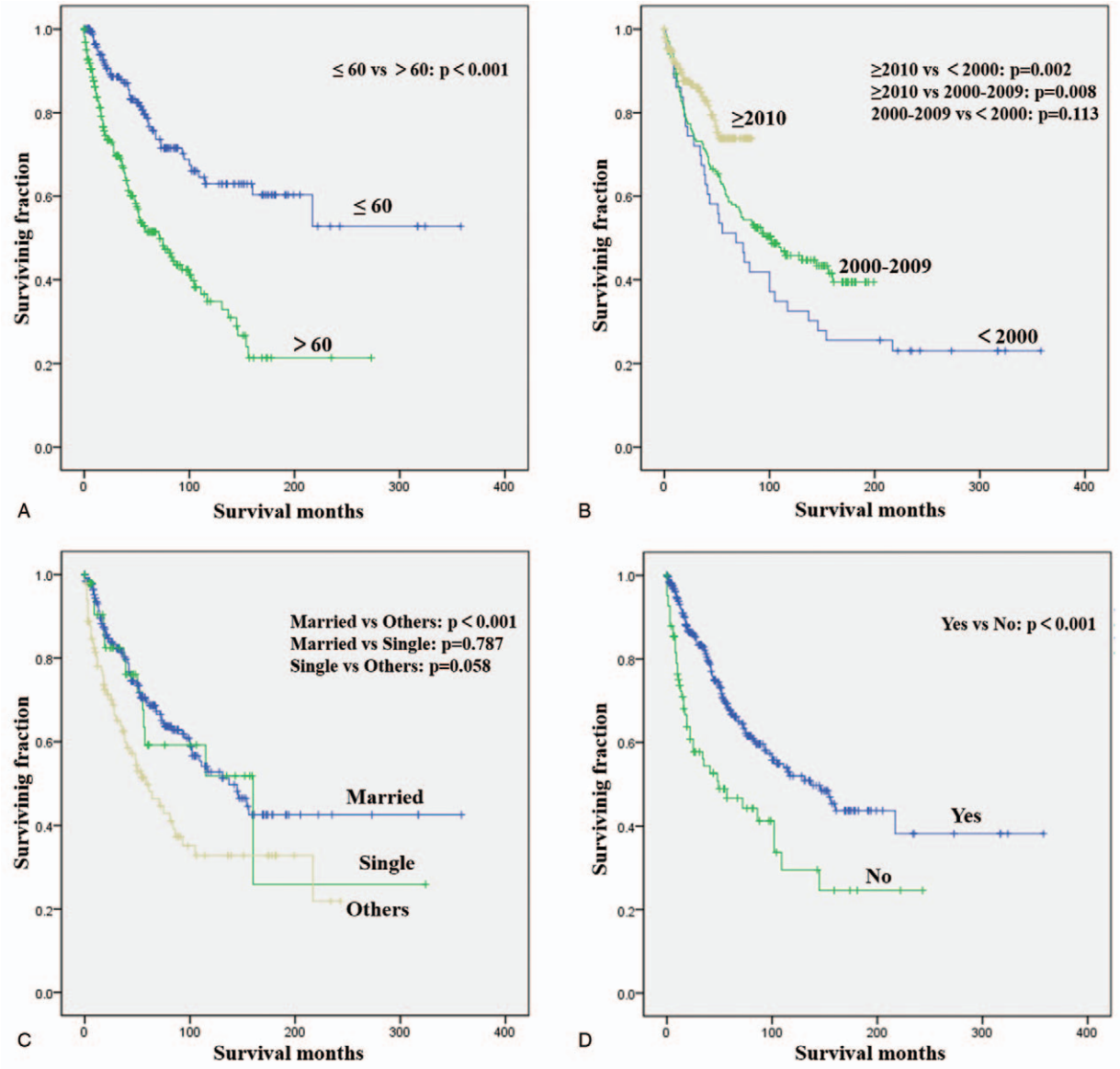


**Figure 2.** Kaplan-Meier curves for CSS in patients with extremity SPB stratified by (A) age at diagnosis, (B) year of diagnosis, (C) marital status at diagnosis, and (D) radiotherapy. CSS = cancer-specific survival, OS = overall survival, SPB = solitary plasmacytoma of bone.

social support and psychological intervention should be actively provided for those vulnerable groups.[18] Multivariate analysis also showed that cases diagnosed after 2010 were significantly associated with better CSS, which may be related to the improvement of modern diagnostic and treatment methods. Knobel et al[13] reported a 5-year OS rate of 70% among SBP patients, which was higher than ours (51.2%).

Surgery, radiotherapy and chemotherapy are currently used in SP, but radiotherapy is widely recognized as the mainstream treatment.[4,8] We also found radiotherapy could significantly prolong the OS and CSS of extremity SBP. The role of surgery in survival benefits for SBP remains unknown. This study first revealed that surgery did not improve survival in patients with extremity SBP. Furthermore, compared with radiotherapy alone, surgery combined with radiotherapy did not significantly prolong the life of patients (data not shown). Evidence also showed that high local control rates can be achieved with radiotherapy alone.[8] However, Huang et a.[19] retrospectively analyzed 19 patients with SP of cervical spine and concluded that surgery combined with radiotherapy can control local recurrences and reduce the risk of progression to multiple myeloma (MM). Thus, the advantage of combination therapy including surgical resection remains to be elucidated. Chemotherapy may slow the progressing to MM but may not decrease the survival.[8,20] Similarly, we found chemotherapy did not have a significant influence on survival.

Although this is the largest study of extremity SBP to date, there are some shortcomings. This is a retrospective observational study with possible bias. The database does not include the records of process of chemotherapy and radiotherapy. Additionally, data of progression to MM and tumor stage are lacking. But

**Table 3**

**Multivariate Cox analysis for OS and CSS for patients with extremity SBP.**

| | OS | | CSS | |
|---|---|---|---|---|
| **Variable** | **Hazard ratio (95% CI)** | ***P*** | **Hazard ratio (95% CI)** | ***P*** |
| *Race* | | | | |
| White | — | | 1 | |
| Black | — | — | 0.821 (0.339–1.992) | .663 |
| Others | — | — | 1.721 (0.652–4.544) | .273 |
| *Age, y* | | | | |
| <60 | 1 | <.001 | 1 | <.001 |
| >60 | 2.580 (1.973–3.376) | | 2.624 (1.838–3.748) | |
| *Sex* | | .584 | | .212 |
| Female | 1 | | 1 | |
| Male | 0.935 (0.736–1.189) | — | 0.811 (0.583–1.127) | .095 |
| *Year of diagnosis* | | — | | .001 |
| <2000 | — | | 1 | |
| 2000–2009 | — | .250 | 0.706 (0.469–1.062) | .317 |
| ≥2010 | — | .078 | 0.405 (0.234–0.703) | .009 |
| *Marital status at diagnosis* | | | | |
| Married | 1 | <.001 | 1 | <.001 |
| Single | 1.255 (0.852–1.847) | | 1.330 (0.761–2.325) | |
| Other status | 1.269 (0.973–1.655) | | 1.607 (1.125–2.294) | |
| *Radiotherapy* | | | | |
| Yes | 1 | | 1 | |
| No | 1.849 (1.439–2.375) | | 2.163 (1.520–3.078 | |

CI = confidence interval, CSS = cancer-specific survival, OS = overall survival, SBP = solitary bone plasmacytoma.

this study does offer a great opportunity to explore rare tumors like extremity SBP.

## 5. Conclusions

This is the first population-based SEER analysis of survival in patients with extremity SBP. Radiotherapy and age were found to be significant independent predictors among patients with extremity SBP. Patients with radiotherapy and age ≤60, had a relatively better prognosis. Although no evidence showed that surgery or chemotherapy could prolong the survival of extremity SBP, further researches are needed to confirm this finding. To conclude, radiotherapy is the mainstream treatment for extremity SBP. Knowledge of these survival predictors may help clinicians provide appropriate management for extremity SBP patients.

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**Supervision:** Yali Cheng, Xiaobo Zhu.
**Validation:** Zhaoxin Chen.
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