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Nomograms Predict Survival Outcome of Primary Intramedullary Spinal Cord Lymphoma Patients

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

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Background: Primary intramedullary spinal cord lymphoma (PISCL) is a rare cause of myelopathies. Considering its poor prognosis, it is essential to determine the appropriate treatment strategies and to develop nomograms to predict survival outcome for PISCL patients.

Material/Methods: Data were collected from the Surveillance, Epidemiology and End Results (SEER) database. We used 364 patients to investigate overall survival (OS) and 289 patients for cancer-specific survival (CSS). Kaplan-Meier method was to evaluate correlations of survival with different treatment strategies and clinicopathologic factors. Univariate and multivariable analyses were conducted to assess OS and CSS based on different variables. Risk factors were integrated to build nomograms.

Results: Most of the 414 PISCL patients diagnosed with positive histology had diffuse B cell lymphoma, were under 60 years old, were male, were of white race, had 1 primary tumor, were married, were low stage, and had previously undergone chemotherapy. We found that radiation therapy had no effect on patient OS and CSS, and patients receiving chemotherapy alone tended to have better OS and CSS in comparison with other groups. In addition, we showed that clinicopathologic factors, including histologic type, age, stage, and marital status, could serve as independent prognostic factors for PISCL patient OS and CSS. These factors were utilized to construct nomograms. The calibration curves demonstrated good agreement. The concordance indexes for OS and CSS were 0.672 (P=0.024) and 0.683 (P=0.029), respectively.

Conclusions: Practical nomograms were established for patients' OS and CSS. Besides, this study can guild clinician to make the right decision for appropriate treatment of PISCL patients.

MeSH Keywords: **Chemotherapy, Adjuvant • Drug Therapy • Lymphoma • Nomograms • Survival Analysis**

Abbreviations: **PISCL** – primary intramedullary spinal cord lymphoma; **SEER** – the Surveillance, Epidemiology and End Results; **OS** – overall survival; **CSS** – cancer-specific survival; **DSW** – divorced/separated/widowed; **AI/AN** – American Indian/Alaska Native; **PI** – Asian/Pacific Islander; **NOS** – not-otherwise-specified; **K-M** – Kaplan-Meier; **HR** – Hazard ratio; **95% CI** – 95% confidence interval

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Background

Primary intramedullary spinal cord lymphoma (PISCL) is a rare myelopathy which accounts for 1% of all central nervous system lymphomas [1]. Considering the few published case reports of this disease, the clinical features of PISCL are unclear, resulting in complicated diagnosis and delayed therapy. In some cases, diagnosis of this disease is not confirmed until an autopsy is performed [2,3].

From 1980 to present, there have been a total of 394 cases of PISCL recorded in the literature[1–29]. Among these studies, the study conducted by Flanagan et al. reported 14 PISCL patients with 2-year survival of 36% [1], which indicates a high overall morbidity and infrequent long-term survival. Yang et al. conducted a population-based study of 346 PISCL patients using the Surveillance, Epidemiology, and End Results (SEER) database. They found that the clinicopathologic factors age, marital status, race, tumor stage, tumor histology, and year of diagnosis were correlated with PISCL patient survival outcome [30]. However, there has been no study developing a clinical nomogram for PISCL patient prognosis. The poor prognosis of PISCL patients suggests the need to construct nomograms for patient OS and CSS.

In this study, we aimed to develop practical nomograms for the survival outcome of PISCL patients by utilizing the SEER database. We also evaluated the effect of different therapeutic strategies on PISCL survival.

Material and Methods

Study design and patient selection

Patients were selected from the SEER database from 1973 to 2015, released in April 2018. The SEER database is a prospective public-use dataset containing patient-level clinical data from a total of 18 population-based cancer registries. As the 18 registries account for approximately 28% of the United States population, they are able to represent the overall population. The SEER database contains clinical, pathological, demographic, therapeutic, and outcome data.

As demonstrated in Figure 1, patients initially diagnosed with primary lymphoma of the spinal cord from the first day of 1973 to the last day of 2015 were included for analysis (C72.0). Patients with positive histology and known data were selected for further investigation. Overall survival (OS) was assessed based on analysis of 364 patients. After excluding 50 patients who died due to other causes, there were 289 patients assessed for cancer-specific survival (CSS).

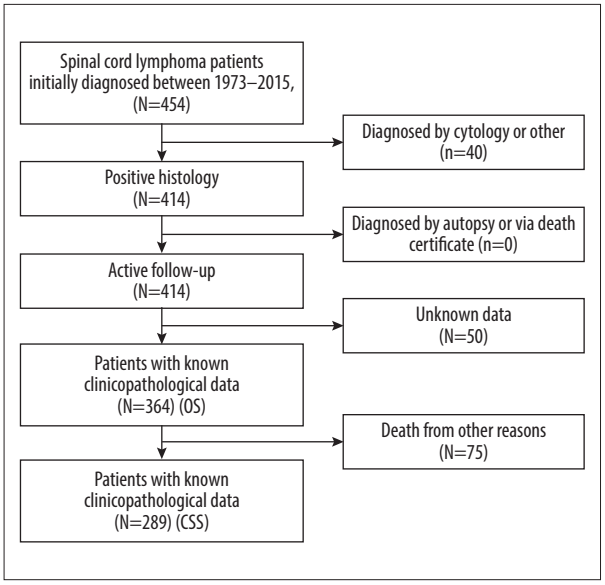

Figure 1. Consort diagram of the study population.

Study variables

There were 9 variables included for analysis: age, sex, first malignancy or not, marital status, race, histologic type, stage, radiation therapy, and chemotherapy. Age was divided into 2 groups: ≤60 and >60 years old. Marital status was categorized into 3 categories: divorced/separated/widowed (DSW), married, and single. Race was divided into 4 groups: white, American Indian/Alaska Native (AI/AN), black, and Asian/Pacific Islander (PI). The Ann Arbor Stage was utilized for staging of lymphoma in the SEER database and was divided into stage I–II and stage III–IV. The histologic types of PISCL were defined by the International Classification of Disease for Oncology (3rd edition) and included diffuse B cell lymphoma (9680), follicular lymphoma (9690–9691, 9695, 9698), other B cell lymphoma (9670–9671, 9675, 9684, 9687, 9699, 9731), precursor cell lymphoma (9727-9728), and other or not-otherwise-specified (NOS) lymphoma [30]. Radiation therapy and chemotherapy were the main treatment strategies for PISCL patients, while surgery is not a conventional treatment method for PISCL. Therefore, radiation therapy and chemotherapy were included for analysis while surgery was excluded from the analyzed variables.

Construction and validation of the Nomogram

Kaplan-Meier (K-M) analysis was performed to make comparisons of survival duration of OS and CSS between different variable groups of PISCL patients. The log-rank test was utilized to assess the OS and CSS differences between different variable groups. The independent prognostic factors for PISCL patients were determined by conducting multivariable analyses with Cox proportional hazard regression. Based on the results of multivariable analyses, nomograms were constructed using

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Table 1. Basic characteristics of spinal cord lymphoma patients.

Characteristic	No. patients	Ratio (%)/range
Total [n (%)]	414	(100)
Median duration of survival time, month (range)	40	(0–389)
Age at diagnosis, years		
≤60 [n (%)]	214	(47.0)
>60 [n (%)]	200	(53.0)
Chemotherapy [n (%)]		
Yes	285	(51.7)
No	129	(48.3)
Radiation [n (%)]		
Yes	162	(39.1)
No	252	(60.9)
Sex [n (%)]		
Male	258	(62.3)
Female	156	(37.7)
Radio-chemo-therapy [n (%)]		
Radio-chemo-therapy	106	(25.6)
Chemotherapy	179	(43.3)
Radiation	56	(13.5)
No	73	(17.6)
Race/ethnicity [n (%)]		
White	359	(86.7)
AI/AN	5	(1.2)
Black	34	(8.2)
Asian/PI	15	(3.6)
Unknown	1	(0.3)
First malignant [n (%)]		
Yes	368	(88.9)
No	46	(11.1)
Marital status [n (%)]		
Married	233	(56.3)
DSW	78	(18.8)
Single	91	(22.0)
Unknown	12	(2.9)
Stage [n (%)]		
Stage I–II	236	(57.0)
Stage III–IV	140	(33.8)
Unknown	38	(9.2)
Histologic type [n (%)]		
Diffuse B-cell lymphoma	194	46.8
Follicular lymphoma	47	11.4
Other B-cell lymphoma	64	15.5
Precursor cell lymphoma	5	1.2
Other or NOS	104	25.1
Survival status [n (%)]		
Alive	186	(44.9)
Dead	228	(55.1)

Unk –unknown; AI – American Indian; AN – Alaska Native; PI – Pacific Islander; DSW – divorced/separated/widowed; NOS – not-otherwise-specified.

R package rms version 5.1-2. Then, the nomogram was validated by evaluating its discrimination and calibration. A concordance index (C-index) was used to evaluate the discrimination. A calibration curve was calculated by comparing the mean expected survival rate with the mean observed survival rate.

Statistical analysis

SEER*Stat Software version 8.3.5 was used to collect primary data in the SEER database. Two-tailed P values less than 0.05 were considered statistically significant. All of the analyses were performed using R software version 3.5.1 (*https://www.r-project.org/*).

Results

Basic characteristics of PISCL patients

As demonstrated in Table 1, there were 414 PISCL patients diagnosed with positive histology. The median duration of survival time was 40 months. Most patients tended to be: younger than 60 years old (n=214,%=47.0), male (n=258,%=62.3), white race (n=359,%=86.7), with 1 primary tumor (n=368,%=88.9), and married (n=233,%=56.3). For the histologic types of PISCL, most of the population had diffuse B cell lymphoma (n=194,%=46.8), which was much more prevalent than T cell

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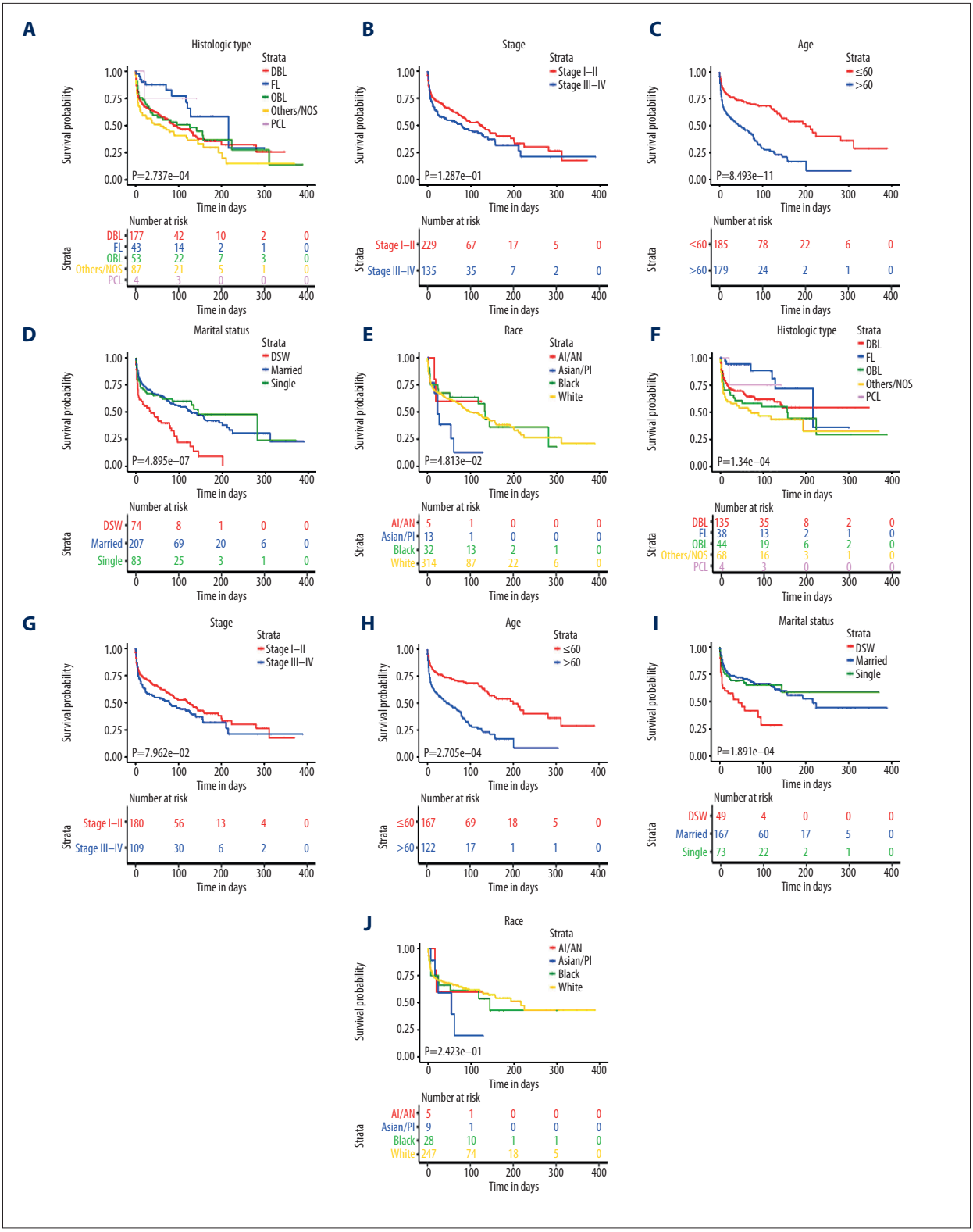

Figure 2. Kaplan-Meier analysis of overall survival (top) and cancer-specific survival (bottom) for PISCL patients according to (**A, F**) histologic type, (**B, G**) stage, (**C, H**) age, (**D, I**) marital status, and (**E, J**) race. DBL – diffuse B cell lymphoma; FL – follicular lymphoma; OBL – other B cell lymphoma; NOS – not-otherwise-specified; PCL – precursor cell lymphoma; DSW – divorced/separated/widowed.

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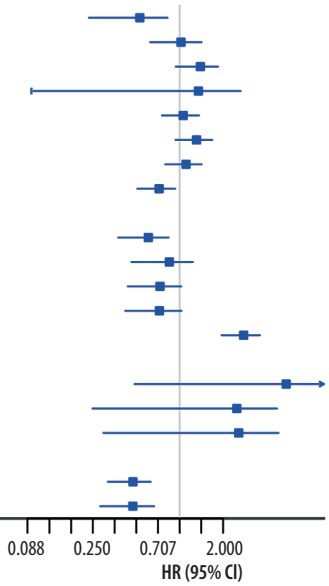
A

Factors	HR	95% CI	P
Histologic type			
FL *vs.* DBL	0.440	0.235–0.823	0.010
OBL *vs.* DBL	0.940	0.624–1.415	0.767
Others/NOS *vs.* DBL	1.315	0.939–1.843	0.111
PCL *vs.* DBL	0.368	0.051–2.644	0.321
Gender (male *vs.* female)	1.013	0.755–1.360	0.929
Stage (III–IV *vs.* I–II)	1.254	0.936–1.680	0.130
Radiation (yes *vs.* no)	1.061	0.794–1.418	0.689
Chemotherapy (yes *vs.* no)	0.688	0.509–0.930	0.015
Therapy			
Chemotherapy *vs.* no	0.560	0.375–0.837	0.005
Radiation *vs.* no	0.756	0.463–1.234	0.264
Radio-and-chemo-therapy *vs.* no	0.669	0.437–1.024	0.064
First malignant (yes *vs.* no)	0.656	0.419–1.028	0.066
Age (>60 *vs.* ≤60)	2.650	1.953–3.595	<0.001
Race			
Asian/PI *vs.* AI/AN	2.257	0.487–10.453	0.298
Black *vs.* AI/AN	1.084	0.249–4.725	0.914
White *vs.* AI/AN	1.197	0.296–4.836	0.801
Marital status			
Married *vs.* DSW	0.447	0.318–0.629	<0.001
Single *vs.* DSW	0.432	0.281–0.665	<0.001



B

Factors	HR	95% CI	P
Histologic type			
FL *vs.* DBL	0.452	0.240–0.852	0.014
OBL *vs.* DBL	1.015	0.663–1.552	0.946
Others/NOS *vs.* DBL	1.289	0.902–1.841	0.164
PCL *vs.* DBL	0.564	0.076–4.213	0.577
Gender (male *vs.* female)	1.265	0.925–1.731	0.141
Stage (III–IV *vs.* I–II)	1.363	1.003–1.853	0.048
Radiation (yes *vs.* no)	0.705	0.419–1.186	0.188
Chemotherapy (yes *vs.* no)	1.026	0.631–1.669	0.917
Therapy			
Chemotherapy *vs.* no	0.594	0.316–1.118	0.107
Radiation *vs.* no		NA–NA	
Radio-and-chemo-therapy vs. no		NA–NA	
First malignant (yes *vs.* no)	0.840	0.528–1.335	0.460
Age (>60 *vs.* ≤60)	2.367	1.661–3.373	<0.001
Race			
Asian/PI *vs.* AI/AN	1.303	0.267–6.349	0.743
Black *vs.* AI/AN	0.789	0.176–3.530	0.757
White *vs.* AI/AN	0.606	0.143–2.573	0.497
Marital status			
Married *vs.* DSW	0.536	0.370–0.776	0.001
Single *vs.* DSW	0.652	0.395–1.077	0.095

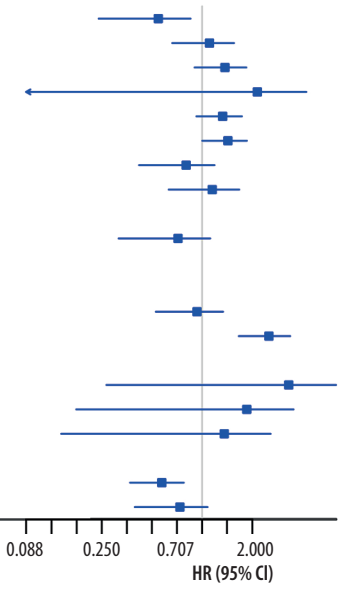


Figure 3. Univariate analysis (**A**) and multivariable analysis (**B**) of clinicopathologic factors of overall survival. DBL – diffuse B cell lymphoma; FL – follicular lymphoma; OBL – other B cell lymphoma; NOS – not-otherwise-specified; PCL – precursor cell lymphoma; AI – American Indian; AN – Alaska Native; PI – Pacific Islander; DSW – divorced/separated/widowed; NOS – not-otherwise-specified.

lymphoma. Most of the patients were Ann Arbor Stage I–II (n=236,%=57.0). There were 285 patients (51.7%) who underwent chemotherapy and 162 patients (39.1%) who underwent radiation therapy. To assess the influence of different treatment strategies on OS and CSS, we regrouped patients into 4 categories according to radiation therapy and chemotherapy: a combined radiation therapy and chemotherapy (radio-chemotherapy) subgroup (n=106,%=25.6), a chemotherapy alone group (n=179,%=43.3), a radiation therapy alone subgroup (n=56,%=13.5), and a no radiation therapy or chemotherapy

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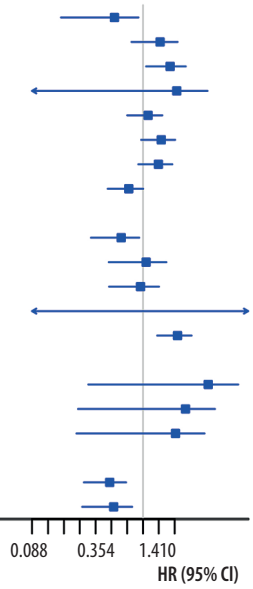
A

Factors	HR	95% CI	P
Histologic type			
FL *vs.* DBL	0.387	0.166–0.904	0.028
OBL *vs.* DBL	1.286	0.777–2.130	0.328
Others/NOS *vs.* DBL	1.652	1.070–2.550	0.023
PCL *vs.* DBL	0.566	0.078–4.105	0.574
Gender (male *vs.* female)	1.040	0.708–1.526	0.842
Stage (III–IV *vs.* I–II)	1.393	0.960–2.022	0.081
Radiation (yes *vs.* no)	1.309	0.903–1.899	0.155
Chemotherapy (yes *vs.* no)	0.680	0.462–1.003	0.052
Therapy			
Chemotherapy *vs.* no	0.543	0.320–0.921	0.023
Radiation *vs.* no	0.888	0.473–1.667	0.711
Radio-and-chemo-therapy *vs.* no	0.821	0.476–1.418	0.480
First malignant (yes *vs.* no)	27029829.306	0–Inf	0.993
Age (>60 *vs.* ≤60)	1.987	1.364–2.894	<0.001
Race			
Asian/PI *vs.* AI/AN	1.559	0.302–8.040	0.596
Black *vs.* AI/AN	1.080	0.241–4.830	0.920
White *vs.* AI/AN	0.945	0.233–3.843	0.937
Marital status			
Married *vs.* DSW	0.434	0.274–0.690	<0.001
Single *vs.* DSW	0.457	0.264–0.789	0.005



B

Factors	HR	95% CI	P
Histologic type			
FL *vs.* DBL	0.362	0.153–0.854	0.020
OBL *vs.* DBL	1.145	0.678–1.931	0.612
Others/NOS *vs.* DBL	1.556	0.978–2.476	0.062
PCL *vs.* DBL	0.688	0.090–5.272	0.719
Gender (male *vs.* female)	1.364	0.902–2.063	0.141
Stage (III–IV *vs.* I–II)	1.551	1.042–2.309	0.031
Radiation (yes *vs.* no)	1.033	0.522–2.046	0.926
Chemotherapy (yes *vs.* no)	0.853	0.453–1.606	0.622
Therapy			
Chemotherapy *vs.* no	0.791	0.340–1.836	0.585
Radiation *vs.* no		NA–NA	
Radio-and-chemo-therapy *vs.* no		NA–NA	
First malignant (yes *vs.* no)	35697345.938	0–Inf	0.993
Age (>60 *vs.* ≤60)	1.981	1.296–3.030	0.002
Race			
Asian/PI *vs.* AI/AN	1.059	0.192–5.843	0.947
Black *vs.* AI/AN	0.850	0.181–4.000	0.837
White *vs.* AI/AN	0.581	0.134–2.526	0.469
Marital status			
Married *vs.* DSW	0.422	0.252–0.709	0.001
Single *vs.* DSW	0.491	0.258–0.933	0.030

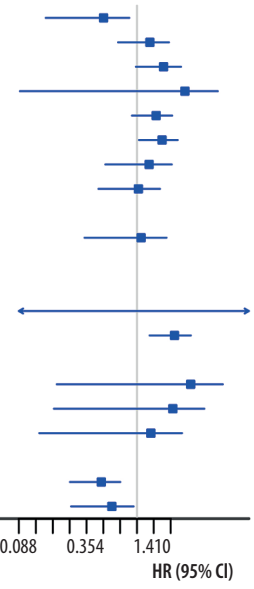


Figure 4. Univariate analysis (**A**) and multivariable analysis (**B**) of clinicopathologic factors of cancer-specific survival. DBL – diffuse B cell lymphoma; FL – follicular lymphoma; OBL – other B cell lymphoma; NOS – not-otherwise-specified; PCL – precursor cell lymphoma; AI – American Indian; AN – Alaska Native; PI – Pacific Islander; DSW – divorced/separated/widowed; NOS – not-otherwise-specified.

subgroup (n=73,%=17.6). The demographic characteristics of therapy subgroups for spinal cord lymphoma patients are exhibited in Supplementary Table 1.

Survival analysis of demographic, pathological, and clinical variables

The K-M analysis indicated that follicular lymphoma type (Figure 2A, 2F), younger age (Figure 2C, 2H), and married and

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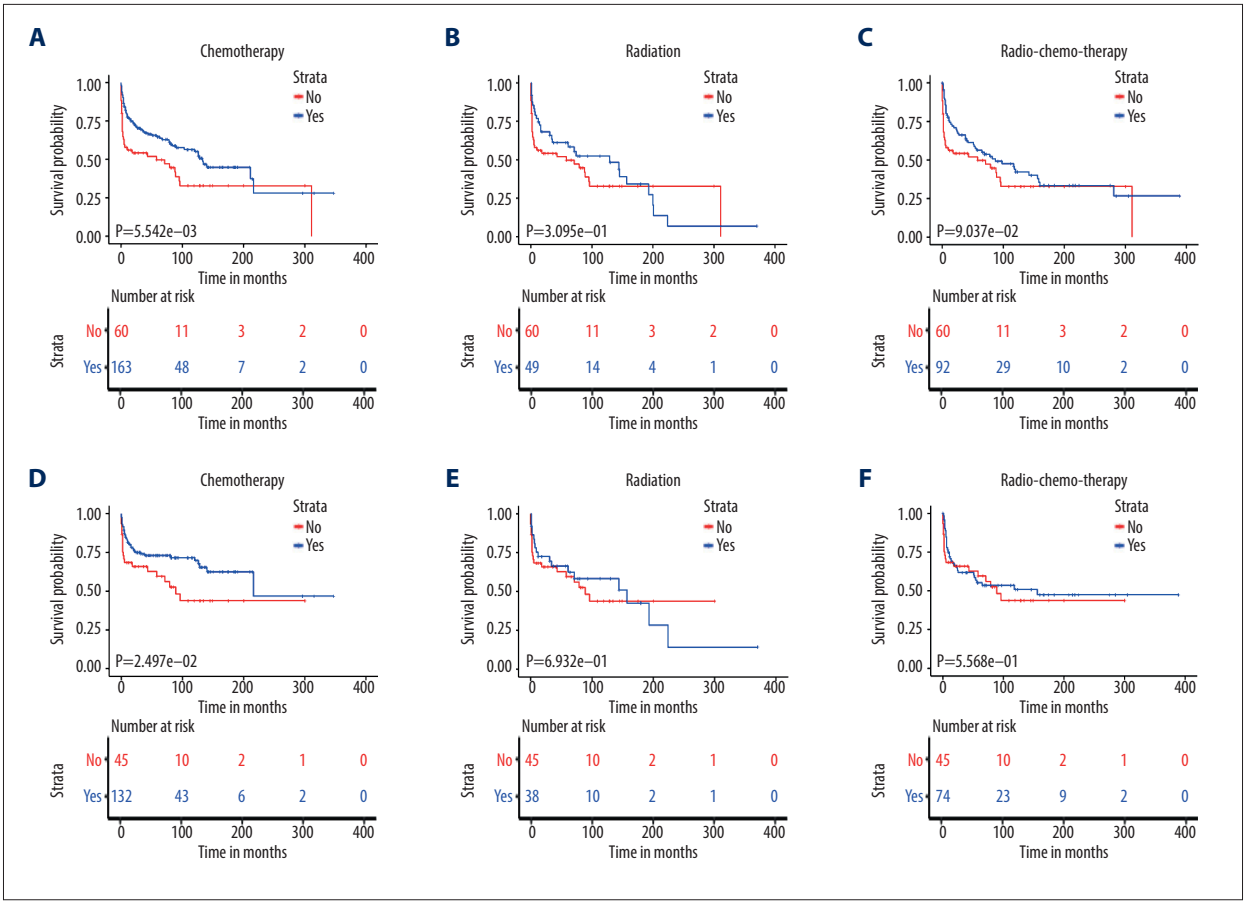

Figure 5. Kaplan-Meier analysis of overall survival (top) and cancer-specific survival (bottom) for PISCL patients according to (**A, D**) chemotherapy *vs.* no treatment, (**B, E**) radiation therapy *vs.* no treatment, and (**C, F**) radio-chemo-therapy *vs.* no treatment.

single patients (Figure 2D, 2I) were found associated with longer survival for both OS and CSS (P<0.05). In the K-M analysis, there was no significant difference between stage I–II and stage III–IV for OS or CSS (Figure 2B, 2G), but the race variable was significantly different on OS but not CSS (Figure 2E, 2J). Then, the univariate analysis for each variable was conducted. The univariate analysis for subgroups of some variables was consistent with the K-M analysis. However, sex, stage, and race did not make a significant difference in the univariate analysis for OS or CSS (Figures 3A, 4A). The multivariable regression model demonstrated that follicular lymphoma type [Hazard ratio (HR)=0.452, 95% confidence interval (95% CI)=0.24–0.852, P=0.014], stage III–IV (HR=1.363, 95% CI=1.003–1.853, P=0.048), older age (HR=2.367, 95% CI=1.661–3.373, P<0.001), and married status (HR=0.536, 95% CI=0.37–0.776, P=0.001) could serve as independent prognostic factors for PISCL patient OS (Figure 3B). The multivariable analysis for CSS showed that follicular lymphoma type [HR (hazard ratio)=0.362, 95% CI (confidence interval)=0.153–0.854, P=0.02], stage III–IV (HR=1.551, 95% CI=1.042–2.309, P=0.031), older age (HR=1.981, 95% CI=1.296–3.03, P=0.002), being married (HR=0.422, 95% CI=0.252–0.709, P=0.001), and being single (HR=0.491, 95% CI=0.258–0.933, P=0.03) were able to independently predict patient prognosis (Figure 4B).

Survival analysis of different treatment strategies

Considering the poor prognosis for PISCL patients, we further assessed the influence of different treatment strategies on OS and CSS. The radiation therapy demonstrated no effect on OS and CSS in the univariate and multivariable analysis (Figures 3, 4). Patients who underwent chemotherapy exhibited better survival outcomes of OS and CSS in the univariate analysis, but no significant differences were observed in the multivariable analysis (Figures 3, 4). The K-M analysis indicated that patients who only underwent chemotherapy had a better OS and CSS than those who did not receive either chemotherapy or radiation therapy (Figure 5A, 5D). In accordance with the results of univariate analysis, patients who only underwent radiation therapy did not show a survival benefit compared with those not receiving either therapy (Figure 5B, 5E). Interestingly, we found that the OS and CSS of PISCL patients

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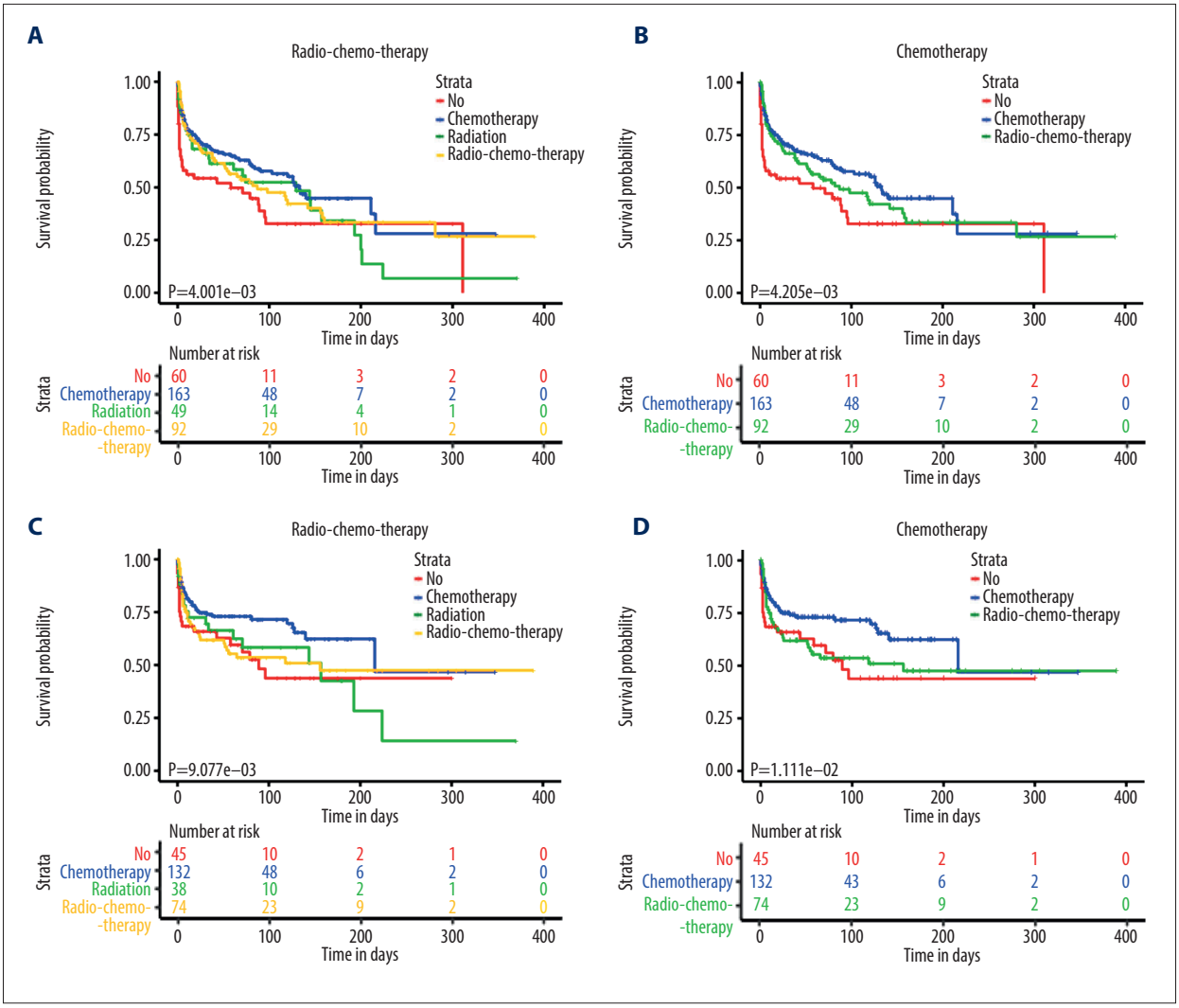

Figure 6. Kaplan-Meier analysis of overall survival (top) and cancer-specific survival (bottom) for PISCL patients according to (**A, C**) chemotherapy alone *vs.* radiation therapy alone *vs.* radio-chemo-therapy *vs.* no treatment and (**B, D**) chemotherapy alone *vs.* radio-chemo-therapy *vs.* no treatment.

receiving both chemotherapy and radiation therapy was not significantly different from those not receiving both therapies (Figure 5C, 5F). Finally, the comparison of combined radiation therapy and chemotherapy, chemotherapy alone, radiation therapy alone, and no radiation therapy or chemotherapy on survival outcome was performed. The patients who only received chemotherapy were more likely to have better OS and CSS compared with other groups, as shown in Figure 6A–6D.

Construction and validation of a nomogram for OS and CSS

The significant independent prognostic factors – histologic type, age, stage, and marital status – were used to construct a nomogram for OS and CSS, as shown in Figure 7A and Figure 7C. The nomogram exhibited that histology type made the largest contribution to survival outcome, followed by age, marital status, and stage. Factors in these variables were assigned a score. Each patient's probability of survival was calculated by accumulating scores for every variable. Then, the nomogram was validated using calibration plots and Harrell's C-index. The calibration plots demonstrated the predicted 5-year OS and CSS closely corresponded with the observed OS and CSS (Figure 7B, Figure 7D). The C-index for established nomograms predicting OS was 0.672 (P=0.024) and the C-index to predict CSS was 0.683 (P=0.029).

Discussion

Considering the unclear pathological features of PISCL, we performed the largest retrospective study on PISCL patients using the SEER database to construct a nomogram to predict

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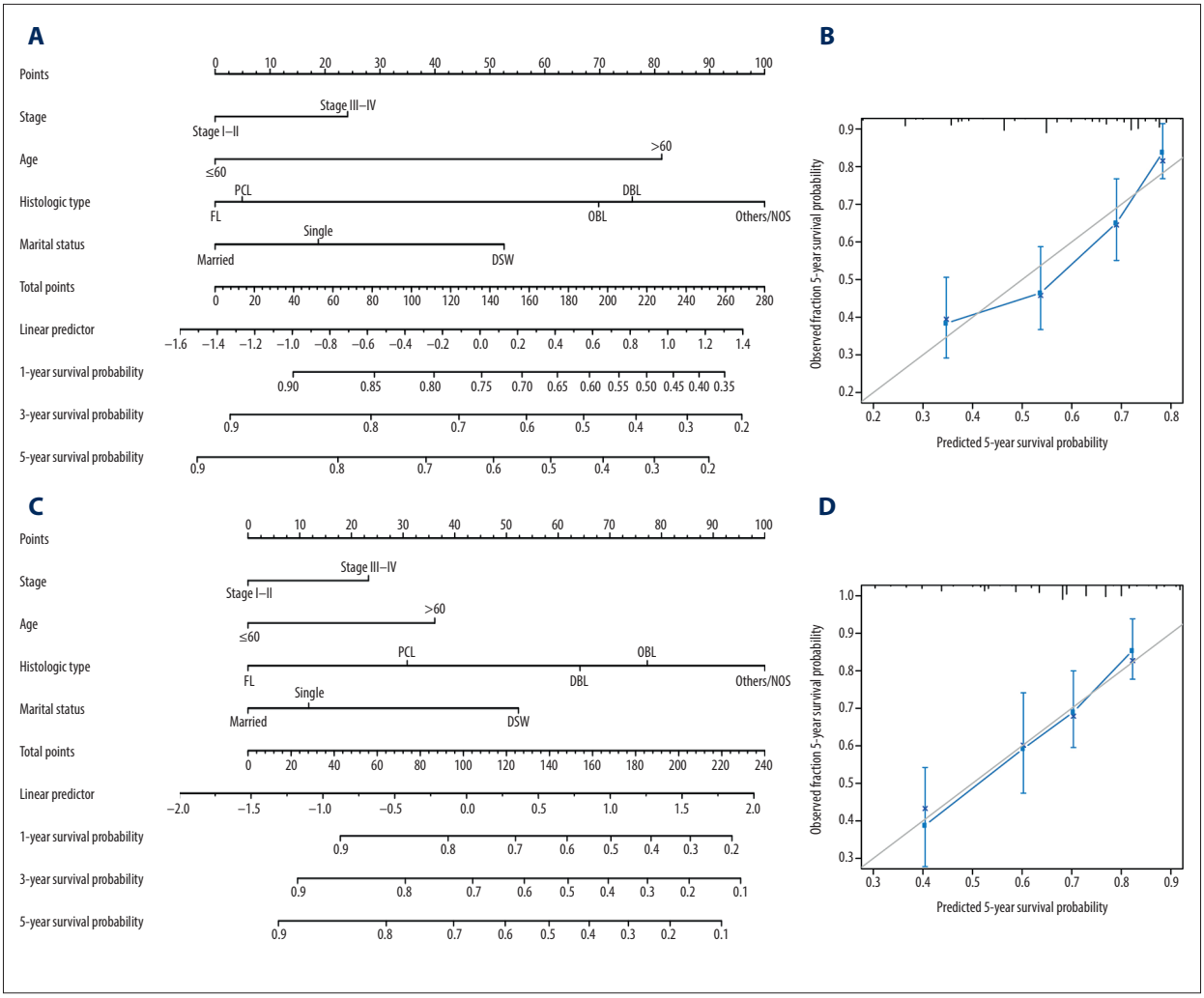

Figure 7. The nomogram predicted the probability survival of 1-year, 3-year and 5-year OS and CSS in PISCL patients. (**A, C**) Prognostic nomogram including tumor stage, age, histologic type, and marital status estimated probability survival of 1-year, 3-year, and 5-year; (**B, D**) Calibration curves of the prognostic nomogram for OS and CSS.

the survival outcome of PISCL patients. Different treatment strategies were assessed to provide guidelines for treatment.

The established nomograms in our study can supply a quantifiable prediction for each patient's OS and CSS, since the nomograms can easily incorporate significant prognostic factors. Nomograms are a very powerful tool for facilitating individualized clinical predictions and can help in developing treatment strategies. To the best of our knowledge, our study is the first to develop nomograms for PISCL patients. These nomograms can help to further subgroup patients according to their homogeneous prognosis, which enables clinicians to evaluate a variety of parameters more objectively and accurately so as to clearly interpret clinical trial outcome.

In our baseline investigation of PISCL, we found PISCL is a malignancy that tends to occur in young men of white race, with a median survival time shorter than 3.5 years. As PISCL is a rare disease with delayed diagnosis, this may help physicians to diagnose this disease [1]. Our study found that radiation therapy had no benefit for OS and CSS, which is in accordance with the study of Yang et al. [30]. This may be due to the severe neurotoxicity caused by radiation therapy. PISCL is a subtype of primary CNS lymphoma. Abrey et al. found that delayed neurotoxicity is common in older patients with primary CNS lymphoma who received radiation therapy [31]. Interestingly, we found that patients only receiving chemotherapy had better OS and CSS compared with other treatment strategies. DeAngelis et al. found improved survival outcome with the combination of chemotherapy plus radiation therapy compared to radiation therapy alone [32]. Our study is the first to find that chemotherapy alone is superior to combined therapies and radiation therapy in improving PISCL patient OS and CSS. Sandor et al. reported that chemotherapy

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alone can achieve optimal response and survival for primary CNS lymphoma [33]. Despite the fact that both chemotherapy and radiotherapy have changed enormously, the optimal treatment method for PISCL has not been fully elucidated because of the rarity of the disease. Considering the variety of treatment strategies for PISCL, our investigation can help guide clinicians in making the right decision regarding treatment of PISCL patients.

Our investigation also found several variables associated with PISCL patients' OS and CSS in the multivariable analysis, including histologic type, stage, and marital status. Interestingly, we showed married patients were more likely to have a good survival outcome than those who were widowed or divorced, perhaps because married patients have better health insurance status, receive psychological support from family, and have better neighborhood socioeconomic status compared to widowed or divorced patients. Our investigation also confirmed the accuracy of Ann Arbor Stage for lymphoma, since low-stage patients had better OS and CSS.

Several limitations of our study should be considered. The SEER database does not provide detailed diagnostic and treatment information on PISCL patients. This study was limited by its retrospective nature, causing inevitable bias. Future investigations utilizing prospective data are needed to validate the results of our investigation. Furthermore, the SEER database may cause geographic bias, although it contains patients from 17 registries in the United States. Last but not least, due to the limited number of cases, there was bias in subgroups of patients. Nevertheless, we are now collecting the clinical information, other biomarkers, and treatment method of PISCL patients, and in future research we plan to exclude bias due to the imbalanced groups and make our conclusions more comprehensive and accurate.

Conclusions

We established and validated novel nomograms to predict survival outcome of ISCL patients. We found chemotherapy alone is more beneficial than other therapy strategies. Our results may be useful in generating guidelines for the diagnosis and treatment of PISCL patients.

Conflicts of interests

None.

Supplementary Data

Supplementary Table 1. Demographic characteristics of therapy subgroups for spinal cord lymphoma patients.

Characteristic	No. patients(%)	Therapy				P-value
		Radio-chemo-therapy	Chemotherapy	Radiation	No	
Total [n (%)]	414 (100)	106	179	56	73	
Age at diagnosis, years						
≤60 [n (%)]	214 (47.0)	64	96	18	36	<0.001
>60 [n (%)]	200 (53.0)	42	83	38	37	
Sex [n (%)]						
Male	258 (62.3)	66	116	28	48	<0.001
Female	156 (37.7)	40	63	28	25	
Race/ethnicity [n (%)]						
White	359 (86.7)	91	156	52	60	<0.001
AI/AN	5 (1.2)	0	5	0	0	
Black	34 (8.2)	10	11	3	10	
Asian/PI	15 (3.6)	5	7	1	2	
Unknown	1 (0.3)	0	0	0	1	

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Characteristic	No. patients(%)	Therapy				P-value
		Radio-chemo-therapy	Chemotherapy	Radiation	No	
Marital status [n (%)]						
Married	233 (56.3)	59	104	33	37	0.910
DSW	78 (18.8)	18	30	10	20	
Single	91 (22.0)	24	41	11	15	
Unknown	12 (2.9)	5	4	2	1	
Stage [n (%)]						<0.001
Stage I–II	236 (57.0)	61	91	42	42	
Stage III–IV	140 (33.8)	36	76	9	19	
Unknown	38 (9.2)	9	12	5	12	
Histologic type [n (%)]						<0.001
Diffuse B-cell lymphoma	194 (46.8)	55	89	12	38	
Follicular lymphoma	47 (11.4)	7	24	10	6	
Other B-cell lymphoma	64 (15.5)	21	24	10	9	
Precursor cell lymphoma	5 (1.2)	1	4	0	0	
Other or NOS	104 (25.1)	22	38	24	20	

Unk – unknown; AI – American Indian; AN – Alaska Native; PI – Pacific Islander; DSW – divorced/separated/widowed; NOS – not-otherwise-specified.

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