Clinicopathologic Characteristics, Therapeutic Modalities and Survival Outcomes of Plasmablastic Lymphoma: A Real-World Study

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Abstract

Introduction: Plasmablastic lymphoma (PBL) is an extremely rare subtype of B-cell non-Hodgkin lymphoma (NHL), is characterized by aggressiveness, rapid progression and bleak prognosis. Neither standardized regimen nor consensus for PBL treatment has been established.

Methods: We retrospectively analyzed the clinicopathologic characteristics, therapeutic modalities and survival outcomes of 418 patients registered in the Surveillance, Epidemiology, and End Results (SEER) database from 2008 to 2016 and 21 (19 treated) patients in our institution. Kaplan-Meier survival curves and log-rank test for overall survival (OS) and cancer-specific survival (CSS) were performed to compare each variable. Variables with statistical significance in the univariate Cox regression were incorporated into the multivariate Cox model to determine the independent prognostic factors.

Results: In patient cohort from the SEER, PBL has a striking male predilection. The median OS for all PBL patients was 17 months. The 1-year, 3-year and 5-year OS rate were 54.4%, 40.4% and 37.2% respectively. Patients who suffered from previous malignancy had a significant survival disadvantage compared to those without previous cancer. Patients with higher Ann Arbor stage at diagnosis were at higher risk of death than those with lower stage. Chemotherapy alone or chemotherapy combined with radiotherapy could significantly reduce the risk of death and extend the patients' survival, yielding HR of 0.209(95%CI 0.152-0.288) and 0.187(95%CI 0.089-0.394), respectively. Radiation alone seemed useless. All patients from our institution were HIV-negative. The main therapeutic regimens were CHOP or CHOPe, DA-EPOCH, DHAP and ESHAP. Complete response (CR) was achieved in only 3 patients, while partial response (PR) in 10 patients. The median OS was 7 months. Fourteen patients later died of the disease progression.

Conclusions: Previous malignancy history, Ann Arbor stage and therapeutic modality were independent prognostic factors. Bortezomib combined with DA-EPOCH may serve as an effective regimen for PBL. The optimal therapeutic modality necessitates further exploration.

Introduction

Plasmablastic lymphoma (PBL) is an extremely rare and distinct subtype of B-cell non-Hodgkin lymphoma (NHL). [1, 2] PBL exhibits mixed morphological characteristics of diffuse large B-cell lymphoma (DLBCL) and multiple myeloma (MM) with its highly aggressive attribute and plasmacytic differentiation. [3] The cell origin of PBL is considered the post-germinal center B-lymphocyte or plasmablast. Although PBL cells usually express classic biomarkers of plasmacytic differentiation (CD38, CD138 and MUM1) like MM and seldomly express B-lymphocyte differentiation markers (CD19, CD20, and PAX5), PBL bears a striking resemblance to DLBCL via genomic profiling. [4] It is often believed that PBL afflicts immunocompromised individuals, including those infected with human immunodeficiency virus (HIV), those receiving intense chemotherapy or radiotherapy for cancers, those undergoing organ or stem cell transplantation and those receiving immunorepressive drugs. [5–7] PBL was once regarded as a tumor that predominantly arose in patients with HIV-infection. [8] However, Castillo et al reported 71 HIV-negative PBL patients with unique clinicopathological characteristics markedly distinct from their HIV-positive counterparts. [9]

PBL is notorious for resistance to chemotherapy, invasiveness and rapid progression. CHOP regimen (cyclophosphamide, doxorubicin, vincristine, and prednisone) serves as the first-line choice for the treatment of NHL. However, the National Comprehensive Cancer Network (NCCN) guidelines stipulate that standard CHOP seems 'inadequate and less intense' for PBL. [10] Despite the use of various regimens, the prognosis of PBL remains bleak. Owing to the rarity of PBL, previous publications mainly focus on clinical case report or case series with small sample-size. Little is known about this rare hematological malignancy. What's worse, neither standardized regimen nor consensus for PBL treatment has been established yet. The objective of our study is to further explore the clinical characteristic, prognostic factors and therapeutic modality of PBL on a larger scale. Patients in our study derived from the Surveillance, Epidemiology, and End Results (SEER) database and our institution. We also discussed the recent therapeutic approaches and advances in PBL.

Methods And Materials

Patient data from the SEER database

Patient selection

Initially constructed by the National Cancer Institute of United States (US), the SEER database accounts for nearly 30% of the US population across 18 cancer registries and is completely available to the public via formal application. We obtained authorization to have access to the unidentified individual information. According to the International Classification of Disease for Oncology, 3rd edition (ICD-O-3), we retrieved the SEER database for PBL patients from 2008 to 2016 using the "9735/3: plasmablastic lymphoma" histology code in the "site and morphology ICD-O-3 histology/behavior, malignant" field. The patient data were downloaded by using SEER*Stat Software (Version 8.3.6, <http://www.seer.cancer.gov/seerstat>).

The patient data include age at diagnosis, gender, race, primary anatomical site, Ann Arbor stage, previous malignancy history, survival months, vital status, cause of death and the first round of treatment modalities(chemotherapy or not, radiation or not). However, the detailed HIV-infection status, immunohistochemical results ,chemotherapy regimens, types of surgery, drug dosage and radiation dosage were not recorded in the SEER database. Patients without pathologically-confirmed diagnosis or sufficient follow-up information were excluded.

Statistical analysis

Overall survival (OS) was determined from the time of diagnosis to death from any cause or the last follow-up. Cancer-specific survival (CSS) was calculated from diagnosis to the date of death caused by PBL. Kaplan-Meier curves and log-rank test for OS and CSS were conducted to compare each potential variable related to prognosis. Variables with $p\text{-value}<0.1$ in the univariate Cox regression model were incorporated into the multivariate Cox model to determine the independent prognostic factors, with hazard ratio (HR) >1 indicating adverse factors. All tests were two-sided, with $p\text{-value}<0.05$ regarded statistically significant. All statistical analysis were performed with SPSS Software (Version 26.0, IBM Corp., USA).

Patient group from our institution

We then retrospectively identified 21 PBL patients in our institution between Aug 2009 and Aug 2018. In accordance with *the 2008 WHO classification of tumors of hematopoietic and lymphoid tissues*, the pathological diagnosis was made through hematoxylin-eosin staining and immunophenotyping results.

Relevant clinical information of 21 PBL patients included age at diagnosis, gender, HIV infectious status, Eastern Cooperative Oncology Group performance status (ECOG-PS), Ann-Arbor stage, international prognostic index (IPI), primary tumor locations, immunochemistry results, specific therapeutic regimen, the best response to therapy and the final survival outcomes. Immunohistochemical studies were conducted on formalin-fixed, paraffin-embedded tissue sections by utilizing the antibodies including CD138, CD38, CD10, CD20, CD79, PAX5, MUM1, CD30, CD56, BCL6, CD5, CD3, CD45 and Ki67. In situ hybridization (ISH) for EB virus-encoded small RNA (EBER) was also detected by employing a fluorescein-labeled peptide nucleic acid probe on the tissue sections.

Given the rarity of PBL and the small sample size from our institution, we consider it unreasonable to conduct log-rank test or COX regression analysis. Therefore, we only plotted an OS survival curve to demonstrate the patient survival outcomes.

Results

Patients from the SEER population registries

After rigorous identification, a total of 418 eligible patients were ultimately enrolled in our study. The flow diagram of selection process was revealed in Figure1. The demographic and clinical characteristics of PBL patients were summarized in Table1. The median age at diagnosis was 56 years-old. PBL has a striking gender predilection for males with the ratio of male to female patient being 3.5:1. Patients with B symptoms accounted for 23.68%. Nearly 18.7% of the patients had a previous history of other malignancies. However, the SEER database did not record the information on the HIV infection status. Only 6% of the patients received both chemotherapy and radiation at initial diagnosis, while 66% received chemotherapy alone and 26.8% of patients were untreated.

The distribution of primary anatomical sites was revealed in Table 2. Of all the patients, 185 cases (44.26%) were detected within the lymph nodes and 233(55.74%) cases suffered from extranodal infiltration. The most frequently-involved extranodal site was gastrointestinal tract(20.10%), followed by nasal cavity/paranasal sinuses (11.72%) and oral cavity, mouth and tongue(5.50%).

The median follow-up time of all eligible patients was 8.5 months. As was revealed in the Kaplan-Meier curves of OS(Figure 2A) and CSS(Figure 2B), the median OS for all PBL patients was 17 months (95%CI 10.3-23.7). The 1-year,3-year and 5-year OS rate were 54.4%, 40.4% and 37.2% respectively. The median CSS was not reached, and the 1-year,3-year and 5-year CSS rate were 69%, 58.6% and 55%, respectively.

In the univariate assessment, marital status($p=0.015$),previous malignancy history($p=0.003$),primary site($p=0.009$),Ann Arbor stage($p=0.001$),therapeutic modality ($p<0.001$) are the possible predictive factors of OS (Table 3). Age, gender and race could not influence PBL prognosis. The predictors of CSS were similar to those of OS (Table 3). Kaplan-Meier survival curves gave a vivid description of the association between various factors and OS(Figure 3) and CSS(Figure 4) of PLB patients. As revealed in Table 4, multivariate analysis verified that previous malignancy history, Ann Arbor stage and therapeutic modality were independent prognostic factors. Patients who suffered from previous malignancy had a significant survival disadvantage [HR=1.444, 95%CI (1.037-2.001)] compared to those without previous cancer. Patients with higher Ann Arbor stage at diagnosis were at higher risk of death than those with lower stage. In terms of therapeutic modalities, chemotherapy alone or chemotherapy combined with radiotherapy could significantly reduce the risk of death and extend the patients' survival, yielding HR of 0.209(95%CI 0.152-0.288, $p<0.001$) and 0.187(95%CI 0.089-0.394, $p<0.001$), respectively. However, radiation alone without chemotherapy seemed useless.

Patients from our institution

We enrolled altogether 21 patients including 12 males and 9 females. The median age at diagnosis was 52 years-old. Clinical features and immunophenotypical results of patients from our institution were demonstrated in Table 5. All patients were HIV-negative and were not in immunocompromised status. Tumor arose extranodally in 16 cases (76.2%). Plasma cell markers including CD38, CD138, and MUM1, were universally detected positively (81%, 90% and 85.7%, respectively), while CD20 and PAX5 were detected negatively in most cases (90.5% and 86.7%, respectively). The proliferation index Ki-67 was commonly high, ranging from 40–95% with 16 cases > 80%. EBER was detected positively in 5 out of 17 cases (29.4%).

Detailed information on therapeutic regimen and survival outcomes was summarized in Table 6. The Kaplan-Meier plot for the whole group revealed that median OS was 7 months (Figure 5). CHOP regimen (cyclophosphamide, doxorubicin, vincristine, and prednisone) or CHOPe regimen (CHOP + etoposide) were selected as the first-line therapy for most patients. DA-EPOCH (dose-adjusted etoposide, adriamycin, vincristine, cyclophosphamide, prednisone), DHAP (cisplatin, high-dose cytarabine, dexamethasone), DICE (cisplatin, ifosfamide, etoposide, dexamethasone), ESHAP (etoposide, methylprednisolone, high-dose cytarabine, cisplatin), GDP (gemcitabine, cisplatin, dexamethasone) and HyperCVAD/high-dose MTX/Ara-C (hyper-fractionated cyclophosphamide, vincristine, doxorubicin, dexamethasone alternating with methotrexate and cytarabine) were reasonable options. Regimens for the treatment of MM such as PAD (bortezomib, adriamycin, dexamethasone), PCD (bortezomib, cyclophosphamide, dexamethasone), TAD (thalidomide, adriamycin, dexamethasone), MPT (melphalan + prednisone + thalidomide) were also administered. Only one patient who received autologous stem cell transplantation (ASCT) with thalidomide maintenance is still alive by the end of our study. Complete response (CR) was achieved in only 3 patients who are still alive at the study endpoint. Partial response (PR) was obtained in 10 patients. Efficacy was limited and transient in most patients. Fourteen patients later died of the disease progression.

Discussion

Initially described in the oral cavity of HIV-infected patients in 1997, PBL is characterized by male predominance, predilection for extranodal involvement and higher incidence among immunocompromised patients. [8] Highly active antiretroviral therapy (HAART) is oriented to kill HIV, which mainly includes stavudine in combination with lamivudine and nevirapine, zidovudine in combination with lamivudine and efavirenz, and emtricitabine in combination with tenofovir and Kaletra. [11, 12] Some case reports depicted the spontaneous regression of HIV-related PBL after use of HAART. However, sustained CR could not be achieved and patients were confronted with early relapse. [13, 14] A study from Lymphoma Study Association (LYSA) Group also verified that HAART alone without chemotherapy could not achieve sustained CR. [15] The administration of HAART combined with chemotherapy is preferably recommended in HIV-positive patients.

With the increased understanding of PBL, we have come to realize that PBL also emanates in HIV-negative or other immunocompetent patients. All patients from our institution were HIV-negative and previously immunocompetent with a normal level of CD4+T cell counts. HIV-positive and HIV-negative PBL are two strikingly distinct subentities with different clinicopathological characteristics. HIV-negative patients bore bleaker prognosis, worse response to chemotherapy and shorter OS than HIV-positive patients. [9, 15, 16]

Despite the fact that the most commonly-used regimen is CHOP or CHOP-like at present, the NCCN guidelines state that CHOP is 'inadequate and inefficient' and propose more intensive regimens including DA-EPOCH, HyperCVAD and CODOX-M/IVAC (cyclophosphamide, vincristine, doxorubicin, methotrexate/ifosfamide, etoposide, cytarabine). [10] The efficacy of adding rituximab (a kind of anti-CD20 monoclonal antibody) to conventional chemotherapy remains obscure. We speculate that the addition of rituximab is unlikely to achieve clinical benefit in that PBL cells scarcely express CD20 antigen. Several studies have shown that EPOCH displayed better efficacy and survival outcomes than CHOP, especially in highly-aggressive B-cell NHL. [17, 18] Castillo et al reported 3 PBL patients achieved a durable CR to V-DAEPOCH (bortezomib in combination with dose-adjusted etoposide, prednisone, vincristine, cyclophosphamide, and doxorubicin) with OS of 12, 18, 24 months respectively. [19] Dittus et al reported V-DAEPOCH regimen was efficacious and well-tolerated in 8 PBL patients, achieving CR rate of 100% and 2-year OS rate of 50%. [20] In 2018, Castillo et al reported that among 16 patients who received V-DAEPOCH regimen (range 4–6 cycles), CR was observed in 15 patients and PR in 1 patient. The 5-year OS rate was 65%. Of the 5 dead patients, 3 died of PBL progression and 2 died of infection. [21] The above-mentioned indicates that V-DAEPOCH is an effective and frontline therapeutic regimen for PBL.

Lenalidomide is a kind of immunomodulatory agent, which is widely used for MM treatment. RCD regimen (lenalidomide in combination with cyclophosphamide and dexamethasone) was reported to successfully treat a stage IE HIV-negative PBL patient, achieving an at least 24 months' durable CR. [22] Similarly, an HIV-positive PBL was effectively treated with lenalidomide combined with CHOP. [23]

A case-control study suggested that there was no significant difference in non-relapse mortality, 2-year disease-free survival and OS between HIV-positive and HIV-negative NHL patients who received ASCT. That is to say, HIV status does not influence the long-term outcome of ASCT for NHL. [24] ASCT during first CR after intensive induction therapy is a feasible solution to improve the PBL outcome. [25] The European Society for Blood

and Marrow Transplantation registry reported 24 PBL patients who underwent ASCT. Those who were autografted in CR displayed a significantly decreased relapse risk and overall mortality risk.[26] ASCT warrants to be further investigated as first-line consolidation and salvage therapy for both HIV-positive and negative PBL patients especially in the absence of effective therapeutic options.[27] Nishi et al reported that an HIV-negative woman with chemotherapy-refractory PBL had disease-free survival of more than 18 months after umbilical cord stem cell transplantation(UBSCT).[28]

There existed several inevitable defects in our study mainly owing to the inherent drawbacks of SEER database. Firstly, the SEER is a population-based registry and does not record some important individual information, such as ECOG-PS, IPI, immunohistochemistry results, FISH results, virus infection status and lactate dehydrogenase (LDH). Secondly, information concerning comorbidities, disease progression and relapse were not documented. What's more, the specific drug dosage and radiation dose were neither recorded in the SEER database. Whether PBL patients received ASCT was unknown from the SEER. Lastly, research on patients from our single center were sample-sized due to the scarcity of PBL.

Conclusion

PBL is an extremely rare and aggressive entity of B-cell NHL. Despite being initially reported in HIV-infected patients, PBL has also been identified in other immunocompetent patients. PBL has a male predilection. The cohort from SEER database revealed that previous malignancy history, Ann Arbor stage, therapeutic modality were independent prognostic factors. Bortezomib combined with DA-EPOCH may serve as an effective and frontline therapeutic regimen for PBL. Prospective clinical trials should also be further conducted to explore the efficacy and safety of novel agents including chimeric antigen receptor T cell(CAR-T) therapy, immune checkpoint inhibitors and other monoclonal antibodies for the treatment of PBL.

Declarations

Funding

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Competing interests

The authors declare that they have no competing interests

Data Availability Statement

All original data throughout our manuscript are available upon request by communicating with corresponding author.

Ethic statement

Before commencing this study, we obtained informed consent from patients or their next of kins(if the patients were dead) and official ethical approval from institutional review board of Fourth Military Medical University. The SEER database provides un-identified individual information and is totally available to the public after formal application. We received permission from the SEER program funded by the National Cancer Institute of United States to gain access to the patient information.

Author Contributions

LL and JF conceived the concept and designed the study. Y-HZ, ZW and HYS performed the data collection. H-TW was responsible for the statistical analyses. Y-HZ, H-TW and BT drafted the manuscript. Y-HZ and JF prepared the figures. All authors have read and approved the final version of this manuscript.

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Tables

Due to technical limitations, tables 1 to 6 are only available as a download in the Supplemental Files section.

Figures

Figure 1

The flow chart of the selection process for the eligible patient cohort.

Figure 2

Kaplan-Meier curves of the whole eligible cohort: (A) Overall survival; (B) Cancer-specific survival

Figure 3

Kaplan-Meier estimate of overall survival by subgroup analysis: (A) Age; (B) Marital status; (C) Previous malignancy history; (D) Primary site; (E) Ann Arbor stage; (F) Therapeutic modality.

Figure 4

Kaplan-Meier estimate of cancer-specific survival by subgroup analysis: (A) Marital status; (B) Primary site; (C) Ann Arbor stage; (D) Therapeutic modality.

Figure 5

Overall survival of 19 plasmablastic lymphoma patients treated in our institution.

Supplementary Files

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