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Clinical Characteristics and Outcomes of Primary Vitreoretinal Lymphoma in Northern Thailand

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ABSTRACT

OBJECTIVE This study aims to describe clinical characteristics and outcomes after treatment of primary vitreoretinal lymphoma (PVRL).

METHODS Fifteen patients with a proven diagnosis of PVRL by histology, cytology and/or flow cytometry were analyzed.

RESULTS The median age of the 15 patients was 59 years (range 41-71). Median follow-up time was 37 months (IQR 22.5-80) (range 4-106). Ophthalmic presentations of 25 eyes included vitritis (72%), chorioretinal infiltrations (60%), and retinal vasculitis (20%). Bilateral involvement was observed in 10 patients at presentation and in 4 patients during follow up. Ten patients (67%) developed brain involvement after ocular presentation with a median time of 22.5 months (range 2-84). Treatment modalities were included: 1) isolated intravitreal (IVT) methotrexate (6/15 patients; 40%) with a median number of injections of 4 (IQR 1,6) (range 1-16) 2) combined with IVT methotrexate and/or rituximab and systemic chemotherapy and/or radiation (8/15; 53%) with a median of 6 injections (IQR 1,11) (range 1-16) and 3) systemic chemotherapy alone (1/15; 7%). Whole brain radiotherapy (WBRT) was performed in 10 of 15 patients (67%). Among the 6 patients who received isolated IVT methotrexate, 3 patients had complete remission (3/6; 50%), one died at 96 months after treatment, and one was lost to follow up after a single injection. Nine of 15 patients who received systemic chemotherapy with or without IVT chemotherapy and/or WBRT had complete remission (8/9; 89%).

CONCLUSIONS Vitritis and chorioretinal infiltrations were the main ocular presentations of PVRL. Two-thirds of the patients developed brain involvement which resolved after treatment. Systemic chemotherapy tends to provide a higher rate of complete remission compared to local therapy alone.

KEYWORDS primary vitreoretinal lymphoma, intraocular lymphoma, intravitreal methotrexate, intravitreal rituximab, Thailand

INTRODUCTION

Primary vitreoretinal lymphoma (PVRL) is an uncommon intraocular malignancy which is classified as a diffuse large B-cell lymphoma in most cases. Currently, PVRL is categorized as a subtype of primary central nervous system lymphoma (PCNSL). Its incidence was reported to be 0.28% per 100,000 persons per year in immuno-

competent patients and to be more prevalent in immunocompromised patients (1). There are limited data regarding the worldwide incidence of PVRL due to its rarity, but most studies suggest its prevalence is increasing (1-4).

Typically, PVRL occurs in elderly patients and its clinical manifestations can resemble intraocular inflammation. For that reason, PVRL also carries the name "masquerade syndrome". This intraocular inflammation presentation may lead to delayed or missed diagnosis (5). Several tools have been used to help in the diagnosis of PVRL including ocular and brain imaging and laboratory tests such as ocular fluid or tissue samples for cytology, histology, immunocytochemistry for CD20, flow cytometry, biochemical analysis (interleukin-10/interleukin-6 ratio) and polymerase chain reaction for gene mutations such as myeloid differentiation primary response 88 (MYD88) mutation (6).

PVRL is frequently accompanied by CNS involvement and has a poor prognosis. Current treatment includes various approaches. Due to its rarity, there is no consensus regarding the best treatment strategy. Treatment modalities include ocular chemotherapy as well as combined ocular and systemic chemotherapy with or without radiotherapy of CNS, eyes, or both. More recently, autologous stem cell transplantation is also being used (6). The choice of modalities depends on the extent of the disease, age and baseline status of the patient (7). Unfortunately, the survival rate of PVRL is approximately 34 to 44 months (8).

We conducted this study to assess clinical characteristics and final outcomes of patients with a proven diagnosis of PVRL.

METHODS

The study was approved by the Institutional Ethics Committee of faculty of medicine, Chiang Mai University. The study included 15 patients with proven PVRL from the Department of Ophthalmology, Chiang Mai University Hospital from 2008 through 2021. All patients underwent pars plana vitrectomy either with or without retinal biopsy and had positive results of tests for intraocular lymphoma by histology, cytology and/or flow cytometry. The patients' medical records were reviewed for demographic data including age, gender, underlying diseases, immune status, and laterality. Clinical characteristics, including best corrected visual acuity (VA) at first visit and final visit, ocular symptoms and signs, ocular imaging (i.e., fundus photography, optical coherence tomography (OCT), fundus fluorescein angiography (FA)), non-ocular involvement, time to diagnosis of PVRL, cell morphology and immunocytochemistry results were collected.

Treatment modalities were categorized as isolated intravitreal (IVT) with methotrexate (0.4 mg/0.1 mL) combined IVT with methotrexate and/or rituximab (1 mg/0.1 mL) and systemic chemotherapy with or without brain/ocular radiation. Regarding the systemic chemotherapy regimen, the DeAngelis protocol (methotrexate, leucovorin, vincristine, procarbazine and dexamethasone) was used most frequently. The CHOP regimen (cyclophosphamide, doxorubicin, vincristine and prednisolone) still has a role in treatment of lymphoma, though it was given to only one patient. Final outcomes after treatment, including VA, brain involvement, and progression of disease were analyzed. Complete remission was defined as no recurrence of ocular lesions or systemic disease during the follow-up period.

Statistical analysis

Categorical data is shown as percentages. Numerical data are presented as a median (interquartile range; IQR). Survival time is demonstrated by Kaplan-Meier estimates curve. The duration of remission is calculated from the first date on which patients had stable activity of the disease to the date of the last follow-up, relapse, progression, or death from any cause.

RESULTS

Demographic data are presented in Table 1.1 and 1.2. The median age of the 15 patients was 59 years (range 41-71) with more females affected than males (ratio 2:1). The median time to diagnosis was 8 months (range 1-14) counted from the onset of the first symptoms. Bilateral involvement was observed in 10 patients (67%). HIV infection was present in 2 patients (13%). Diabetes mellitus and hypertension were mostly found as underlying diseases, and all were under control.

The most common symptoms at the first presentation were blurred vision (94%) and floaters (40%). Initial VA varied from 6/6 to light perception. The median (IQR) of VA (Log MAR) in the affected eye was 0.5 (0.2-1.25) (range 0.2-3.0).

The most common ocular findings were vitritis (72%; 18/25 eyes), anterior uveitis (60%; 15/25 eyes) and retinal lesions (60%; 15/25 eyes). Retinal vasculitis was observed in 20% (5/25 eyes). Vitritis, chorioretinal lesion and retinal vasculitis are shown in Figure 1A-C.

OCT of 13 patients (16 eyes) were able to be analyzed. Subretinal infiltration and sub-RPE deposits were the most frequently observed (50%; 8/16 eyes) (Figure 1D). Other findings included intraretinal infiltration (46%) and focal disruption of photoreceptors (25%). FA was performed in 3 patients of whom one exhibited hypo and hyper fluorescence with a granular pattern consistent with a leopard spot pattern with late leakage (Figure 1E).

Most diagnostic samples were obtained from vitreous samples (10/15 patients; 67%). Three patients (20%) were diagnosed with lymphoma based on brain tissue biopsy. Two of eleven patients (18%) who underwent retinal biopsy were recognized as having intraocular lymphoma from retinal tissue biopsy results. Eight patients were labeled as B-cell type (53%), three patients as T-cell type (20%) and the rest were labeled as atypical lymphocytes (Table 1.1).

Cerebrospinal fluid examination was performed in 10 patients (67%) and was positive in only one patient (10%). All patients had CT or MRI brain imaging. One patient had brain involvement at the time of the diagnosis.

The treatment modalities are shown in Table 1.2. Six of 15 patients (40%) received only IVT chemotherapy, most of whom received methotrexate. The median number of injections per eye was 4 (IQR 1,6) (range 1-16).

IVT combined with systemic chemotherapy was provided in 8 patients (53%). Rituximab was used in combination with methotrexate in 2 patients (13%) with concurrent systemic chemotherapy. One patient (7%) underwent systemic chemotherapy combined with ocular radiation.

IVT chemotherapy regimens used in our center were methotrexate and/or rituximab. The median number of IVT methotrexate and rituximab injections was 6 (IQR 1,10.5) (range 1-16) and 2 (IQR 1,6) (range 0-6), respectively. DeAngelis regimen was used primarily as systemic chemotherapy. Whole brain radiotherapy was given to ten patients (67%). The IVT, systemic chemotherapy and brain radiotherapy were the most frequently used regimen (7 patients; 67%).

Ten of 15 patients (67%) developed brain involvement later despite receiving the treatment. The duration of the interval between ocular lymphoma and brain involvement ranged from 2 months to 84 months with median time of 22.5 months.

Among the 6 patients who received isolated IVT methotrexate, 3 patients had complete remission (3/6; 50%), one died at 96 months after treatment, and one was lost to follow-up after a single injection. Nine of 15 patients who received systemic chemotherapy with or without IVT chemotherapy and/or WBRT had complete remission (8/9; 89%).

After completing the treatment, eleven patients (73%) had complete remission. Three patients (25%) were unilaterally blind. One patient was lost follow-up during the study. One patient was in remission for 8 years but died after a relapse of the disease.

VA outcomes varied from 6/6 to light perception. The median VA outcomes in the right and left eye were 0.65 (0.225-2.375) and 0.2 (0.05-0.575), respectively. The median VA outcomes of all 25 eyes with PVRL without laterality was 0.6 (0.2-2.4). The median period of progression-free survival was 13 months (IQR 4-61) (range 0-96) and the median follow-up time was 37 months (IQR 22.5-80) (range 4-106). (Figure 2)

A summary of demographic data, laboratory results and treatment modalities are shown in Table 2.

DISCUSSION

Our study demonstrated that vitritis and chorioretinal infiltrations with OCT of subretinal infiltration and sub-RPE deposits were the main ocular presentations of PVRL and affected more females than males. Several studies have reported that the average age of PVRL patients to be in the range of 60 years, which corresponds with our study population (3,4,9). There was no difference in the average age of patients in this study compared to other studies of Asian subjects (10).

Kimura et al. (10) and Kim et al. (11) found the average intervals from initial evaluation to diagnosis were 10.6 and 11 months, respectively, which is comparable to the present study (8 months). The delay in diagnosis could be due to the variety of ocular manifestations of PVRL which can mas-

Figure 1. A. Fundus photography of primary intraocular lymphoma showed vitreous haze with yellowish subretinal infiltration, B. Fundus photography of primary intraocular lymphoma demonstrated creamy yellowish subretinal infiltration (Leopard spot), C. Fundus photography of primary intraocular lymphoma demonstrated retinal vasculitis, D. Optical coherence tomography demonstrated irregular retinal pigment epithelial contour with subretinal and intraretinal hyperreflectivity deposit and photoreceptor disruption, E. Fluorescein angiography showed early hyper-hypo fluorescent spots with late hyperfluorescent staining.

Table 1.1 Clinical characteristics and laboratory results of 15 primary vitreoretinal lymphoma patients

Patient	Gender age (year)	Immune status	Laterality at onset	Underlying diseases	Ocular signs	Initial VA (OD, OS)	Final VA (OD, OS)	Positive samples	Cell type	Cytology result	Flow cytometry result
1	Male 68 Y	Immuno-competent	Bilateral	HT	Retinis and vitritis	6/18, 6/36	HM, 6/9	Vitreous	Atypical lymphocytes	Negative	Positive (CD20, CD45)
2	Female 61 Y	Immuno-competent	Unilateral	DM	Anterior uveitis and vitritis	Fc 2 ft (OS)	6/18 (OS)	Vitreous	Atypical lymphocytes	Negative	Positive (CD3, CD4, CD5, CD7, CD8)
3	Female 47 Y	Immuno-competent	Unilateral	None	Anterior uveitis, retinitis, vitritis and vasculitis	HM (OD)	NPL (OD)	Vitreous	Atypical lymphocytes	Negative	Positive (CD3, CD4, CD8)
4	Female 65 Y	Immuno-competent	Bilateral	None	Anterior uveitis, retinitis, vitritis and vasculitis	PL, 6/60	NPL, NPL	Vitreous	T cell	Positive (Large lymphoid cells)	Not done
5	Female 71 Y	Immuno-competent	Bilateral	HT, DM	Anterior uveitis, retinitis, vitritis and vasculitis	6/18, HM	6/36, NPL	Vitreous	B cell	Positive (Large lymphoid cells)	Positive (CD3, CD20)
6	Female 60 Y	Immuno-competent	Bilateral	None	Vitritis	HM, 6/9	HM, 6/9	Vitreous	B cell	Positive (Atypical lymphoid cells)	Positive (CD20)
7	Male 54 Y	Immuno-competent	Unilateral	HT, DM	Anterior uveitis, retinitis and vitritis	6/24 (OS)	6/24 (OS)	Vitreous	Atypical lymphocytes	Positive (Atypical lymphoid cells)	Negative
8	Male 61 Y	Immuno-competent	Unilateral	DM	Anterior uveitis and vitritis	Fc 1 ft (OD)	6/18 (OD)	Vitreous	T cell	Positive (Atypical lymphoid cells)	Positive (CD3, CD10, CD19)
9	Female 56 Y	Immuno-competent	Unilateral	None	Anterior uveitis, vitritis and vasculitis	Fc 3 ft (OD)	HM (OD)	Retinal tissue	B cell	Positive (Atypical lymphoid cells)	Not done
10	Female 43 Y	Immuno-compromised (HIV)	Bilateral	COPD	Retinitis, vitritis and vasculitis	6/9, 6/24	6/24, 6/24	Vitreous and retinal tissue	B cell	Positive (Atypical lymphoid cells)	Not done
11	Male 59 Y	Immuno-compromised (HIV)	Bilateral	None	Anterior uveitis and vitritis	6/9, 6/9	6/9, 6/9	Vitreous	T cell	Positive (Atypical lymphoid cells)	Not done
12	Male 51 Y	Immuno-competent	Bilateral	None	Retinitis and vitritis	6/6, 6/9	6/6, 6/9	Brain	B cell	Negative	Not done
13	Female 52 Y	Immuno-competent	Bilateral	None	Retinitis and vitritis	HM, HM	6/60, HM	Brain	B cell	Negative	Not done
14	Female 41 Y	Immuno-competent	Bilateral	None	Vitritis and anterior uveitis	HM, 6/9	6/9, 6/6	Brain	B cell	Negative	Negative
15	Female 60 Y	Immuno-competent	Bilateral	None	Anterior uveitis, retinitis and vitritis	HM, HM	NPL, PL	CSF	B cell	Negative	Negative

Table 1.2 Treatment modalities, brain involvement and outcomes of 15 primary vitreoretinal lymphoma patients

Patient	Gender age (year)	Initial VA (OD, OS)	Final VA (OD, OS)	Cell type	Ocular treatment*	Systemic treatment**	WBRT	Systemic involvement	Preceding time of primary organ	Side effects of treatment	Outcomes at 1 year after diagnosis
1	Male 68 Y	6/18,6/36	HM,6/9	Atypical lymphocytes	IVT Methotrexate	None	None	Brain	84 months	None	Perish
2	Female 61 Y	Fc 2 ft (OS)	6/18(OS)	Atypical lymphocytes	IVT Methotrexate	None	Yes	Brain	15 months	None	Remission
3	Female 47 Y	HM (OD)	NPL(OD)	Atypical lymphocytes	IVT Methotrexate	None	None	None	None	None	Remission
4	Female 65 Y	PL,6/60	NPL,NPL	T cell	IVT Methotrexate	De-Angelis	Yes	Brain	4 months	Headache	Active disease
5	Female 71 Y	6/18, HM	6/36,NPL	B cell	IVT Methotrexate and IVT rituximab	De-Angelis	Yes	None	None	Skin irritation	Remission
6	Female 60 Y	HM,6/9	HM,6/9	B cell	Ocular radiation	De-Angelis	Yes	Brain	11 months	None	Remission
7	Male 54 Y	6/24 (OS)	6/24(OS)	Atypical lymphocytes	IVT Methotrexate	De-Angelis	None	None	None	None	Remission
8	Male 61 Y	Fc 1 ft (OD)	6/18(OD)	T cell	IVT Methotrexate	None	None	None	None	None	Active disease
9	Female 56 Y	Fc 3 ft (OD)	HM (OD)	B cell	IVT Methotrexate	CHOP	Yes	Brain	2 months	Nausea	Remission
10	Female 43 Y	6/9,6/24	6/24,6/24	B cell	IVT Methotrexate and IVT rituximab	De-Angelis	Yes	Brain	6 months	None	Remission
11	Male 59 Y	6/9,6/9	6/9,6/9	T cell	IVT Methotrexate	None	None	None	None	None	Loss follow up
12	Male 51 Y	6/6,6/9	6/6,6/9	B cell	IVT Methotrexate	De-Angelis	Yes	Brain	5 months	None	Remission
13	Female 52 Y	HM, HM	6/60, HM	B cell	IVT Methotrexate	De-Angelis	Yes	Brain	12 months	Nausea	Remission
14	Female 41 Y	HM,6/9	6/9,6/6	B cell	IVT Methotrexate	De-Angelis	Yes	Brain	1 month	Nausea	Remission
15	Female 60 Y	HM, HM	NPL, PL	B cell	IVT Methotrexate	None	Yes	Brain	1 month	Nausea	Remission

*Intravitreal (IVT) methotrexate (0.4 mg/0.1 mL) with frequency of weekly injection; IVT rituximab (1 mg/0.1 mL) with frequency of one injection in two to four weeks until the patients received systemic chemotherapy with or without brain radiation

**Systemic treatment composed of De Angelis Regimen (methotrexate, leucovorin, vincristine, procarbazine and dexamethasone) or CHOP regimen (Cyclophosphamide, Doxorubicin, Vincristine and Prednisolone)

HT, hypertension DM: Diabetes mellitus; Fc, finger count; Ft, foot; HM, hand motion; PL, light perception; NPL, no light perception; CSF, cerebrospinal fluid; HIV, human immunodeficiency virus; WBRT, whole brain radiation therapy

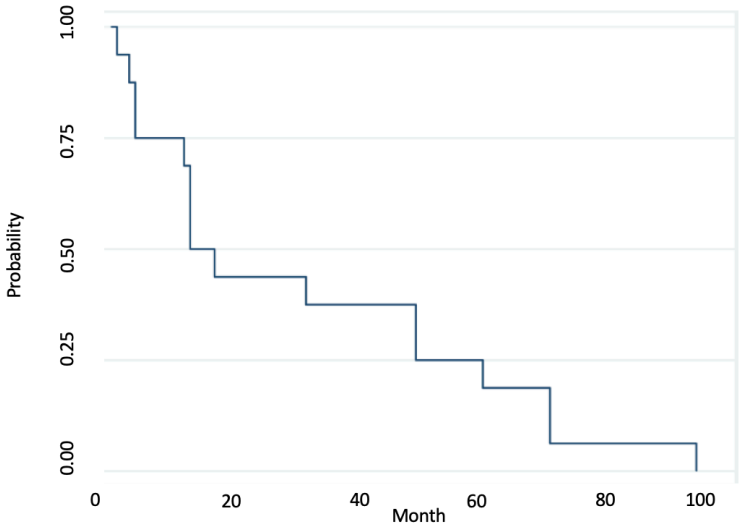

Figure 2. Kaplan-Meier estimate curve showing progression-free survival of 15 primary vitreoretinal lymphoma patients.

Table 2. Summarized table of demographic data, laboratory results and treatment modalities

Male to female ratio	Average age (year)	HIV infection	Bilateral involvement at onset	B cell to T cell ratio	Positive cytology	Positive flow cytometry	Ocular chemotherapy	Systemic chemo-therapy	Radiation (ocular/whole brain)
1:2 (5:10)	57±8.57	2/15	Unilateral: 5/15 Bilateral: 10/15	8:3	8/15	6/9	IVT MTX: 12/15 IVT MTX+RTX: 2/15 None: 1/15	9/15	10/15 (ocular RT 1, WBRT 9)

IVT, intravitreal; MTX, Methotrexate (0.4 mg/0.1 mL); RTX, Rituximab (1 mg/0.1 mL)

querade as multiple ocular conditions. Additionally, achieving a correct diagnosis of PVRL requires the use of multimodal technologies that are usually available only in referral centers.

Previous studies (3, 4, 9, 10) have found that B-cell lymphoma is the most common type in PVRL which is similar to the present study. All three patients in this study who had T-cell types shared common features of anterior uveitis and vitritis. OCT imaging depicted intraretinal infiltration in 2 of 3 patients. People with B-cell lymphomas often have a better prognosis than those with T-cell lymphomas (2). In this study, Two of 3 patients with T-cell lymphoma still had an active disease after one year from the diagnosis.

In OCT imaging, outer retinal and subretinal abnormalities were the most frequently detected which is comparable to other studies (12, 13). At initial examination, some images could not be obtained due to severe vitritis. For that reason, the severity of abnormalities observed might be lower if OCT were performed after partial treatment.

Presently, there is no consensus regarding the treatment regimen for PVRL or PCNSL (14). Multidisciplinary approaches which include hematologists and radiologists are needed to create a treatment plan. Methotrexate is still a main protagonist used for this disease in both ocular and systemic involvements. According to the International PCNSL Collaborative Group Symposium (14), local therapies, e.g., IVT chemotherapy and ocular radiation, were selected for localized PVRL despite bilateral involvement, while systemic chemotherapy was omitted in cases of CNS involvement to prevent excessive side effects. In our study, IVT methotrexate was used in most cases, both isolated and combined with systemic chemotherapy. This study found that isolated IVT chemotherapy had a lower remission rate: there was only one patient who had a complete remission for 8 years after CNS development. Patients who had systemic chemotherapy tend to have a higher rate of complete remission when compared to only local therapy.

Due to the aggressive course of this disease, PVRL patients still had only a fair prognosis even though extensive treatment, including combined local and systemic therapy, was provided. Riemens

et al. (8) reported that the median overall survival of PVRL patients without CNS involvement was 44 months and 34 months in those with CNS involvement. The progression-free survival in our study (13 months (IQR 4-61)) was significantly less than Riemens et al. (8) This might be affected by our patients being referred to another hospital after complete remission, leading to shorter follow - up time.

Our study had several limitations, including a limited number of patients and a shorter follow time than other studies (8, 10, 11). The vitreous cytology examination is a useful investigation for definite diagnosis of PVRL. Nevertheless, malignant cells are quite scarce and prone to degenerate easily (9, 15). This barrier decreases the chance of vitreous cytology to diagnose PVRL.

CONCLUSIONS

This study demonstrated that vitritis and chorioretinal infiltrations are the main ocular presentations of PVRL. More than half of the patients developed brain involvement, but that can be resolved after treatment. Systemic chemotherapy improved the rate of complete remission compared to local therapy alone.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to report.

REFERENCES

1. Behin A, Hoang-Xuan K, Carpentier A, Delattre J. Primary brain tumours in adults. Lancet. 2003;361:323-31.
2. Tang L, Gu C, Zhang P. Intraocular lymphoma. Int J Ophthalmol. 2017;10:1301-7.
3. Levasseur S, Wittenberg L, White V. Vitreoretinal lymphoma: a 20-year review of incidence, clinical and cytologic features, treatment, and outcomes. JAMA Ophthalmol. 2013;131:50-5.
4. Hoffman P, McKelvie P, Hall A, Stawell R, Santamaria J. Intraocular lymphoma: a series of 14 patients with clinicopathological features and treatment outcomes. Eye (Lond). 2003;17:513-21.
5. Rothova A, Ooijman F, Kerkhoff F, Van Der Lelij A, Lokhorst H. Uveitis masquerade syndromes. Ophthalmology. 2001;108:386-99.
6. Pulido J, Johnston P, Nowakowski G, Castellino A, Raja H. The diagnosis and treatment of primary vitreoretinal lymphoma: a review. Int J Retina Vitreous. 2018;4:18. PubMed PMID: 29760948
7. Venkatesh R, Bavaharan B, Mahendradas P, Yadav N. Primary vitreoretinal lymphoma: prevalence, impact, and management challenges. Clin Ophthalmol. 2019; 13:353-64.
8. Riemens A, Bromberg J, Touitou V, Sobolewska B, Missotten T, Baarsma S, et al. Treatment strategies in primary vitreoretinal lymphoma: a 17-center European collaborative study. JAMA Ophthalmol. 2015;133:191-7.
9. Yeh S, Weichel E, Faia L, Albini T, Wroblewski K, Stetler-Stevenson M, et al. 25-Gauge transconjunctival sutureless vitrectomy for the diagnosis of intraocular lymphoma. Br J Ophthalmol. 2010;94:633-8.
10. Kimura K, Usui Y, Goto H, Japanese Intraocular Lymphoma Study G. Clinical features and diagnostic significance of the intraocular fluid of 217 patients with intraocular lymphoma. Jpn J Ophthalmol. 2012;56:383-9.
11. Kim M, Dabaja B, Medeiros J, Kim S, Allen P, Chevez-Barrios P, et al. Survival Outcomes of Primary Intraocular Lymphoma: A Single-institution Experience. Am J Clin Oncol. 2016;39:109-13.
12. Xu L, Huang Y, Liao A, Anthony C, Voloschin A, Yeh S. Multimodal diagnostic imaging in primary vitreoretinal lymphoma. Int J Retina Vitreous. 2022;8:58. PubMed PMID: 36028905
13. Sagoo M, Mehta H, Swampillai A, Cohen V, Amin S, Plowman P, Lightman S. Primary intraocular lymphoma. Surv Ophthalmol. 2014;59:503-16.
14. Grimm S, McCannel C, Omuro A, Ferreri A, Blay J, Neuwelt E, et al. Primary CNS lymphoma with intraocular involvement: International PCNSL Collaborative Group Report. Neurology. 2008;71:1355-60.
15. Sen H, Bodaghi B, Hoang P, Nussenblatt R. Primary intraocular lymphoma: diagnosis and differential diagnosis. Ocul Immunol Inflamm. 2009;17:133-41.