Treatment of circumscribed choroidal hemangioma using CyberKnife: A viable alternative

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Circumscribed choroidal hemangioma is a benign vascular hamartoma without systemic associations. For symptomatic cases, treatment options are photodynamic therapy (PDT), transpupillary thermotherapy (TTT), intravitreal injection of anti-vascular endothelial growth factor (VEGF), or radiation therapy. CyberKnife radiosurgery is an image-guided radiation therapy that delivers radiation to lesions anywhere in the body with an accuracy of 0.5 mm without damage to surrounding structures. We report a case of circumscribed choroidal hemangioma which was successfully treated with CyberKnife therapy. The literature search reveals cases of uveal melanoma, intraocular, and periocular lymphoma successfully treated with CyberKnife therapy. To the best of our knowledge, this is the first report on such treatment for choroidal hemangioma.

Key words: Choroid, eye, CyberKnife, hemangioma, radiation, tumor

Circumscribed choroidal hemangioma is a benign vascular hamartoma without systemic associations, which may present with exudative retinal detachment or cystoid macular edema. Photodynamic therapy (PDT) is the treatment of choice for symptomatic cases. Transpupillary thermotherapy (TTT), laser photocoagulation, or intravitreal anti-VEGF (vascular endothelial growth factor) injection remains as alternative forms or adjuvant therapy to PDT. Radiation therapy like proton beam radiotherapy, stereotactic radiotherapy (gamma knife radiosurgery), plaque brachytherapy, and external beam radiotherapy (EBRT) are reserved for cases not amenable to PDT or adjuvant therapies and for large hemangiomas with bullous retinal detachment.[1–3]

CyberKnife radiosurgery is an image-guided radiotherapy that delivers radiation to lesions anywhere within the body with an accuracy of 0.5 mm without damage to surrounding structures.[4] We present a case of circumscribed choroidal hemangioma which was successfully treated with CyberKnife radiotherapy without radiation-related complications till the last follow-up visit. To the best of our knowledge, successful treatment of circumscribed choroidal hemangioma with CyberKnife radiotherapy has not been reported in the literature.

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Case Report

A 46-year-old African lady presented with decreased vision, floaters, and flashes in the right eye of 6 months duration. She was diagnosed as right eye choroidal hemangioma elsewhere and treated with 5 monthly intravitreal anti-VEGF injections elsewhere. On examination, best-corrected visual acuity (BCVA) in the right eye was finger counting at 50 cm. Anterior segment examination was bilaterally normal. Right eye fundus examination showed an orange-red choroidal mass at the posterior pole, with subretinal fluid (SRF) [Fig. 1a]. Left eye visual acuity was 6/6 and fundus examination was normal. Right eye ultrasound (USG) showed a solitary tumor abutting the optic nerve head with high surface reflectivity and non-homogeneous, moderate-to-high internal reflectivity [Fig. 1b], measuring 8.4 mm (horizontal basal) × 10.6 mm (vertical basal) × 5.3 mm (height). Magnetic resonance imaging (MRI) on T2-weighted image revealed ovoid-shaped heterogeneous mass predominantly hyperintense [Fig. 1c]. Optical coherence tomography (OCT) of the right eye showed choroidal tumor with overlying retinoschisis and SRF [Fig. 1d and e]. Right eye fundus fluoroscein and indocyanine green angiography showed early hyperfluoroscence with staining in the last phase [Fig. 1f and g]. Treatment options of PDT (gold standard), TTT, low-dose EBRT, and CyberKnife were discussed, and the patient chose CyberKnife radiation therapy. She was treated with single fraction radiation of 12 Gy (gray) dose given over 30 min. At 10 months follow-up (which was the last follow-up), the right eye vision improved to 3/60 and fundus examination showed subretinal pigmentary changes at the treated area [Fig. 2a]. Post-treatment ultrasound dimensions were: 8.4 mm (horizontal basal) × 10.4 mm (vertical basal) × 2.8 mm (height) [Fig. 2b]. OCT showed complete resolution of retinochisis and SRF with foveal thinning [Fig. 2c]. MRI revealed mass enchancing homogeneously, decreased in size as compared to previous scan [Fig. 2d]. No evidence of treatment-related side effects like dry eye, cataract, radiation retinopathy, or optic neuropathy were noted till the last follow-up.

Discussion

CyberKnife uses a robotic arm with 6 MV linear accelerator along with a pair of diagnostic X-ray tubes and corresponding

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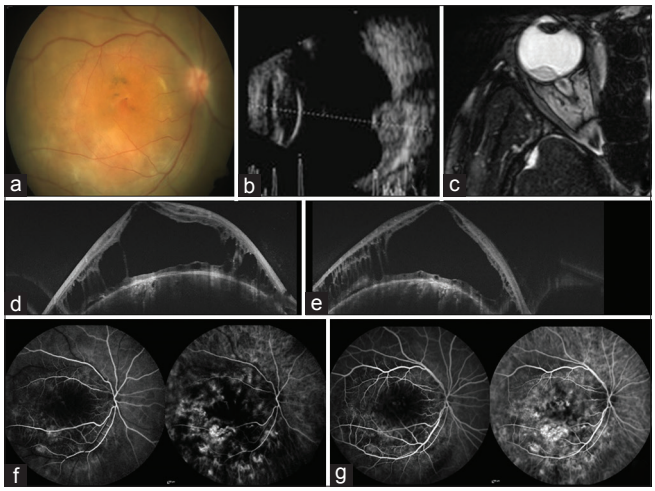

Figure 1: At presentation: fundus photo of the right eye showing circumscribed choroidal hemangioma at the posterior pole with subretinal fluid (a). B-scan ultrasound showing solitary tumor with high surface and moderate-to-high internal reflectivity (b). Magnetic resonance imaging scan showing the tumor that is isointense on T2-weighted image (c). Vertical and horizontal optical coherence tomography scan showing retinoschisis with subretinal fluid (d and e). Simultaneous fundus fluorescein angiography (FFA) and indocyanine green angiography (ICGA) reveals stippled hyperfluorescence in the early phase and increased hyperfluorescene in late phase corresponding to the choroidal hemangioma (f and g)

image detectors. Specialized software uses the position verification X-ray images taken throughout the treatment to verify the patient position based on either radiographic fiducials or bone anatomy. For ocular tumors, the skull tracking option is used. The system has a dedicated image-guidance mechanism that consists of two X-ray sources and two flat-panel detectors, which acquire orthogonal images of the target area. Exact patient positioning is done through an automated patient couch. During treatment, the robotic manipulator automatically corrects for translational and rotational motion of the target within a range of 0.5–10 mm based on periodically acquired images. A non-invasive monitoring system for fixing the eye has also been developed to treat orbital and choroidal tumors with CyberKnife-based radiotherapy. This device monitors the eye during CT/MRI scanning before procedure and during treatment. With CyberKnife therapy it is possible to deliver a highly conformal, uniform dose with step dose gradients to all stereotactic targets throughout the patient's body.[5]

Bianciotto *et al*. reported successful treatment of intraocular and periocular lymphoma in 14 eyes of 13 patients with CyberKnife radiotherapy. Mean treatment dose was 1718 centigray given over a mean of 5 days. Complete tumor resolution without local recurrence over a mean follow-up of 23 months was documented in all cases. Visual acuity was preserved or improved in 13 eyes and decreased in 1 eye due to the presence of cataract.[6] Eibl-Lindner *et al*. reported 217 patients of unilateral uveal melanomas (3% small, 62% medium, and 35% large) treated with CyberKnife therapy with dose ranging from 18–22 Gy. Three year and 5-year eye retention rates were 86.7 and 73%, respectively. Local control at 3 and 5 years were 87.4 and 70.8%, respectively. Vision was maintained in 30.9%. However, treatment-induced glaucoma developed in 33 patients. Other adverse effects were hemorrhage (26 patients)

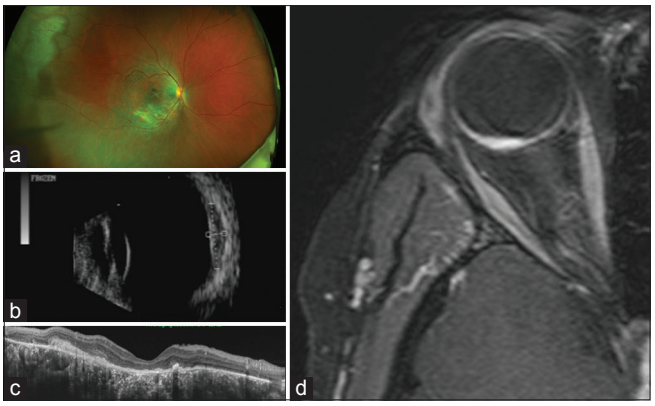

Figure 2: At 10 months follow-up: Optos fundus image shows subretinal pigmentary changes over the treated area (a). B-Scan ultrasound shows significant decrease in tumor height (b). Optical coherence tomography shows complete resolution of retinoschisis and subretinal fluid (c). Magnetic resonance imaging also shows decrease in size of the tumor (d)

and macular edema (7 patients).[7] Zorlu *et al*. also concluded that CyberKnife fractionated radiosurgery seems to be a viable alternative local treatment modality in uveal melanoma with no serious acute side effects.[8]

Disadvantages of CyberKnife therapy include headache, nausea, cataract, longer duration of treatment time (30–45 min/session) and high cost.[6] However, these side effects are less common as compared to other forms of radiotherapy as CyberKnife treatment delivers high radiation beams in fractionated doses with great accuracy due to the robotic arm. The treatment of choice PDT has advantages like non-exposure to radiation, no increased risk of cataract over CyberKnife radiotherapy. The advantages of CyberKnife radiotherapy over PDT are its non-invasive nature, no need for precautions like protection from sunlight or bright indoor lights, no side effects of PDT like sun burns, anaphylaxis, extravasation of dye, or severe vision loss (seen in 4% patients treated with PDT).

Cumulative radiation maximum point dose limit for lens is 10 Gy, retina is 50 Gy, and optic nerve is 55 Gy.[9] For our patient, a single radiation fraction of 12 Gy was used which is below the harmful dose limit for important ocular structures except the lens. Reports suggest that EBRT has been used for cases of choroidal hemangioma with dose ranging from 20–40 Gy.[10] Plaque brachytherapy with palladium-103, cobalt-60, ruthenium-106, and iodine-125 have been reported for circumscribed choroidal hemangioma.[11] Plaque radiotherapy is generally used for choroidal hemangioma with extensive SRF in which PDT is not advisable. Dose with this therapy is not homogeneous, with higher doses at the tumor base than the apex of tumor. One report on use of this modality for eight patients showed that 48 Gy target apex dose was used and radiation retinopathy was noted in 38% patients.[12] Complications of plaque therapy include pigment migration into the treated area, subretinal fibrosis, and atrophic scar. Its disadvantage is necessity for two surgeries for plaque placement and removal.[13] These modalities have clearly used radiation above the maximum dose limit for various structures of the eye.

CyberKnife has the capacity to minimize irradiation of nearby critical structures through the use of multiple beams

coming from different directions, with the intent to reduce collateral damage.[14] Economically, CyberKnife therapy is of higher cost and less availability. However, since a single session treatment is usually curative, there is not much difference in treatment cost between PDT and CyberKnife.

CyberKnife treatment represents a favorable therapeutic option for different types of intraocular tumors as it offers a dose distribution characterized by high degree of conformity and protection of organs at risk.[15] This makes it a valuable alternative to surgery (eye enucleation) or other radiotherapy techniques (brachytherapy, proton therapy).[16]

Conclusion

In conclusion, CyberKnife is an effective option for treatment of circumscribed choroidal hemangioma in patients averse to invasive procedures, or with known adverse effects to verteporfin. This case showed a good response to CyberKnife treatment. However, further studies are required to make a definite conclusion.

Statement of ethics

As per institutional policy, ethics approval is not required for the publication of case reports.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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