Choroidal Melanoma Treated with Linear Accelerator-based Hypofractionated Stereotactic Radiotherapy: First Case of Globe Conservation in Uveal Melanoma from the Philippines

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ABSTRACT

Objective: This is a case report of a 60-year-old woman with a juxtapapillary choroidal melanoma who underwent globe-sparing treatment using linear-accelerator (LINAC)-based hypofractionated stereotactic radiotherapy (FSRT).

Methods: Clinical data, ophthalmologic findings, and imaging results were obtained through retrospective chart review.

Results: At three months and nine months post-treatment, tumor thickness decreased by 20.5% (from 13.00 mm to 10.34 mm) and 33.2% (to 8.69 mm), respectively. Partial resolution of subretinal fluid and vitreous hemorrhage was confirmed clinically and by B-scan. No metastatic spread was detected on liver ultrasound and chest radiography. Best-corrected visual acuity in the treated eye remained stable at hand motion. Radiation-induced dry eye was managed effectively with preservative-free sodium hyaluronate eye drops.

Conclusion: LINAC-based hypofractionated FSRT achieved marked local control and tumor regression in this case of a medium-large, juxtapapillary choroidal melanoma, while preserving the globe and the baseline vision. In regions without access to plaque brachytherapy, this technique offers a practical, cost-efficient, and multidisciplinary approach to eye-conserving therapy.

Keywords: juxtapapillary uveal melanoma, fractionated stereotactic radiotherapy; ocular oncology; linear accelerator therapy

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Choroidal melanomas are the most common primary intraocular malignancy in adults and account for 90% of uveal melanomas.[1] Globally, most cases arise in adults aged 50-70 years,[2] reflecting cumulative epigenetic changes in genetically susceptible individuals. In Western countries, the annual incidence is approximately 5-6 per million, whereas in Asia it is lower (0.25-0.6 per million).[3] Although relatively uncommon in Asian populations, these melanomas present at younger ages, and the average diameter at diagnosis ranges from 12 to 14.8 mm, making medium-sized and large tumors more common than small ones.[3] Such advanced presentations often leave enucleation as the only viable option, especially in resource-limited settings.

Modern ocular oncology now offers radiation strategies—episcleral plaque brachytherapy and stereotactic radiotherapy—that can spare the globe and maintain useful vision even in large or anatomically unfavorable melanomas. Plaque brachytherapy involves sewing a radioactive plaque onto the sclera, while stereotactic methods like fractionated stereotactic radiotherapy (FSRT) or single-dose stereotactic radiosurgery (SRS) use image-guided CT/MRI planning to deliver conformal external-beam radiation. These modalities optimize radiation dose delivery to the tumor while sparing critical structures (lens, optic nerve, macula). In the Philippines, dedicated plaque brachytherapy is unavailable, and proton beam therapy remains inaccessible for most patients. We hereby describe our experience with linear-accelerator (LINAC)-based hypofractionated FSRT in the first reported case of globe conservation in a Filipino patient with large juxtapapillary uveal melanoma.

CASE PRESENTATION

A 60-year-old woman presented with a one-year history of gradually worsening vision in her right eye, which was eventually reduced to hand motion. She also experienced photopsias. She had no systemic illnesses, no prior cancers or infections, and no relevant family history. General physical examination was unremarkable; she was afebrile, had normal vital signs, Fitzpatrick Skin Type II (fair skin, tans poorly), had no suspicious cutaneous lesions, no lymphadenopathy, and had normal cardiopulmonary and abdominal examination findings. Neurologic examination was also unremarkable.

On initial examination, the best corrected visual acuity of the right eye was hand motion (Table 1). The extraocular movements, lids, lashes, conjunctiva, and sclera were all normal. The pupil was briskly reactive to light and there was no RAPD. The iris was normal. Gonioscopy revealed an anterior chamber angle opening to the ciliary body band, and no abnormal findings. The best corrected visual acuity of the left eye was 20/30. The other findings in the left eye were unremarkable and were identical to those in the right eye.

Table 1. Ophthalmologic Findings of Right Eye at Presentation

Parameter	Findings in Right Eye
Best Corrected Visual Acuity	Hand motion
Lids and Lashes	No swelling, ptosis, discharge, mass, or lash loss
Conjunctiva	No hyperemia; no sentinel vessels; no pigmented lesions
Sclera	Anicteric; no thinning or hyperpigmentation
Pupils	2-3 mm, briskly reactive to light, no RAPD
Iris	No color changes, atrophy, masses, or neovascularization
Intraocular Pressure	12 mm Hg
Extraocular Movements	Full movements; no pain or diplopia on movement
Gonioscopy	Angle opens to ciliary body band; no masses or neovascularization

Fundus examination of the right eye (Figure 1A) revealed a pigmented, dome-shaped choroidal mass obscuring the optic disc, extending from 11 to 4 o'clock, with surface hemorrhages and associated subretinal fluid extending to the fovea and peripheral retina. Vitreous hemorrhage was evident along the inferotemporal arcades. The lesion measured approximately 14 × 14 mm (8 disc areas), and minimal shifting of the subretinal fluid was seen on dynamic exam

B-scan ultrasound (Figure 2A-C) confirmed a solid homogenous mass with low to moderate reflectivity, attached to the superonasal quadrant, measuring 13.8 mm at the base and 13.0 mm in height. Adjacent vitreous hemorrhage produced low-amplitude, amorphous, mobile echoes. A moderate to high amplitude curvilinear band with stiff aftermovement attached to the optic nerve indicated localized retinal detachment.

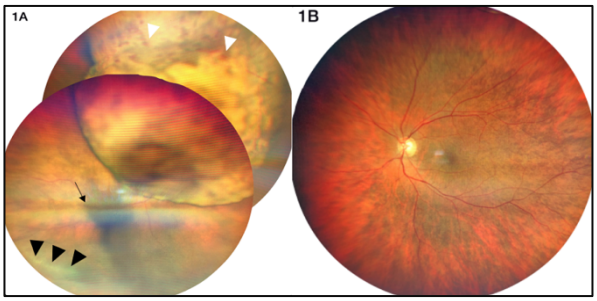
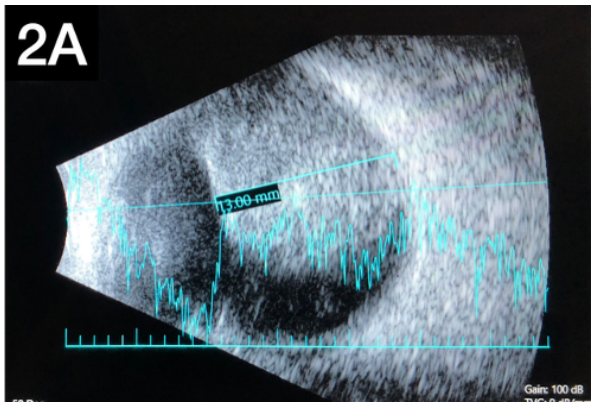
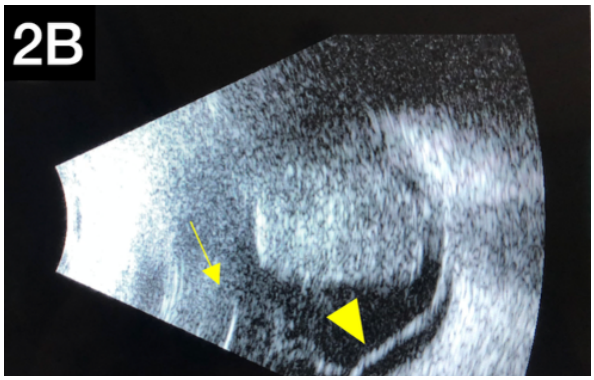


Figure 1. Fundus photos of both eyes. (1A) Fundus photo of the right eye showed an elevated, pigmented, dome-shaped subretinal mass overlying the disc, with overlying surface hemorrhages (white arrowhead) and associated subretinal fluid (black arrowheads) and vitreous hemorrhage inferiorly (black arrow). (1B) Fundus photo of left eye with unremarkable findings.

Imaging procedures to check for metastasis (whole-body PET scan, liver ultrasound, and chest x-ray) all turned out negative. A contrast-enhanced cranial and orbital magnetic resonance imaging (MRI) scan (Figure 3A-D) showed a well-defined, lobulated, avidly-enhancing intraocular mass in the right globe measuring 11 × 12 × 12 mm, with subretinal fluid accumulation temporal to the optic disc, and without extrascleral or intraorbital optic nerve invasion.





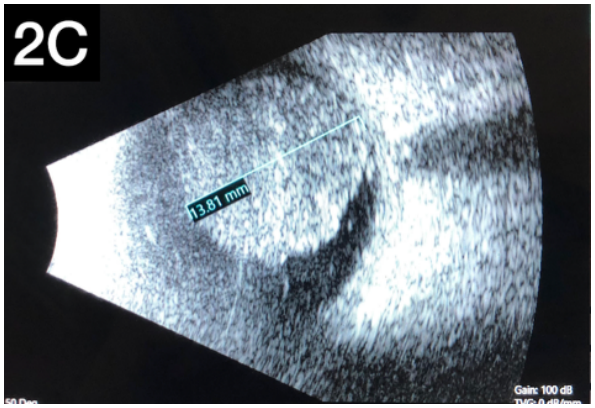


Figure 2. B-scan ultrasound of the right eye on initial consult. (2A, 2C) Ultrasound revealed a button-shaped mass with low-moderate echoes, measuring 13 mm × 13.8 mm, and abutting the optic nerve. (2B) Low-amplitude echoes were seen within the vitreous cavity (yellow arrow). Also seen was a moderate to high amplitude curvilinear band attached to the optic nerve displaying stiff aftermovement (yellow arrowhead).

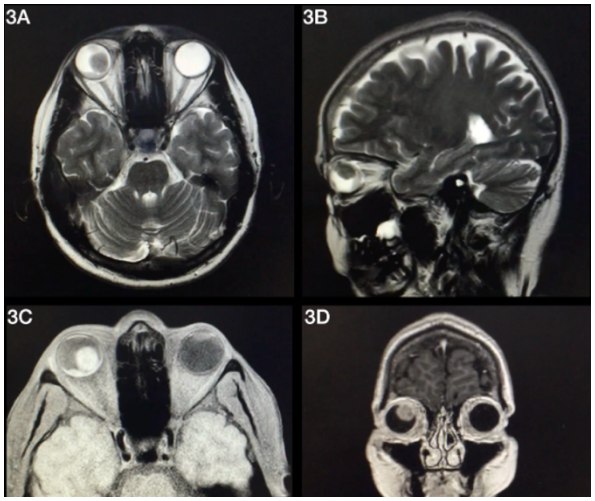


Figure 3. MRI of the brain and orbit. (3A, 3B) Axial and sagittal T2-weighted MRI images showed a well-defined, lobulated, hypointense intraocular mass in the right globe with subretinal fluid accumulation temporal to the optic disc without extrascleral or intraorbital optic nerve invasion. (3C, 3D) Axial and coronal T1 weighted MRI images showed avid enhancement of the said mass with gadolinium contrast.

Spectral-domain optical coherence tomography (SD-OCT) scan of the right eye on initial presentation demonstrated poor signal strength, with signal drop-out noted predominantly in the superior and nasal macula (Figure 4A). The foveal contour appeared blunted, and there were subretinal hyporeflective spaces involving the fovea and inferior macula, consistent with subretinal fluid accumulation. In contrast, OCT scan of the left eye (Figure 4B) showed good signal strength, a normal foveal contour, and no intraretinal cystic changes. The external hyperreflective bands, including the ellipsoid zone,

were intact and regular. The high-definition topography map of the ILM-RPE showed smooth inner and outer retinal surfaces, with no evidence of retinal thickening or thinning across all ETDRS subfields. The central subfield thickness was within the 95th percentile of normative values.

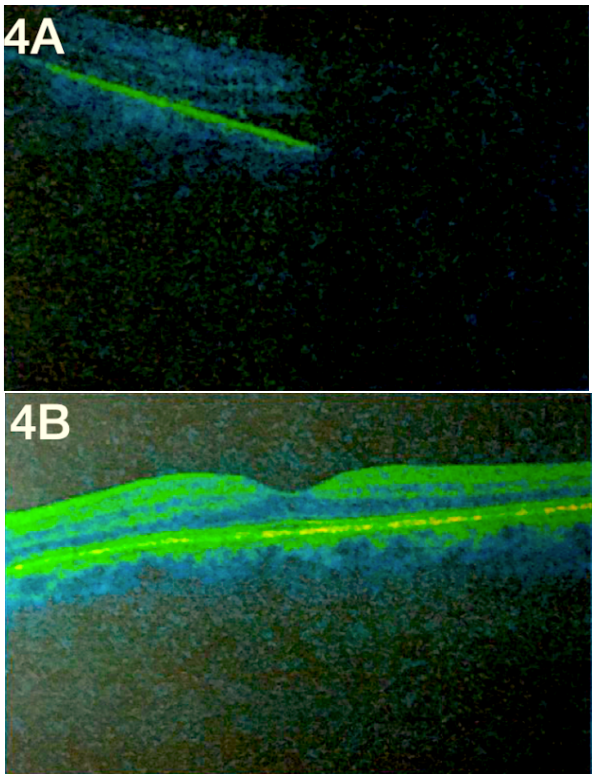


Figure 4. Spectral-domain optical coherence tomography (SD-OCT) of both eyes. (4A) Scan of right eye with poor signal strength, showing large areas of signal drop-out superiorly and nasally. Foveal contour was blunted, with subretinal hyporeflective spaces involving the fovea and inferior macula. (4B) Left eye with good signal strength, normal foveal contour, intact outer retinal layers, and no intraretinal or subretinal fluid.

Given the tumor's size (13.0 × 13.8 mm), juxtapapillary location, and the patient's strong desire to preserve her eye, we elected to proceed with LINAC-based hypofractionated stereotactic radiotherapy (FSRT). On the treatment day, the patient was immobilized with a custom-made thermoplastic mask, and a retrobulbar block was administered to minimize ocular motility. Fiducial markers were placed on the brow and periocular skin, then a high-resolution CT scan (1 mm sections) was obtained and fused with the prior contrast MRI scan for precise target delineation. The gross tumor volume, as demarcated on MRI and B-scan, was expanded by 2 mm to define the clinical target volume (CTV), and an additional 1 mm margin was added to establish the planned target volume (PTV), accounting for residual set-up uncertainty and small eye movements. A total dose of 45 Gy was prescribed, delivered in three equal fractions of 15 Gy over three consecutive days. Treatment planning constraints limited the dose to the optic nerve head to ≤ 20 Gy (0.1 cc) and to the fovea to ≤ 25 Gy (0.1 cc), while ensuring the dose to the lens remained below 10 Gy and the dose to the non-foveal macula remained below 30 Gy. Dose-volume histograms confirmed that all critical structures remained within these tolerance thresholds. The procedure was well tolerated, with no acute adverse effects.

At three months after FSRT, the patient's best corrected visual acuity in the right eye remained hand motion. Fundus examination demonstrated partial visualization of the optic nerve and an approximate reduction of the choroidal lesion to 7 disc diameters (Figure 5). Subretinal fluid was markedly reduced, and vitreous hemorrhage had diminished in volume; there were no new hemorrhages or optic disc edema. A follow-up B-scan ultrasound (Figure 6B) revealed a tumor thickness of 10.34 mm—a 20.5% decrease from baseline—and increased internal reflectivity of the tumor.

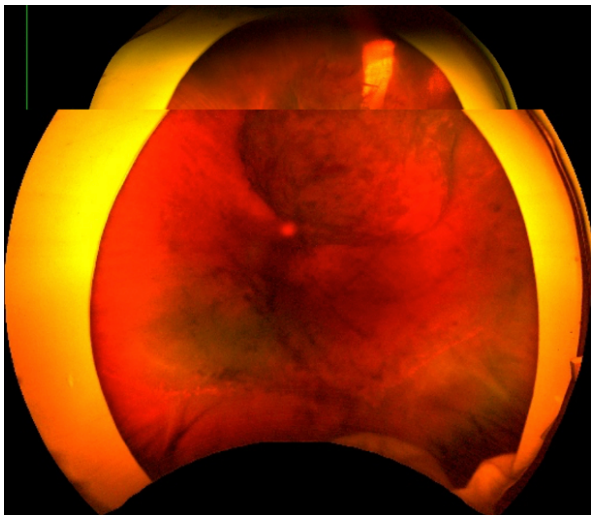


Figure 5. Fundus photo of the right eye. At 3 months after hypofractionated stereotactic radiotherapy (FSRT), the optic nerve was partially visible, with an interval decrease in the tumor size to ~7 disc areas.

At 9 months post-FSRT, visual acuity in the right eye remained stable at hand motion. Funduscopic examination showed further flattening of the lesion (approximately 5.5 disc diameters), with only

shallow residual subretinal fluid and organized vitreous hemorrhage. No new hemorrhages or optic disc edema were present. Repeat B-scan ultrasound showed a tumor thickness of 8.69 mm, indicating a total reduction of 33.2% from baseline. Ultrasound also confirmed persistent high reflectivity within the tumor (Figure 6C).

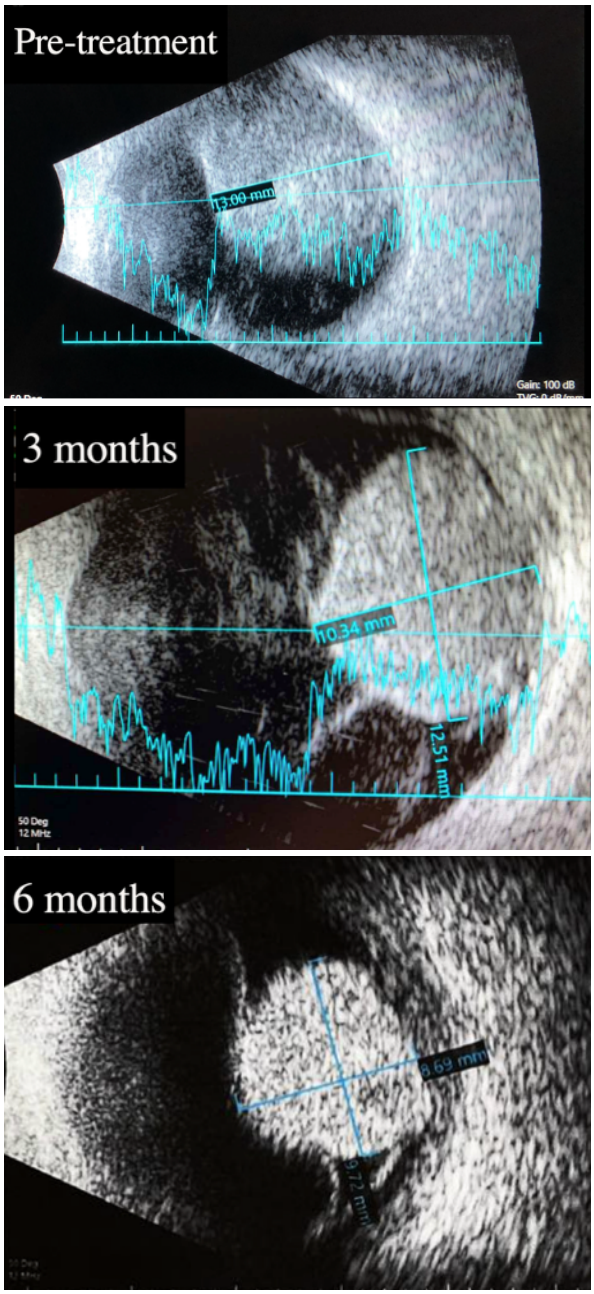


Figure 6. B scan images pre-treatment and throughout 9 months of treatment. Tumor thickness decreased to 10.34 mm at 3 months post-treatment (6B), and further decreased to 8.69 mm at 9 months (6C), achieving local tumor control. An increase in total internal reflectivity was noted post-treatment.

Systemic imaging (liver ultrasound and chest radiography) remained negative for metastatic disease. At this visit, the patient complained of mild foreign body sensation in her right eye. Slit lamp examination disclosed punctate epithelial erosions consistent with radiation-induced dry eye, which were successfully managed with preservative-free sodium hyaluronate drops. No radiation retinopathy, optic neuropathy, macular edema, neovascular glaucoma, or cataract formation was observed at 9 months.

DISCUSSION

The primary goal in managing uveal melanoma is to reduce mortality by preventing or delaying metastatic spread, while secondary objectives include preservation of the globe and visual function. Historically, large tumors and juxtapapillary tumors (within 1 disc diameter from the optic disc margin) were managed by enucleation when plaque brachytherapy or proton beam therapy was unavailable. The Collaborative Ocular Melanoma Study (COMS) demonstrated no significant difference in 5-year survival between enucleation and ^{125}I plaque brachytherapy for small to medium-sized melanomas,[4] establishing radiation therapy as a globe-sparing alternative. However, in many Asian populations, uveal melanomas often present at greater thickness (> 10 mm) and younger ages,[3] making conservative management more difficult.

Our patient faced enucleation as a standard option, but at the expense of vision and eye retention. Episcleral plaque brachytherapy is discouraged for tumors with apical height > 12 mm because delivering an adequate apex dose would mean an overdose for adjacent structures.[5] The National Comprehensive Cancer Network (NCCN) Guidelines also recommend plaque therapy only for tumors ≤ 18 mm in largest base diameter and ≤ 10 mm in thickness; tumors with largest diameter > 18 mm, thickness > 10 mm, or thickness > 8 mm with optic nerve involvement should undergo proton beam therapy, stereotactic radiosurgery (SRS), or enucleation.[6] Juxtapapillary location further complicates plaque placement, as proximity to the optic nerve increases the risk of radiation-induced optic neuropathy and maculopathy.[7] Moreover, in

the Philippines, dedicated plaque centers remain unavailable.

FSRT via LINAC was chosen for our patient because it delivers a uniform, conformal dose across the entire tumor regardless of height,[8] sparing nearby critical structures (optic nerve and macula).[9] This approach aligns with Dieckmann et al. and Sikuade et al., who recommend SRS or FSRT for tumors too large for plaque therapy or tumors within 2.5 mm of the optic disc or fovea.[8,9] Multi-beam FSRT allows sculpting radiation dose away from the nerve and macula—an advantage when tumors abut critical structures.[10]

We used a hypofractionated regimen—45 Gy in three fractions of 15 Gy each—following the protocol suggested by Yazici et al., which provided high local control with acceptable toxicity.[11] Hypofractionation offers radiobiologic benefits for large tumors: smaller per fraction doses allow sublethal damage repair in normal tissues between treatments,[12] potentially reducing radiation retinopathy or optic neuropathy. Although a meta-analysis showed no significant difference between hypofractionated and single-dose SRS in 5-year local control (90% vs. 89%, $p = 0.28$) or enucleation and toxicity rates,[13] hypofractionation was deemed more prudent for this patient, given the tumor's size, juxtapapillary location, and the goal of minimizing collateral damage.

By 3 months, B-scan UTZ showed a 20.5% reduction in tumor height with increased internal reflectivity, findings consistent with necrosis and fibrosis.[14,15] Early regression (~20–30%) within 3-6 months was reported in both stereotactic and plaque series. Georgopoulos et al. observed a 23% reduction at 12 months after SRS,[16] and Rashid et al. documented 20-30% regression by 3-6 months with ^{125}I plaque,[17] demonstrating that FSRT matches plaque treatment and early control even for large, juxtapapillary melanomas.

At 9 months, tumor height further decreased to 8.69 mm (33.2% regression). Local control was 100%, aligning with reported 100% control at one year in a published FSRT study.[18] No liver metastases were detected at 9 months. In our case, the affected eye was still preserved at 9 months, matching one-year rates of 95-97% in LINAC FSRT series.[8,19] The visual acuity of the affected eye remained the same as at baseline (hand motion). At 9 months, the patient was alive, paralleling a 96% one-year survival rate reported in a larger series.[19]

Despite excellent local control, visual prognosis is guarded for tumors > 10 mm thick, involving the optic disc, or abutting the fovea. Shields et al. identified poor baseline visual acuity, age > 60 years, greater thickness, and juxtapapillary/subfoveal location as predictors of post-radiation vision loss.[20] Our patient exhibited all these risk factors, thus necessitating vigilant monitoring for late radiation retinopathy, optic neuropathy, macular edema, and neovascular glaucoma.

Comparative data between FSRT and plaque brachytherapy for juxtapapillary melanomas show similar local control but differing toxicities. In a retrospective cohort of 94 patients, Krema et al. reported local recurrence rates of 7% with FSRT versus 11% with ^{125}I plaque.[21] FSRT patients had higher rates of radiation retinopathy, neovascular glaucoma, and papillopathy, though differences did not reach statistical significance.[21] In addition, ocular surface complications (such as corneal epithelial defects) occur in 20% of LINAC FSRT cases in the early and subacute phases post-treatment.[22] In our patient, punctate epithelial erosions at 9 months were managed with preservative-free sodium hyaluronate eye drops.

Tumor thickness strongly correlates with metastatic risk: lesions > 10 mm in height have metastasis rates of approximately 28% at 3 years, 40% at 5 years, and 51% at 10 years, with each additional millimeter increasing 10-year metastasis risk by 51%.[23] Although tumor dimensions remain prognostically useful, cytogenetic markers (monosomy 3, 8q gain) provide superior risk stratification.[24] In our patient, cytogenetics studies were not performed due to logistical and financial constraints. We therefore initiated semi-annual systemic surveillance together with a medical oncologist (PET CT scan, liver ultrasound, liver enzyme serum levels) to detect early metastasis.

The greatest clinical utility of FSRT in resource-limited environments is its ability to leverage existing LINAC infrastructure, bypassing the high capital and consumable costs of plaque brachytherapy or proton facilities, while still delivering precise radiation to large or juxtapapillary tumors. Tertiary centers can treat ocular melanomas using equipment already in place for other cancers,

reducing upfront expenditures and patient out-of-pocket costs. It requires only one to five outpatient visits, minimizing hospital admissions and freeing up operating rooms. In the Philippines, where hospitals often operate at capacity and many families pay out-of-pocket, this approach substantially lowers financial burden and logistical complexity. As more cases share the same LINAC, per-patient costs decline, and a modest investment in cross-training radiation oncologists in ocular targeting can expand access to eye-saving care.

This report's analysis of a single case, relatively short follow-up period, and lack of cytogenetic data may limit its generalizability. Late ocular complications such as radiation retinopathy, optic neuropathy, and cataract often manifest beyond one year,[8] necessitating extended monitoring. Additional multicenter studies are needed to refine FSRT protocols, compare cost-effectiveness against proton modalities (available at select Philippine centers), and establish standardized follow-up schedules.

This is the first documented use of LINAC-based hypofractionated FSRT for uveal melanoma in the Philippines. In a setting without ophthalmic plaque access, we achieved early and substantial tumor regression (20.5 % at 3 months; 33.2 % at 9 months), stable visual acuity, and globe preservation without systemic spread. FSRT can serve as a feasible, effective, and adaptable treatment for large juxtapapillary melanomas in resource-constrained environments. Multidisciplinary collaboration between ophthalmology and radiation oncology is essential for successful planning and delivery. Prospective multicenter studies are warranted to optimize protocols, evaluate cost-effectiveness, and determine long-term outcomes in similar patient populations.

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