AROI-ICRO SUN PG TEACHING COURSE ON BRACHYTHERAPY

4th & 5th JUNE 2022

OCULAR PLAQUE BRACHYTHERAPY INDICATION AND TREATMENT PLANNING

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BRACHYTHERAPY IS AN ART , MASTERED BY THE BEST , PLANNED BY THE IMAGINATIVE , AND EXECUTED BY THE FINEST IN, A PERFECT OUTSTANDING CLASS


LOOK AT THE WORLD WITH THE CHILD'S EYE — IT IS VERY BEAUTIFUL.
—
KAILASH SATYARTHI
HB

Incidence / prevalence

- American cancer society estimates (2017) – Primary tumor of eye:
  - 3130 new cases
  - 330 deaths
- Indian Data : Lacking
- M:F ratio – Similar
- Most common tumors :
  - Adults : Melanoma / Lymphoma
  - Children : Retinoblastoma/ Medullo-epithelioma
  - Metastatic deposit : more common than primary tumors (breast and lung)
  - Others : RMS, Optic n glioma, Conjunctival tumors , Eyelid carcinoma.

> Middle East Afr J Ophthalmol. 2021 Jan 19;27(4):199-203. doi: 10.4103/meajo.MEAJO_275_19. eCollection Oct-Dec 2020.

Ocular and Periocular Tumors in India: An EyeSmart Electronic Medical Record Analysis of 9633 Cases from a Referral Center

Swathi Kaliki [1], Anthony V Das [2]

Affiliations + expand

PMID: 33814815 PMCID: PMC7993046 DOI: 10.4103/meajo.MEAJO_275_19

Free PMC article

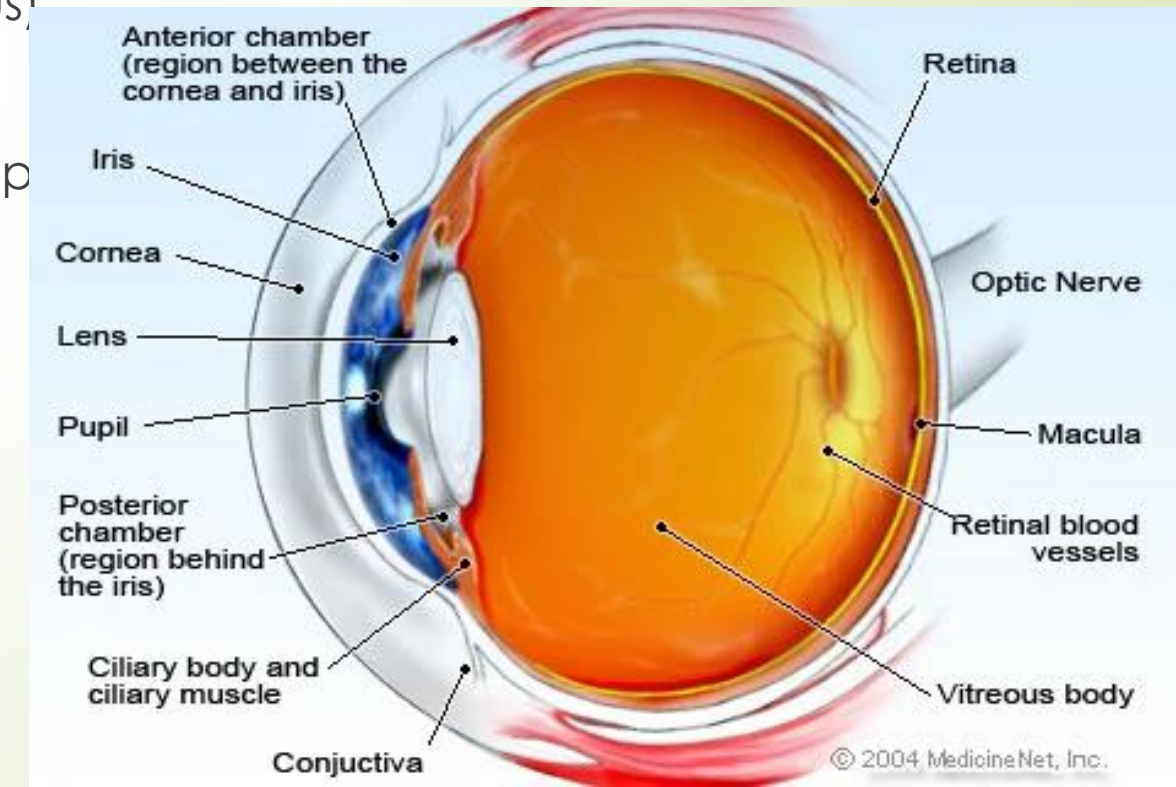
Abstract

Purpose: To describe the epidemiology of ocular and periocular tumors in patients presenting to a multi-tier ophthalmology hospital network in India using the electronic medical records (EMRs) system.

Conclusions: The present study results indicate the incidence and distribution of ocular and periocular tumors in a large cohort in India. Retinoblastoma is the most common tumour encountered in a referral-based comprehensive ophthalmic oncology practice in India. The use of EMRs enables to capture the structured information and big data analysis of the same.
OSSN/NEAVUS/SEBACEOUS GLAND CARCINOMA

Anatomy

- Eye is not a sphere but fused two piece unit .
- Frontal unit (smaller) – cornea (8mm radius)
- Larger unit – sclera (12 mm radius)
- Connected by limbus
- Iris/pupils/ fundus (Optic disc/pap
- Globe vertical – 24 mm



Benign causes

- Pterygium
- Choroidal hemangiomas
- Capillary hemangioma
- Orbital psudo-tumour
- Thyroid associated orbitopathy

Malignant causes

- Metastatic carcinoma to uvea
- Malignant melanoma of uvea
- Retinoblastoma
- Primary intraocular lymphoma
- Optic pathway glioma
- Orbital tumors
  - Primary orbital lymphoma
  - Conjunctival tumors
  - Sebaceous carcinoma of eyelid
  - Orbital RMS
- Periorbital skin cancers
- OSSN

- Generally eye malignancies are managed with enucleation or exentration
- Advantages being – complete removal of tumor
- With a problem of loss of vision and globe with a morbid surgery.

- So with the aim of organ preservation and function alternative methods such as plaque brachytherapy is used .
- Main aim being preventing loss of vision / globe and life.

- Radiation – EBRT / Brachytherapy
- With or without surgery / chemotherapy
- Advanced techniques – IMRT/Proton beam / SRT
- RT dose significant
- Toxicity concerns
- OAR
- Management is interdisciplinary – close coordination with Ophthalmologists.

EBRT

- Advantage:
  - Saves eyeball/globe
  - Saving vision
- Disadvantage :
  - Toxicity – retinopathy / optic neuropathy
  - Dry eye
  - Cataract
  - Growth retardation
  - Secondary malignancies

Radiation tolerance

- Eyelid –
  - Loss of eyelashes – 20 Gy
  - Xeropthalmia – 24-26 Gy
- Conjunctiva –
  - Acute conjunctivitis – 30 Gy
- Lacrimal system –
  - Dry eye syndrome (4-11 yrs after Rx)– 30- 45 Gy
  - Higher dose – 57 Gy (within 9 -10 months)

Cornea – 30 – 50 Gy

Iris – radioresistant – 70 Gy (neovascular Glaucoma)

Lens – radiosensitive –

50% risk of cataract for 1 Gy exposure in children

33% risk of cataract after 2.5-6.5 Gy

66 % risk after 6.5 yrs , 1 – 11.5 Gy

Retina – (retinopathy) – 30 – 35 Gy

Optic nerve: (RION) – 3-7% @ 55-60 Gy and 7-20% @ >60 Gy.

Plaque brachytherapy

ELSEVIER

BRACHYTHERAPY

Brachytherapy 13 (2014) 1—14

The American Brachytherapy Society consensus guidelines for plaque brachytherapy of uveal melanoma and retinoblastoma

The American Brachytherapy Society - Ophthalmic Oncology Task Force

ABSTRACT

PURPOSE: To present the American Brachytherapy Society (ABS) guidelines for plaque brachytherapy of choroidal melanoma and retinoblastoma.

METHODS AND MATERIALS: An international multicenter Ophthalmic Oncology Task Force (OOTF) was assembled to include 47 radiation oncologists, medical physicists, and ophthalmic oncologists from 10 countries. The ABS-OOTF produced collaborative guidelines, based on their eye cancer—specific clinical experience and knowledge of the literature. This work was reviewed and approved by the ABS Board of Directors as well as within the journal's peer-reivew process.

RESULTS: The ABS-OOTF reached consensus that ophthalmic plaque radiation therapy is best performed in subspecialty brachytherapy centers. Quality assurance, methods of plaque construction, and dosimetry should be consistent with the 2012 joint guidelines of the American Association of Physicists in Medicine and ABS. Implantation of plaque sources should be performed by subspecialty-trained surgeons. Although there exist select restrictions related to tumor size and location, the ABS-OOTF agreed that most melanomas of the iris, ciliary body, and choroid could be treated with plaque brachytherapy. The ABS-OOTF reached consensus that tumors with gross orbital extension and blind painful eyes and those with no light perception vision are unsuitable for brachytherapy. In contrast, only select retinoblastomas are eligible for plaque brachytherapy. Prescription doses, dose rates, treatment durations, and clinical methods are described.

CONCLUSIONS: Plaque brachytherapy is an effective eye and vision-sparing method to treat patients with intraocular tumors. Practitioners are encouraged to use ABS-OOTF guidelines to enhance their practice.

- Brachytherapy - Since 1930.
- Modern plaques currently include assemblies of gold shells with
  - Low-energy photon seeds –
    - 125 I,
    - 103 Pd, and
    - 131 Cs.
  - Solid beta –
    - 106 Ru and
    - 90 Sr.

- Gold-198
- Iridium-192
- Palladium-103
- Iodine-125
- Ruthenium-106

Radiological characteristics of radionuclides used for episcleral brachytherapy

Emitters	Half-life[a]	Mean photon energy (keV)[a]
Photon		
^{125}I	59.4 d	28.4
^{103}Pd	16.99 d	20.7
^{131}Cs	9.69 d	30.4
Emitters	**Half-life[a]**	**End point beta energy (MeV)[a]**
Beta		
$^{106}Ru/^{106}Rh$	371.8 d	3.541[e]
^{90}Sr	28.8 y	0.546[f]

Photon emissions less than 5 keV were removed from calculations of mean ener

- The sole standardized clinical trial for choroidal melanoma, The Collaborative Ocular Melanoma Study (COMS), was restricted to the use of 125I plaques. -1985 .
  - Equivalence of I 125 vs Enucleation
  - No difference was seen.
- Lommatzsch et al. have established a long tradition of using 106Ru plaque therapy in Europe.
- AAPM TG-129 report.
- ABS Ophthalmic Oncology Task Force (ABS- OOTF) includes a total of 47 ophthalmic oncologists, medical physicists, and radiation oncologists from Canada, Finland, France, Germany, India, Japan, United Kingdom, the United States, Russia, and Sweden.

American Brachytherapy Society Ophthalmic Oncology Task Force levels of consensus

Level 1: Uniform panel consensus, evidence primarily from the published literature.

Level 2: Uniform panel consensus, based on clinical experience.

Level 3: No uniform panel consensus or specific recommendation.

Advantages of plaque brachytherapy

- High dose delivery
- Selectivity to tumor region
- Minimal dose to surrounding structures
- Safe and efficacious as compared to toxicity of EBRT

Case selection – very important

- Patient history and physical examination
- Slit lamp and ophthalmoscopy are indispensable,
- High and low frequency ultrasound imaging,
- Photography,
- Intraocular angiography,
- Fundus auto-fluorescence imaging,
- Wide-field fundus photography
- Optical coherence tomography,
- CT, MRI, PET-CT, and
- Biopsy .

Indications

- Choroidal melanoma
- Retinoblastoma
- Choroidal hemangioma
- Choroid mets
- Retinal hemangioma
- Ocular surface tumors (OSSN/Lymphoma/Melanoma)

Treatment modalities for various tumors

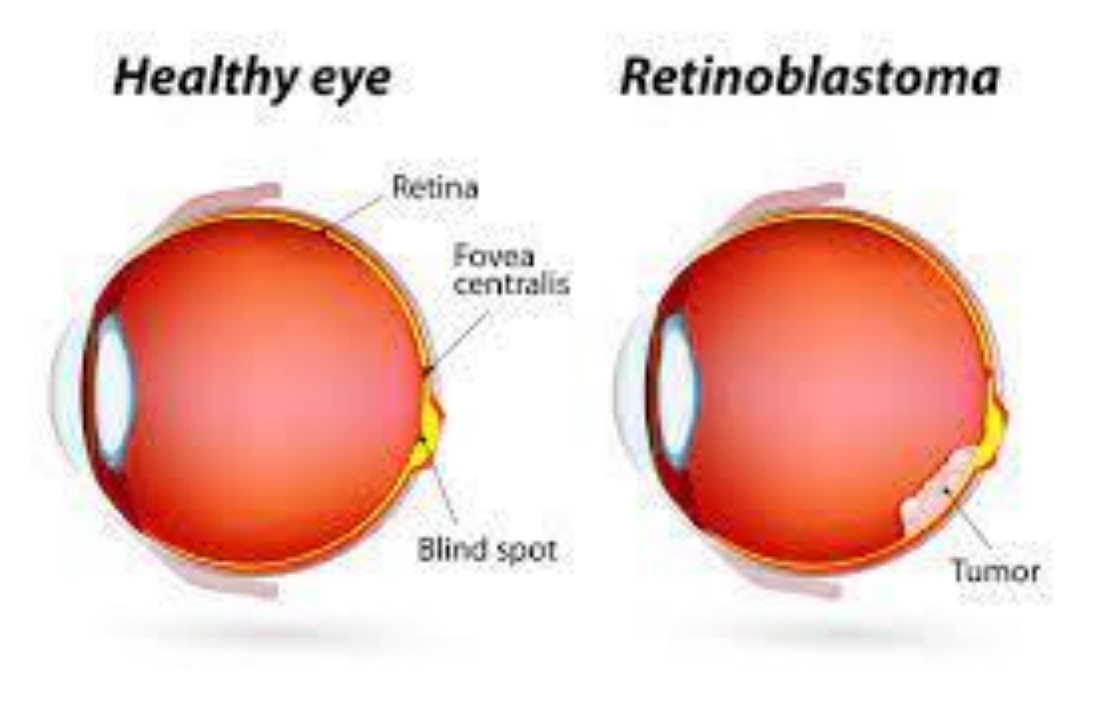
- Hemangioma – EBRT/Plaque
- Choroid melanoma – Enucleation /EBRT/Plaque
- Retinoblastoma – cryotherapy/TTT/chemotherapy /EBRT /Plaque
- OSSN – SX/EBRT/Plaque
- Mets – EBRT/Plaque

Uveal melanoma

- Iris,
- Ciliary body,
- Choroidal,
- Sub foveal,
- Juxtapupillary, and
- Circum-papillary melanomas

- Current ABS recommendations :Clinical diagnosis of uveal melanoma is adequate for treatment.
- Histopathologic verification is not required.
- Small melanomas can be treated at the eye cancer specialist's discretion.
- AJCC T1, T2, T3, and T4a uveal melanoma patients can be treated, after counselling about likely vision, eye retention, and local control outcomes.
- Tumours with T4e extraocular extension, a basal diameters that exceed the limits of brachytherapy, blind painful eyes, and those with no light perception vision are not suitable for plaque therapy.

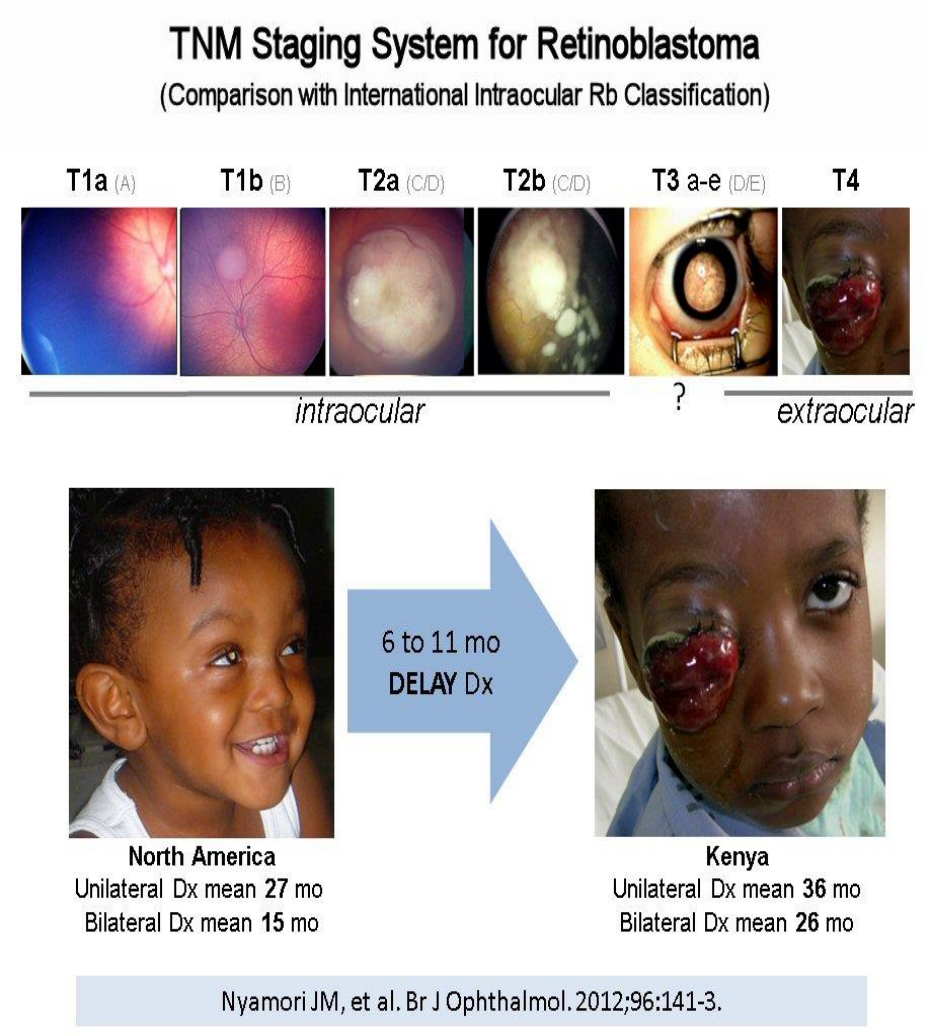
Retinoblastoma



- Primary modality of treatment:
  - Cryotherapy,
  - Chemotherapy [systemic or ophthalmic artery perfusion],
  - Focal therapy [e.g., laser or cryotherapy],
  - EBRT, or a combination thereof.
- Brachytherapy is less commonly used as a primary treatment for Rb.

- Ideal tumors for primary brachytherapy are located anterior to the equator and in unilaterally affected children.
- For secondary treatment, residual or recurrent tumors are treated irrespective of location.
- Exceptions include anterior segment involvement (typically an indication for enucleation) and juxtapapillary location (there exists no reports of slotted plaque therapy for Rb).
- In high-risk patients, imaging is coupled with lumbar puncture and bone marrow aspiration biopsy

Retinoblastoma



- Classification – Resse Ellsworth / St Jude/Grabwosky /Essen / Chantada / New International staging system
- Early Gp I/II (Gp A/B) – Cryotherapy / Thermotherapy / Laser photocoagulation
- Intermediate – Gp III,IV (Gp C,D) – Chemo reduction + Local Rx , Plaque BT , EBRT
- Late – Gp V (Gp E) – Enucleation /Adjuvant Rx /Chemo/EBRT /Orbital exentration.

Indication of plaque BT in Rb

- Failure of chemotherapy
- Recurrence
- Rarely is used as primary modality
- Max 14 mm dia and 6 mm thick tumor can be taken up for Plaque BT
- 45 – 50 Gy to tumor apex dose is delivered

Plaque treatment planning

- Treatment form and fundus diagram
- Treatment form
  - Demographic information,
  - Laterality of the involved eye,
  - The largest basal dimension of the tumour,
  - When treatment is scheduled, and
  - Contact information for the treatment by eye cancer specialists.
- Fundus diagram
  - Tumours clock hour orientation within the eye,
  - Its longitudinal and transverse diameters, and
  - Its largest basal diameter.
  - Measurements from the tumour to the fovea, optic nerve, lens, and opposite eye wall.
- The medical physicist transfers this information to a computerized treatment planning system.

Plaque surgery

- General or regional anaesthesia
- Typically localized by transpupillary or trans ocular illumination of the globe.
- The edges of the shadow are marked on the sclera with tissue dye.
- An additional 2-3 mm ‘‘free margin’’.
- Directly suture the plaque over the marked target or use ‘‘dummy’’ plaques.
- In all cases, the plaque is sutured as to cover the scleral- marked target volume.
- Then, the extraocular muscles and conjunctiva are reattached as not to disturb brachytherapy.
- Lead patch shield.
- Plaque removal based on the activity of the plaque (Hrs to days).

Follow-up after brachytherapy

- Most recurrence - first 5 years.
- Every three monthly follow up is required till 2 yrs then 6 monthly.

Alternative radiation therapy techniques

- Proton therapy was pioneered at the Harvard Cyclotron Laboratory and by the researchers at the Massachusetts Eye and Ear Infirmary and Massachusetts General Hospital
- Proton radiobiologic effectiveness value of 1.1 compared with 60Co.
- Uveal melanoma, doses 60 Gy are delivered in four (15 Gy) daily fractions.
- Although there exists no significant comparison between high-dose-rate proton beam vs. low-dose-rate plaque brachytherapy, the ABS-OOTF recognizes (Level 1 Consensus) that both the dose rates and the dose volumes differ.

- The ABS-OOTF recognizes (Level 1 Consensus) that in the treatment of posterior uveal melanomas, there is less resultant radiobiologic effect on normal anterior ocular structures using low-energy (103Pd, 125I) plaque brachytherapy compared with proton beam.
- External beam radiation techniques (proton, helium ion, gamma knife, and stereotactic radiosurgery) are also complicated by mobile target volume (eye movement). Since eye plaques are sewn to the eye wall beneath their target volume, when the eye moves so does the plaque.
- This is because eye movements cause misapplication of protons within the eye.
- in addition, proton beam facilities are vastly more expensive

Comparison of plaque and proton therapy

Plaque	Proton
Surgical insertion and removal	Surgical clip implantation
Continuous low-dose-rate treatment 5–7 d (^{125}I and ^{103}Pd) 3–7 d (^{106}Ru)	4 Daily high-dose-rate fractions
Mobile radiation field	Static radiation field
Fewer anterior segment complications	More anterior segment complications
Posterior segment complications	Posterior segment complications
Less expensive	More expensive

Complications

- Radiation cataract,
- Intraocular radiation vasculopathy,
- Haemorrhages,
- Edema,
- Cotton wool infarcts,
- Ischemia,
- Neovascularization,
- Irreversible atrophy.
- Radiation maculopathy

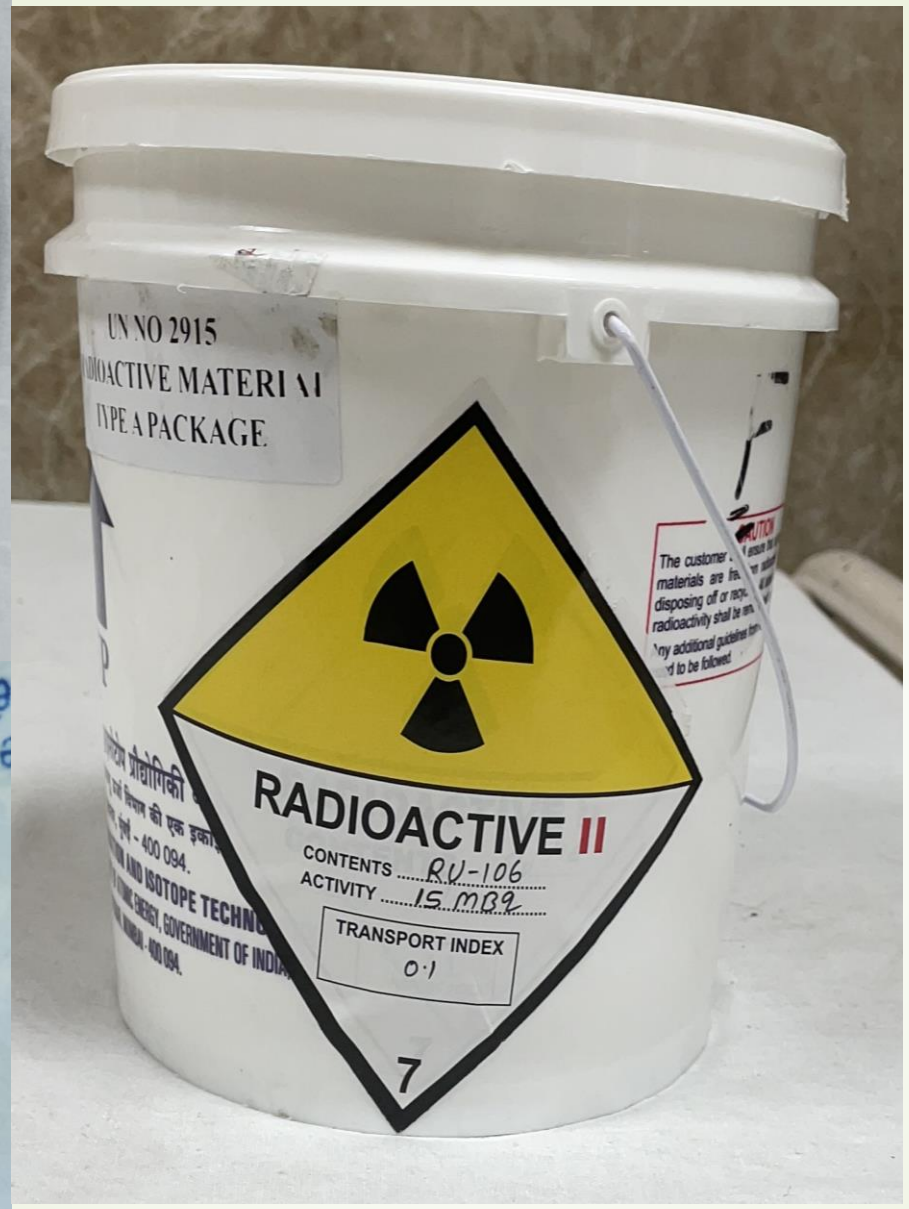
Make in India : Ruthenium 106 (July 2020)

Affordable
50 – 60 Thousand
Comes in round and notched dimension
Reusable up-to 50 times
Fine quality

Made of silver
15.8 mm outer dia
13.3mm core dia
12 mm radius
1 mm thick
15- 37 MBq source strength

- Ruthenium 106 – Eckert & Zeigler BEBIG
  - Imported
  - Costly – 11 – 12 Lakhs


BARC
Ru-106
N-000
VAPEUR
STEAM
DAMPF
EN 868-185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RADIOACTIVE II
CONTENTS Ru-106
ACTIVITY 15 MBq
TRANSPORT INDEX
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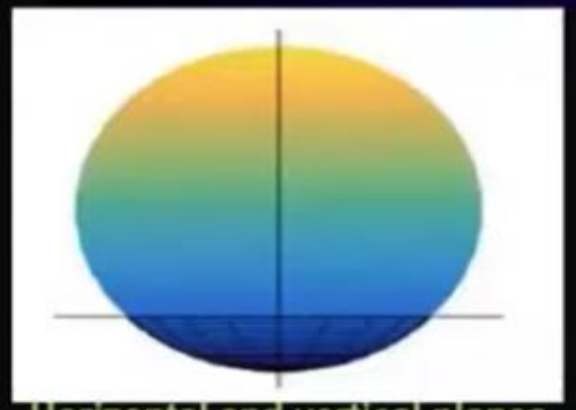
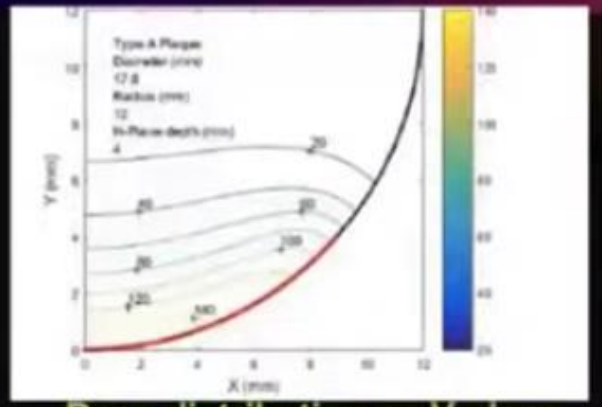
BARC Ru-106 eye pla
(For brachytherapy use
Certificate No: BARC/NRG/Ru-106/018 dt
Serial no.: N-006
Expiry date : May 19, 2023
Activity : 51.5 MBq on January
BRIT BARC Vashi Complex, Navi M

Development of Treatment Planning System

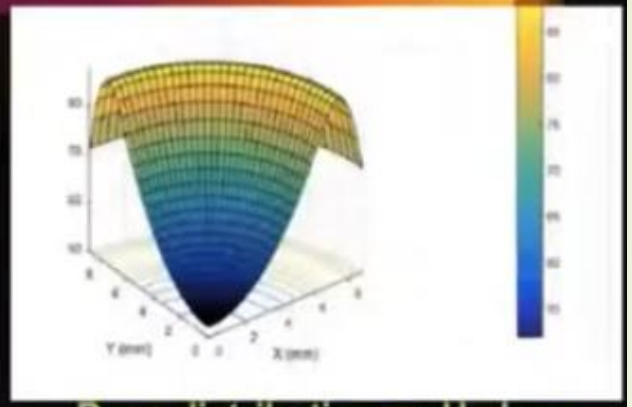
Simulation study on dose distribution has been completed



Horizontal and vertical planes

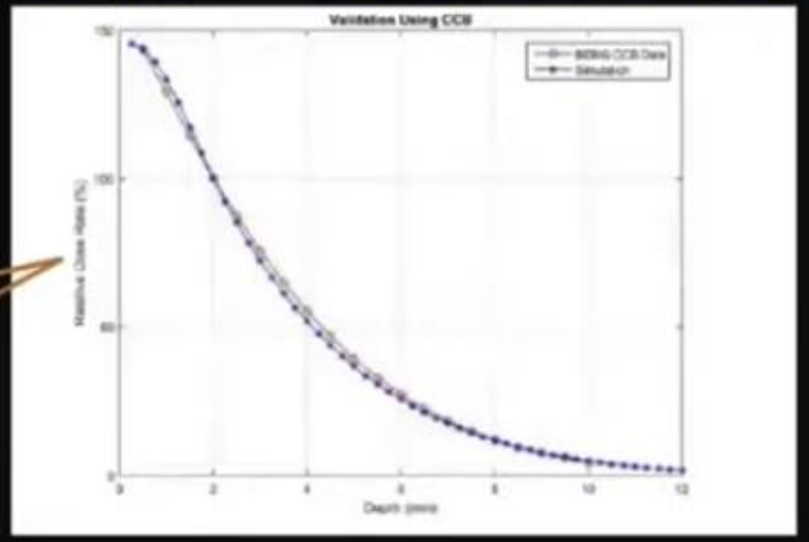


Dose distribution on V plane



Dose distribution on H plane

Model has successfully been validated with experimental data with CCB type plaque



Courtesy Dr. Vijay Anand Red

Sterilization process

Temp – Heat water at 90 Degree C, then place the source and dummy plaque in a drum in the Sterilizer. Temp increased till 121 degree.
Time – 30 minutes
Follow ALARA principle

Our First case – 09 July 2021

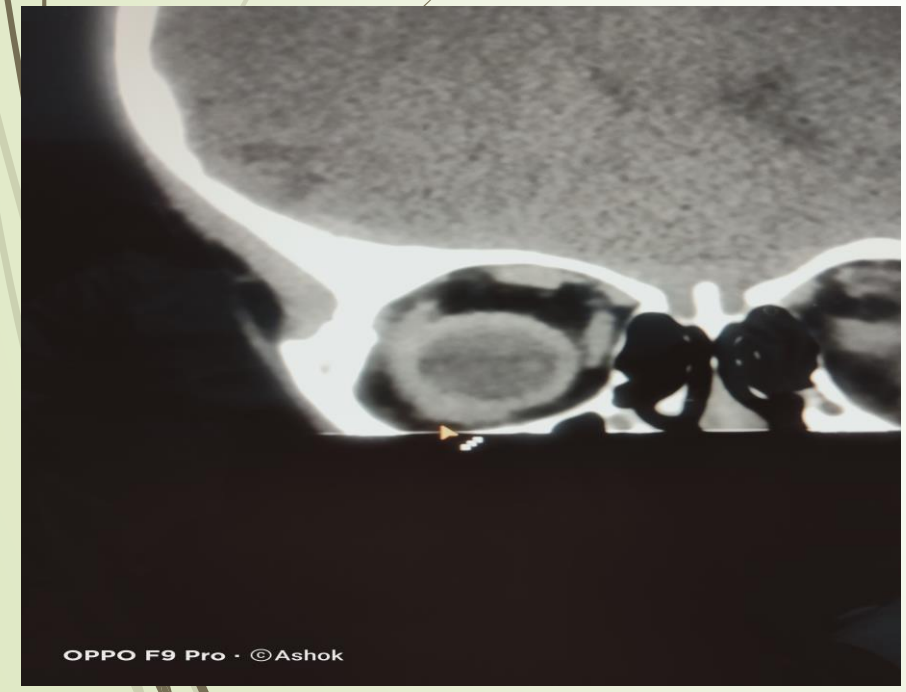
- 4 yrs old child
- Case of Retinoblastoma Lt Eye (Onset at 3yrs of age)
- Prior Rx – Multiple lines of chemo /Cryotherapy.
- Finally Enucleation of Lt eye was done.
- Fresh lesion in right eye.
- Rx with multiple line of chemo / cryo – no response
- As a last ditch effort we planned Ruthenium 106 Plaque Brachy-therapy

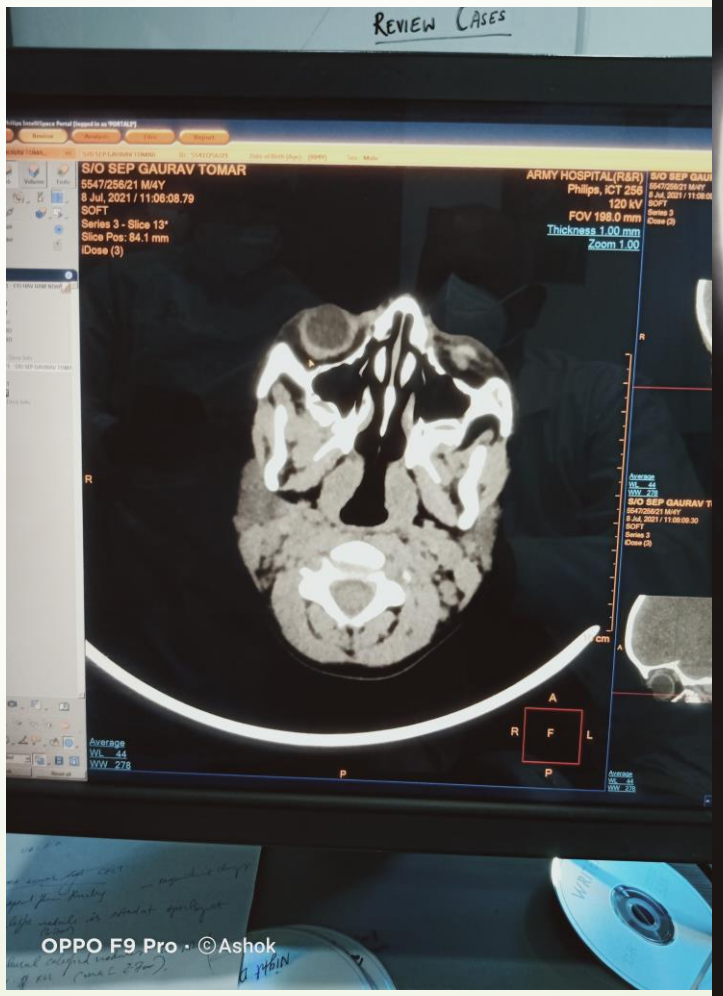
Tumor assessment in detail Clinical and Radiological

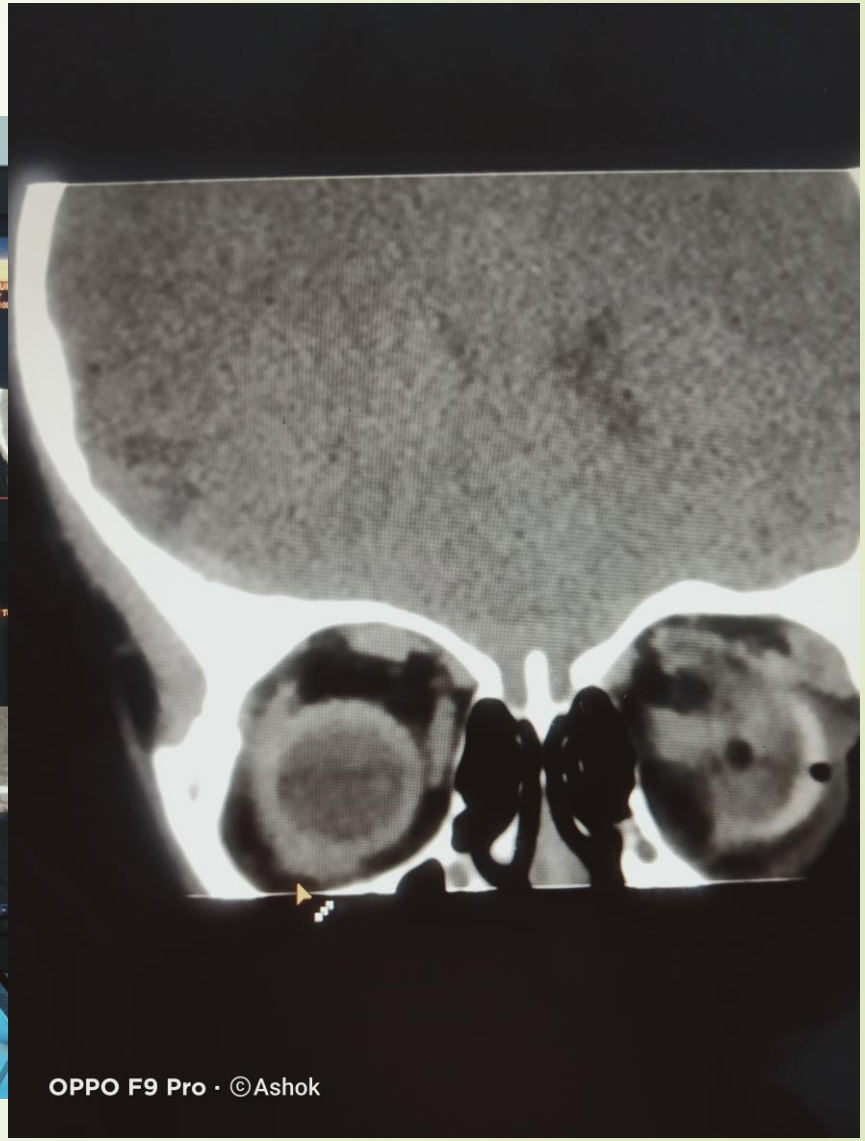
Local

Basal diameter

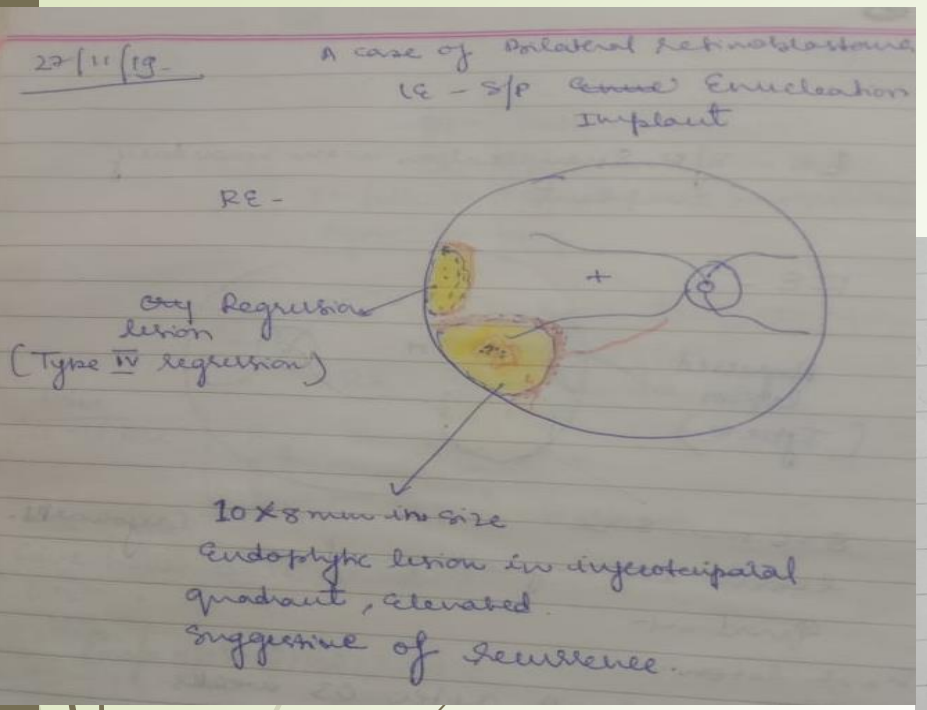
Height







- Retinal diagram
- Radiotherapy planning and dosimetry
- Simulator / manual planning
- Plaque placement
  - Under GA/LA
  - Conjunctival peritomy
  - Tumor location marked on sclera
  - Dummy plaque to confirm the location
  - Rh plaque placed and sutured to sclera
  - Conjunctival sutured
  - Patient kept in isolation



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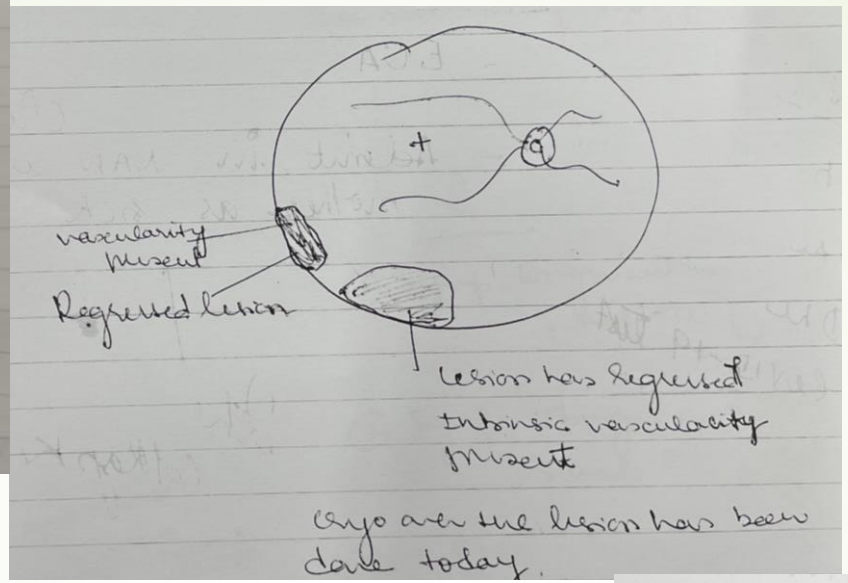

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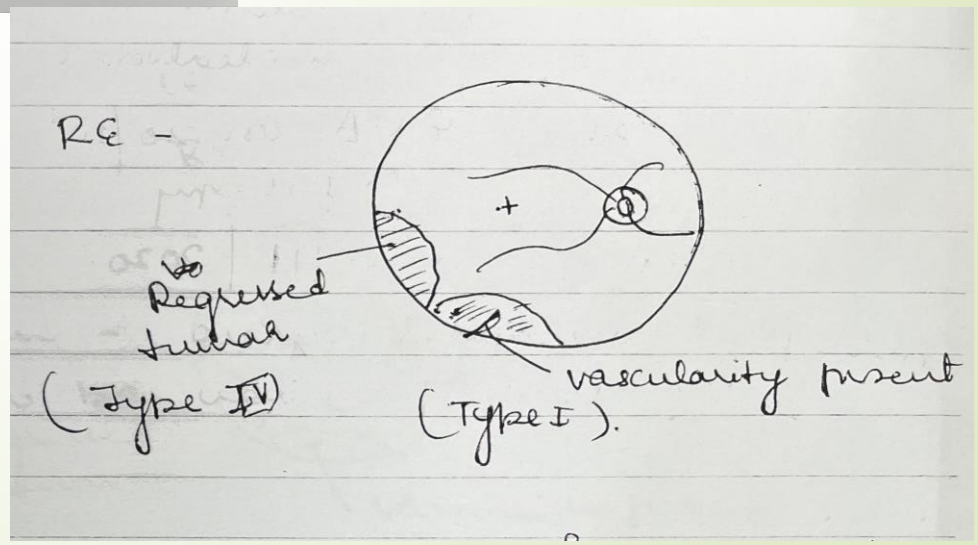
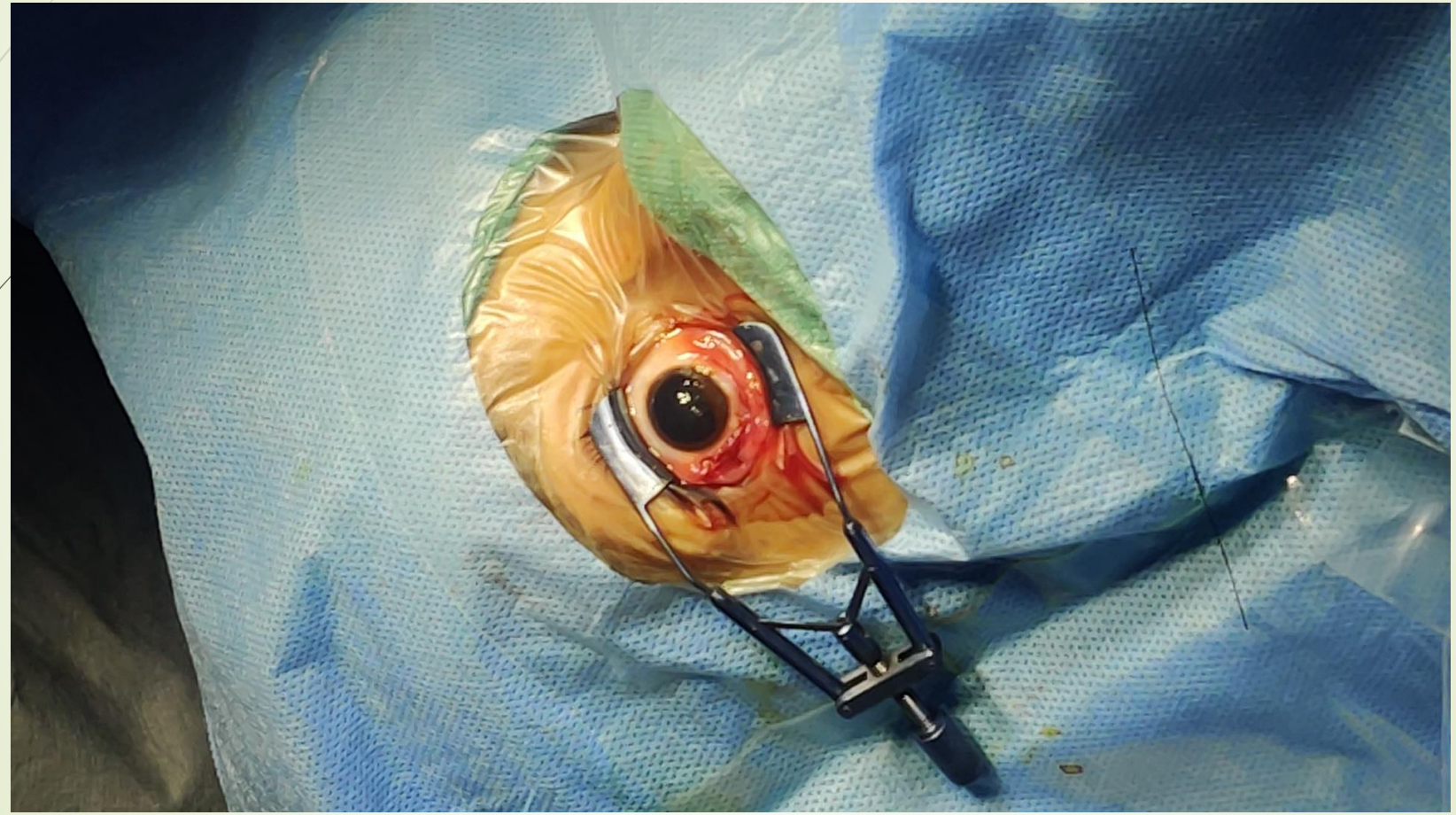
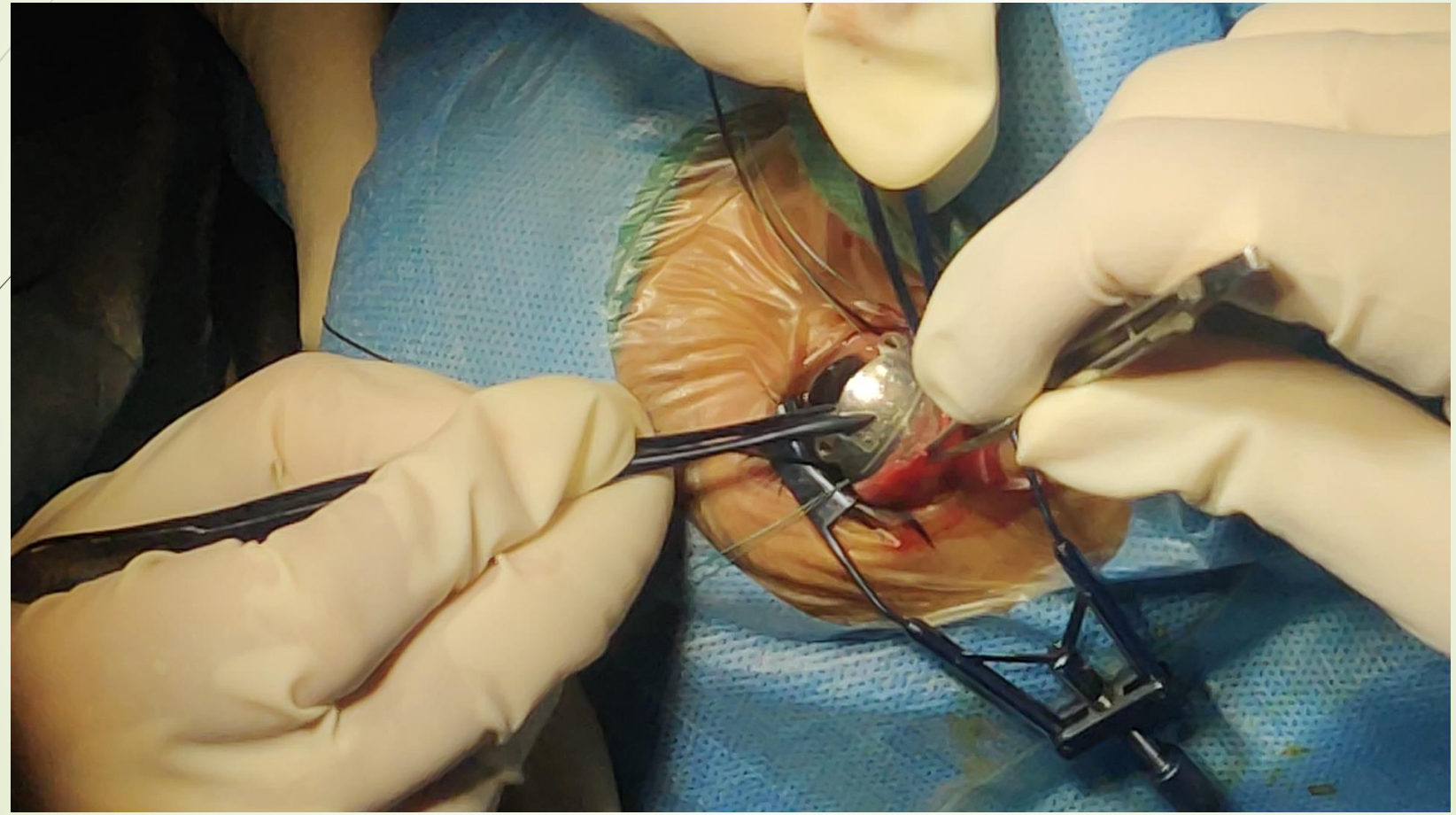


DECEMBER 2020

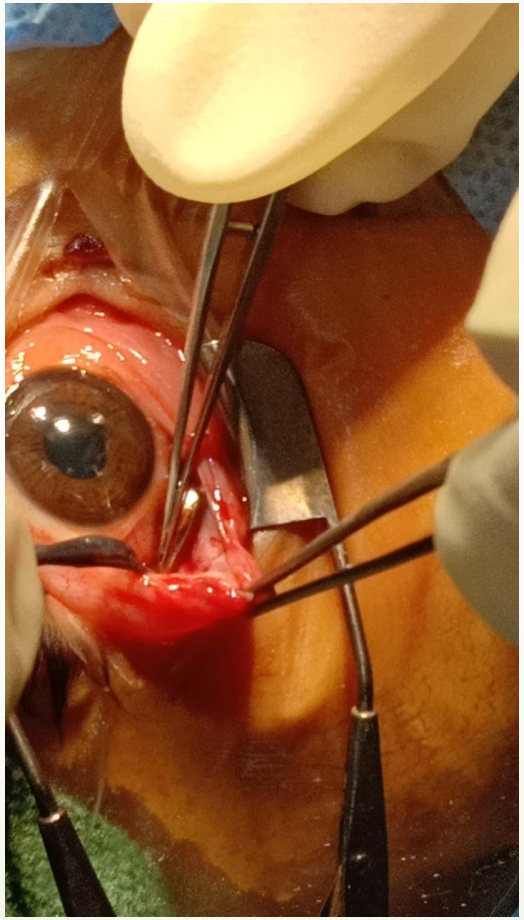
Conjunctival peritomy



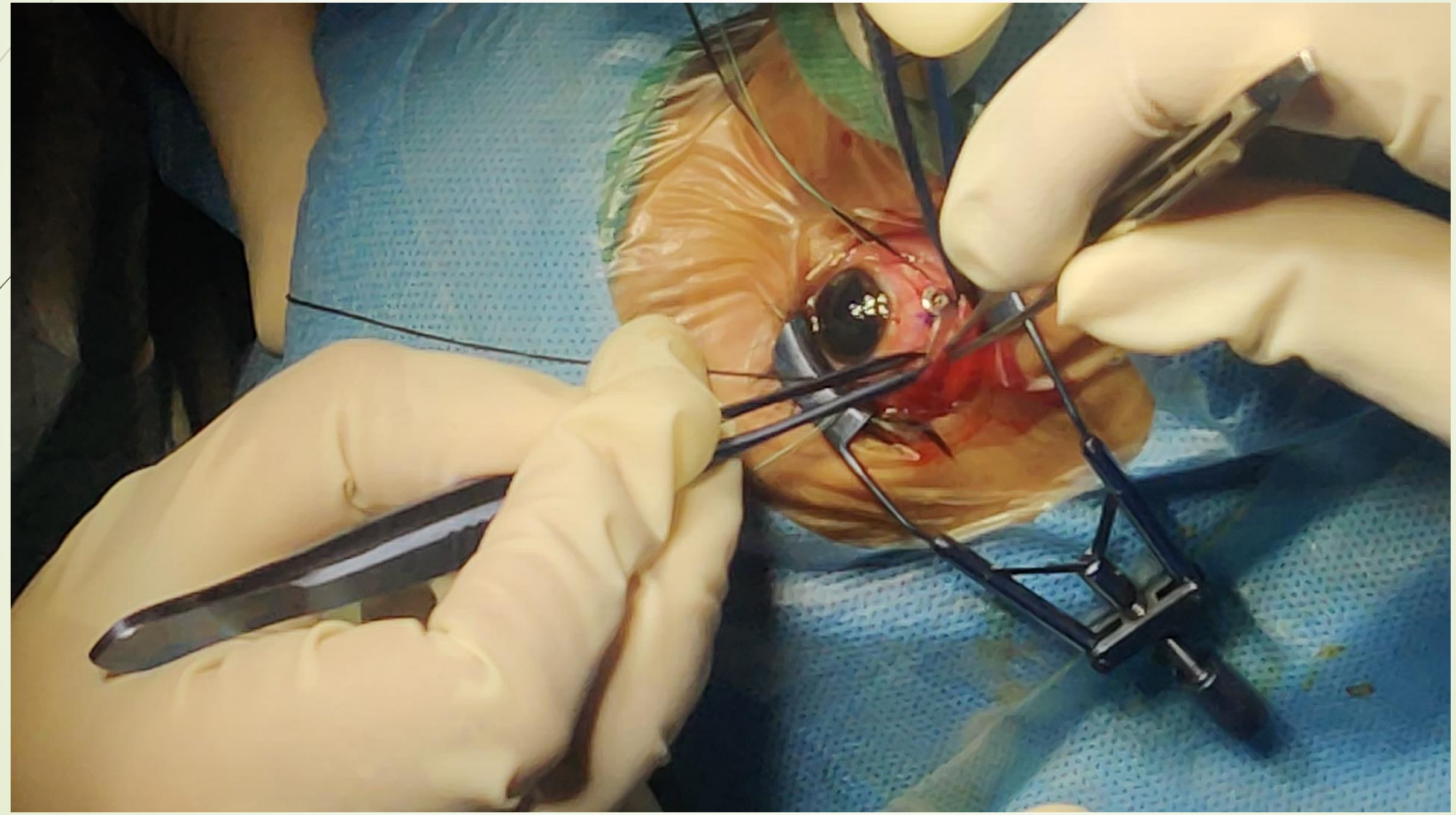
Dummy plaque placed to confirm location



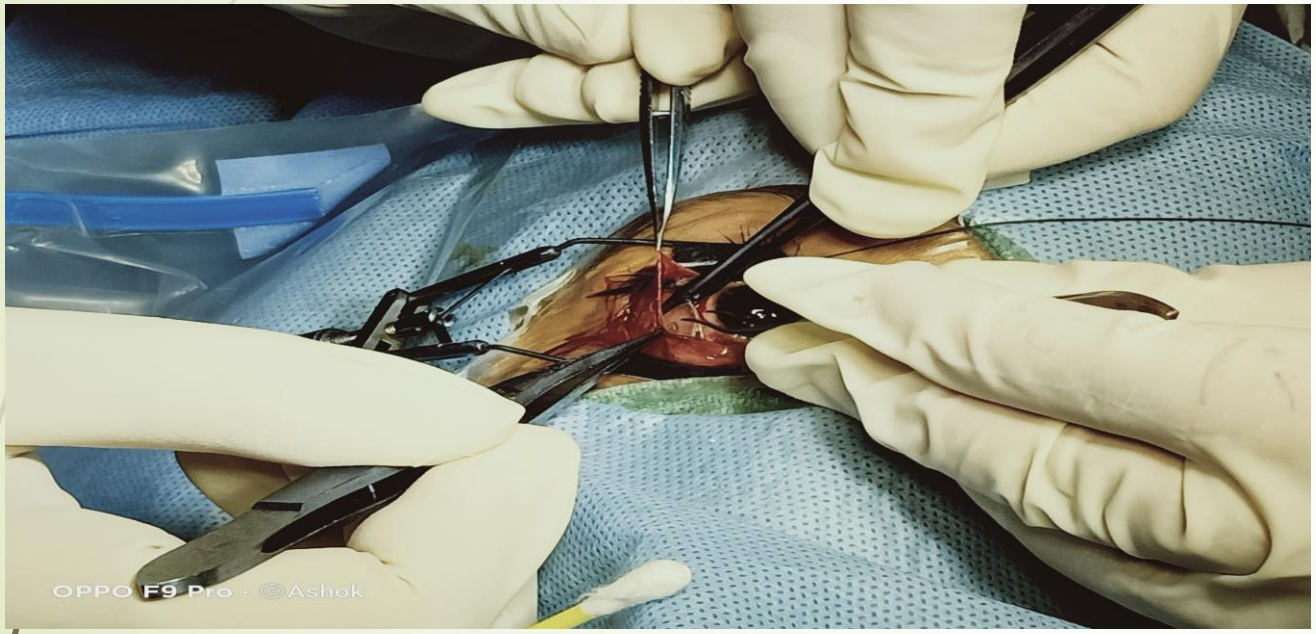
Dummy Plaque placement

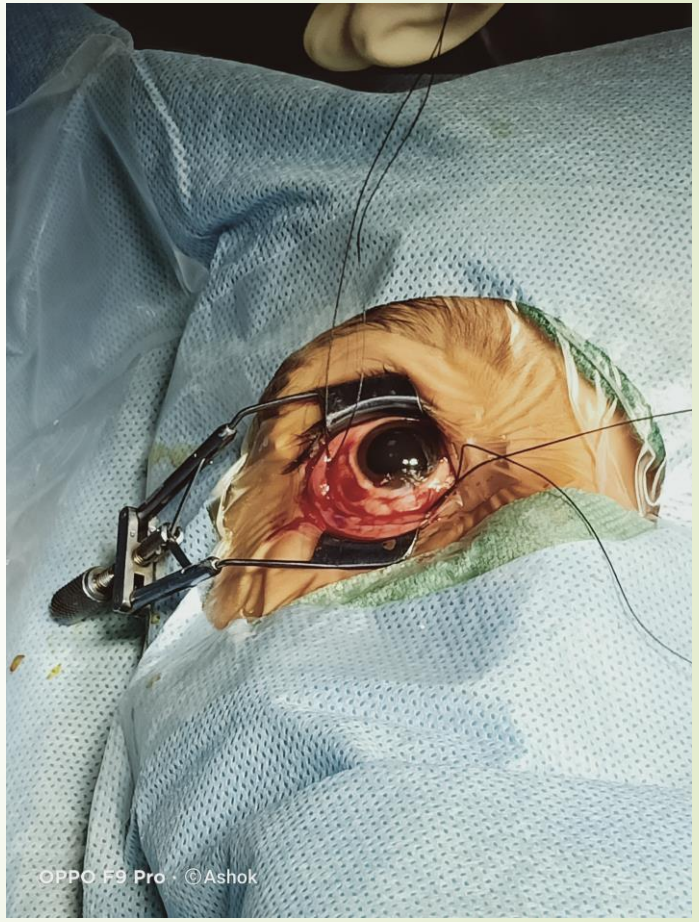


Suture are placed along the eyelets of dummy plaque

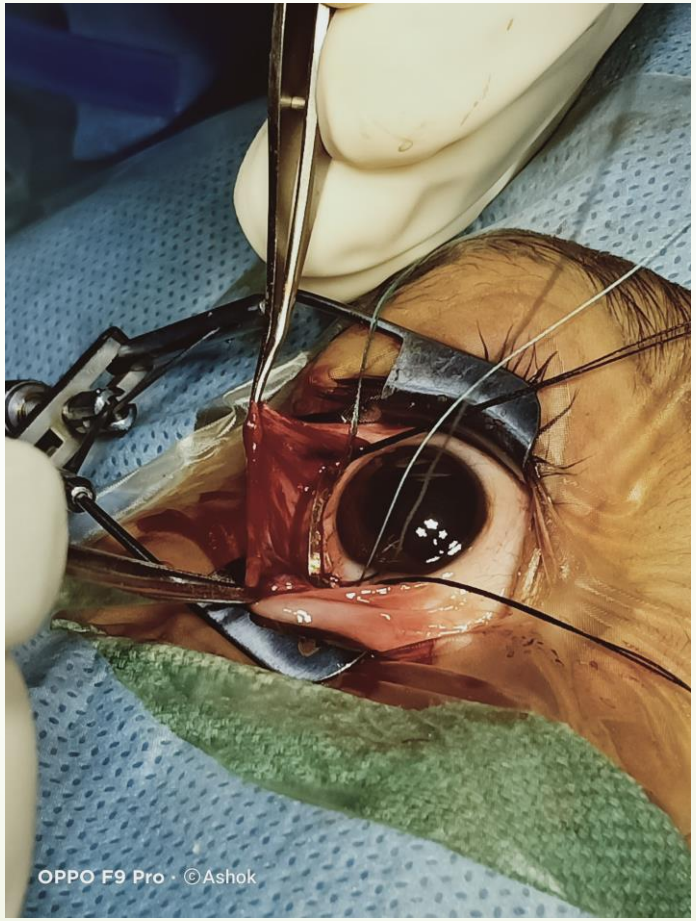


Active plaque is placed taking all precautions





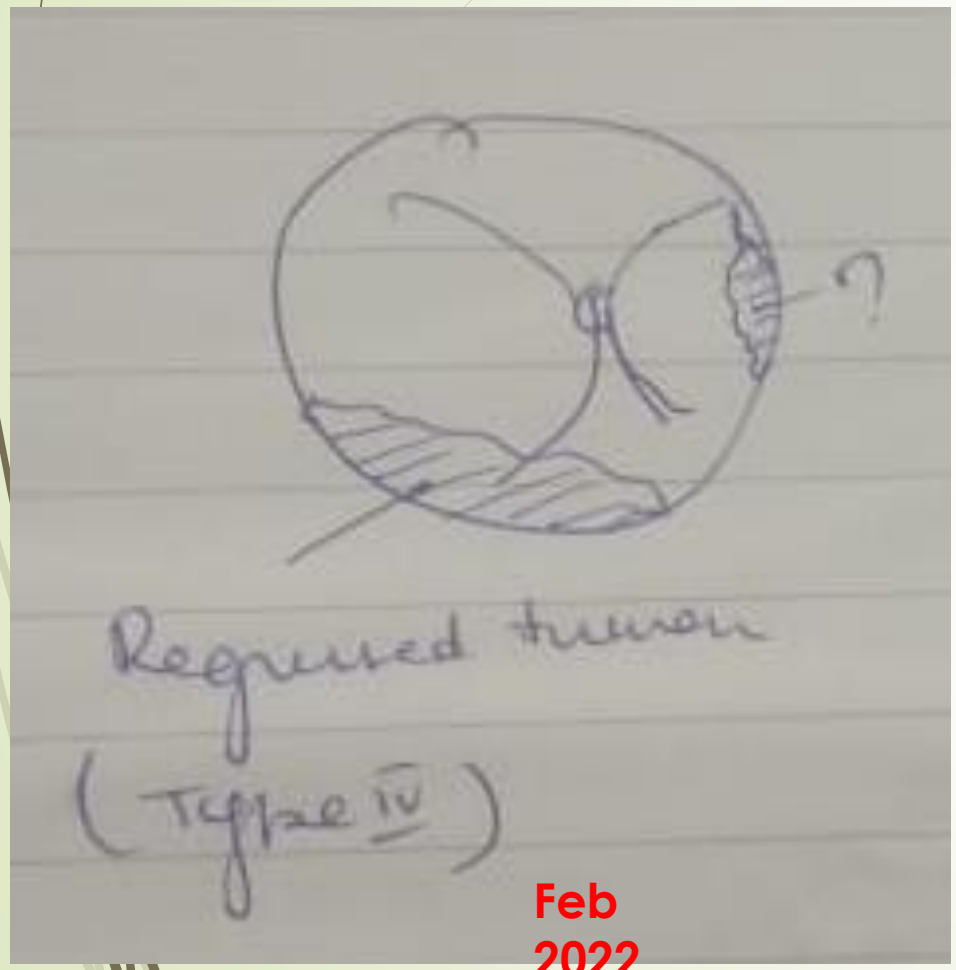
Active plaque sutured in place



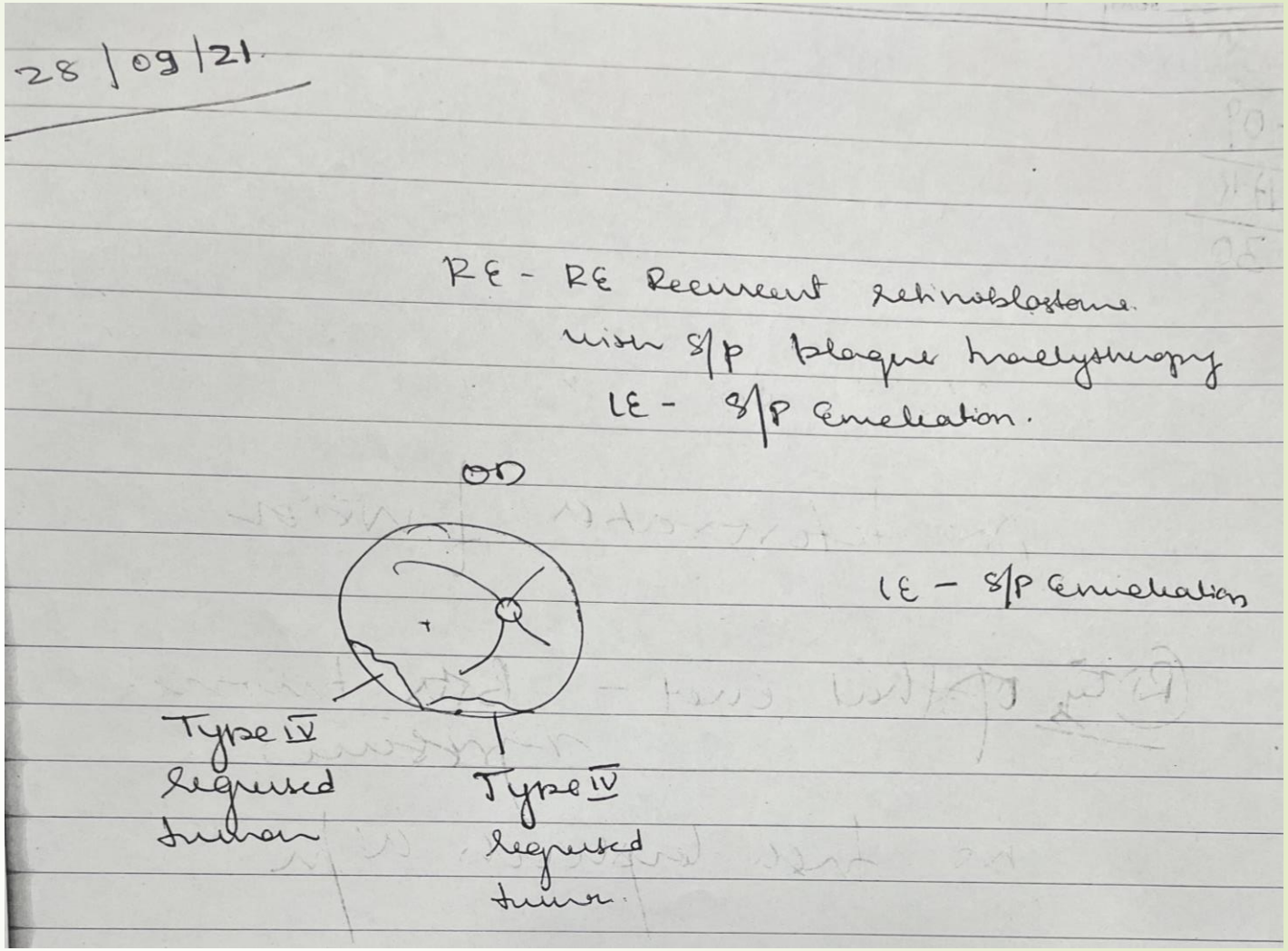
Lead shield to cover the eye to reduce radiation to healthcare workers

Patient kept in isolation

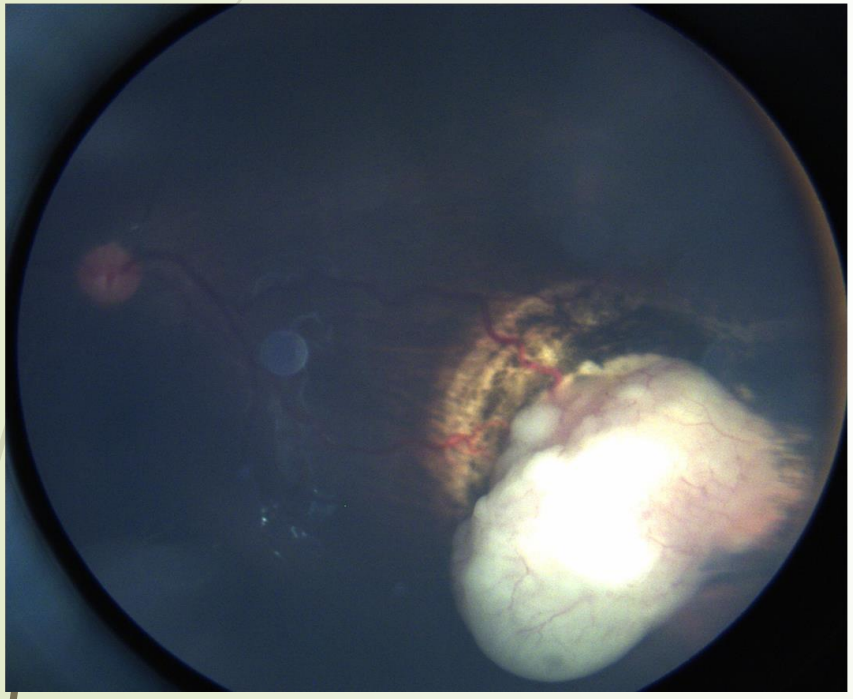
- Follow up
- Every 4 – 6 weeks



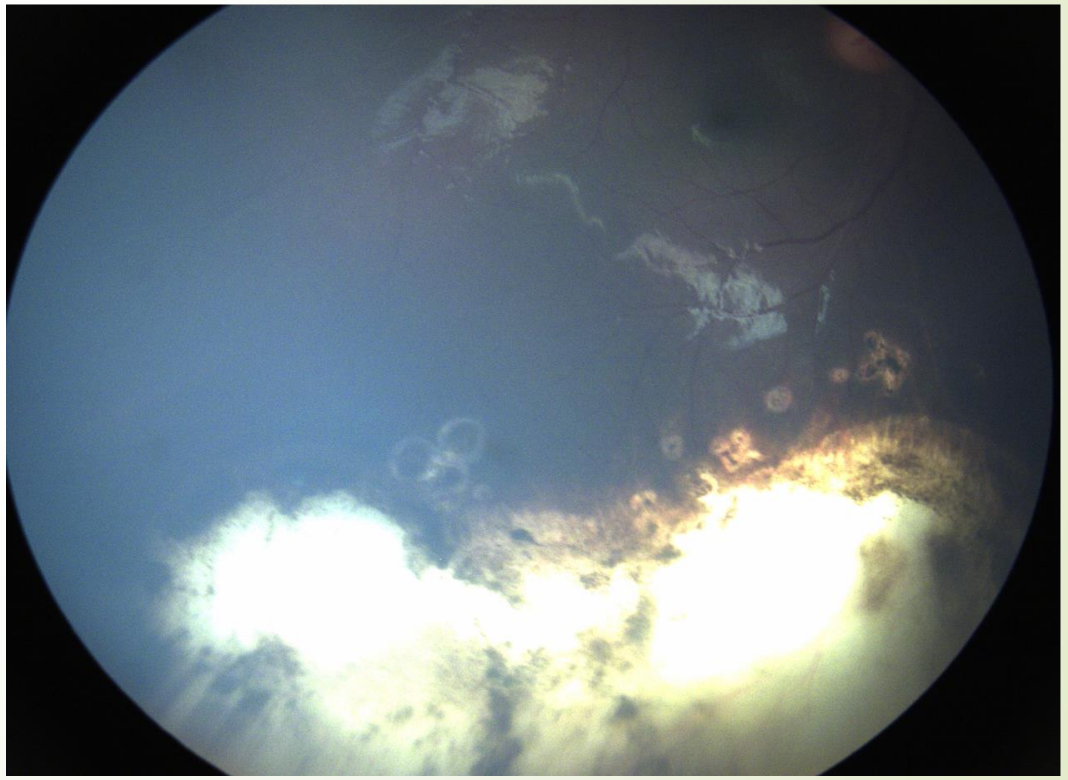
Feb 2022



PRE PLAQUE RETINAL IMAGES SHOWING RECURRENCE OF THE TUMOR



POST PLAQUE RETINAL IMAGE SHOWING REGRESSION OF THE TUMOR



- video

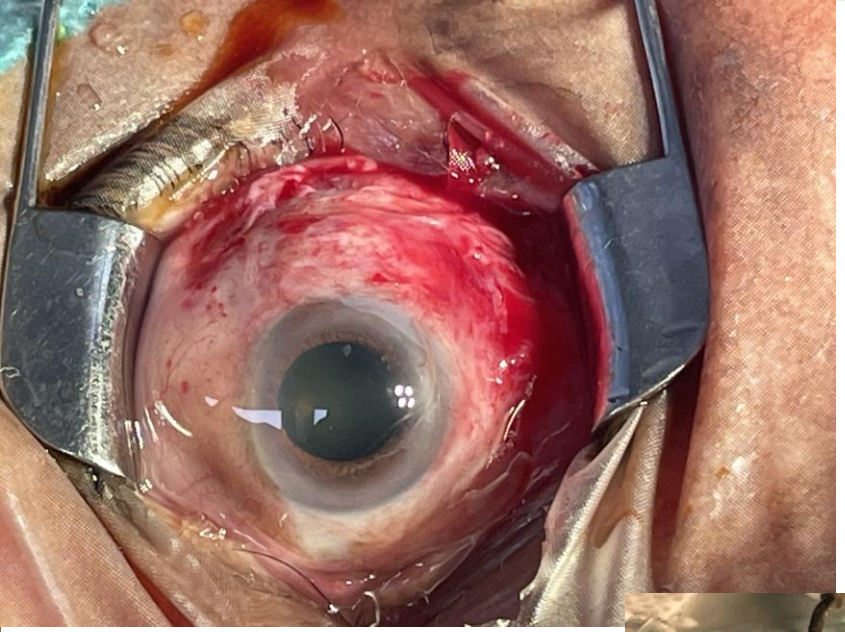

JEANS
OPPO F9 Pro · ©Ashok

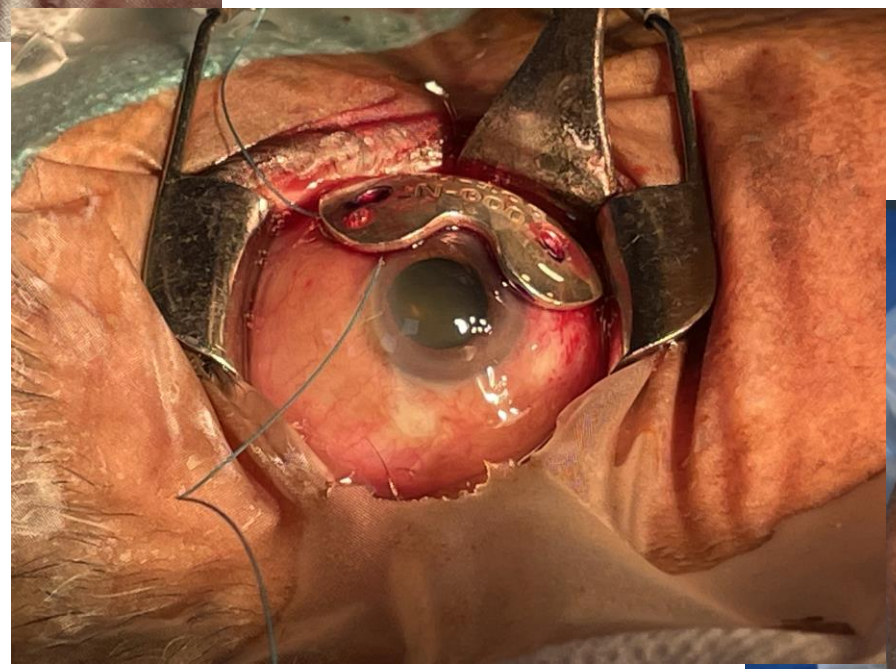

सेना डाक सेवा कोर
2021
ARMY POSTAL SERVICE CORPS
OPPO F9 Pro · ©Ashok

OSSN

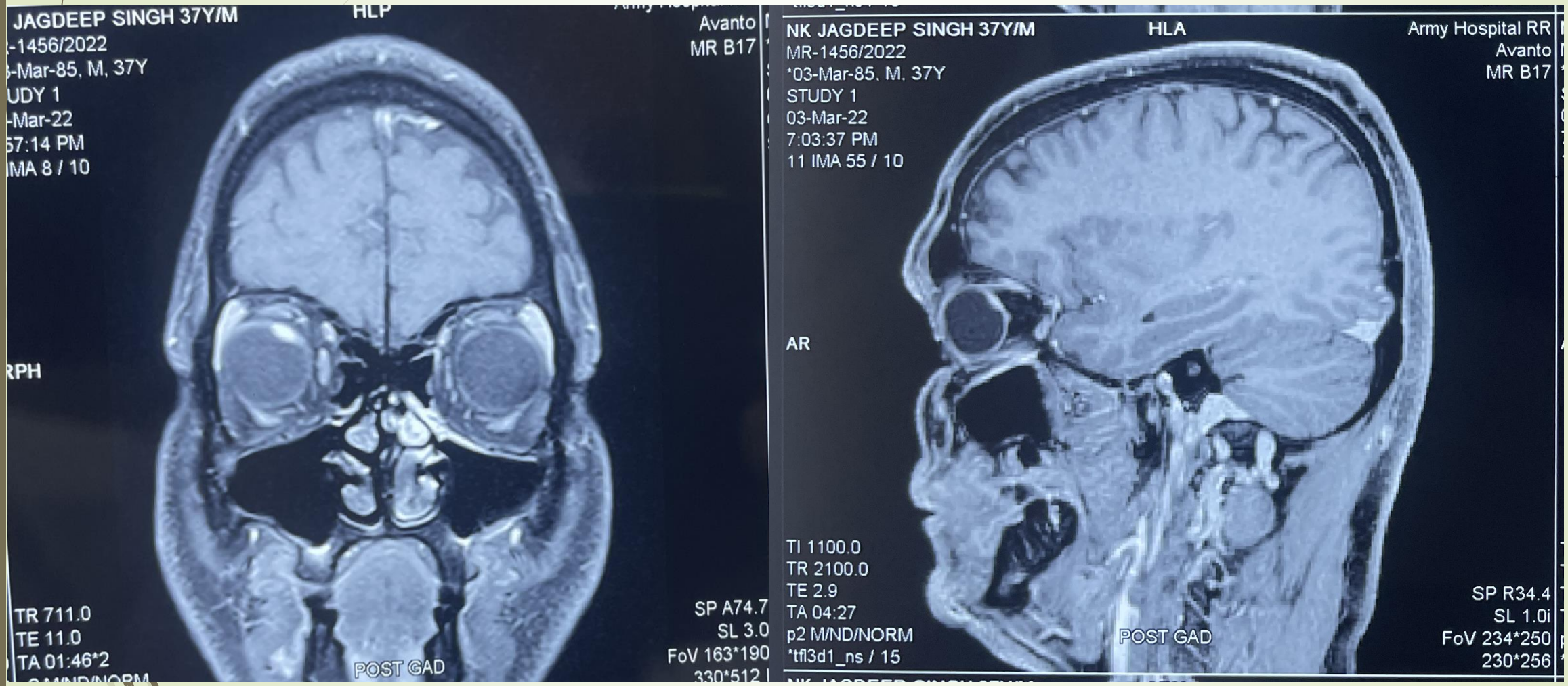
PREOP

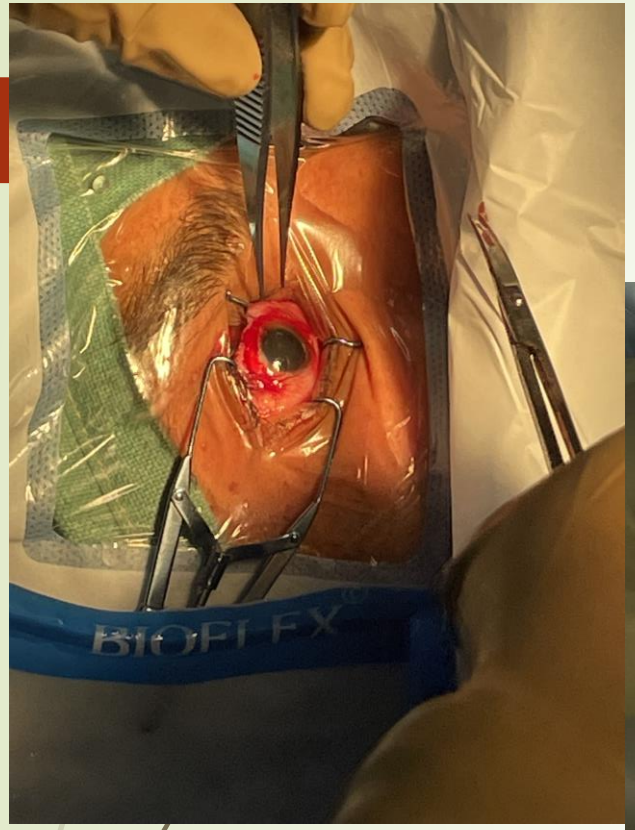
POST BRACHYTHERAPY

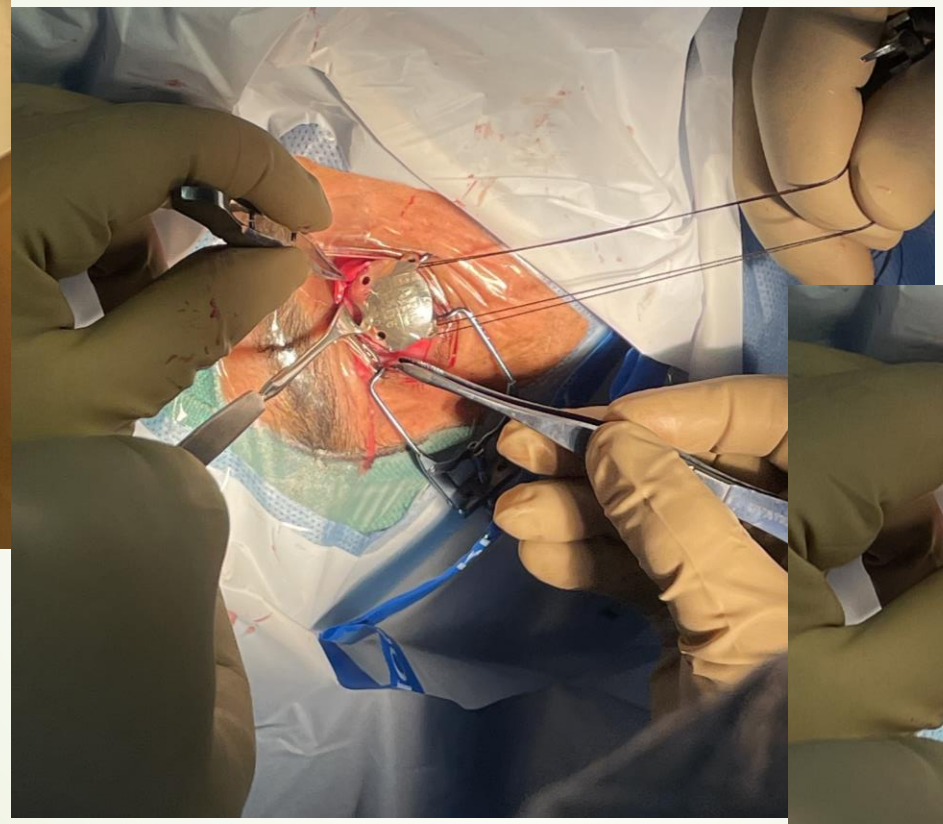




CHOROIDAL HEMANGIOMA




BIOFI FX



RADIATION DOSE

	Mean dose	(Range)
Uveal Melanoma	9643 cGy	(8726 – 15194 cGy)
Choroidal Hemangioma	3555 cGy	(2496 - 5018 cGy)
Retinoblastoma	4730 cGy	(3955 - 7568 cGy)
OSSN	5611 cGy	(4896-6736 cGy)

The team :


RADIATION ONCOLOGY RESIDENTS
TECHNICAL AND SUPPORT STAFF
DR ASHOK KUMAR , RADIATION ONCOLOGIST
DR MANOJ SEMWAL CHIEF MEDICAL PHYSICIST & RSO
DR SONALI – OCULAR SURGEON
OPPO F9 Pro · ©Ashok

Conclusion

- Effective treatment option
- Eye salvage
- Prevents vision loss
- Decreased toxicity
- Less complications

Other interstitial brachytherapy procedures at our center

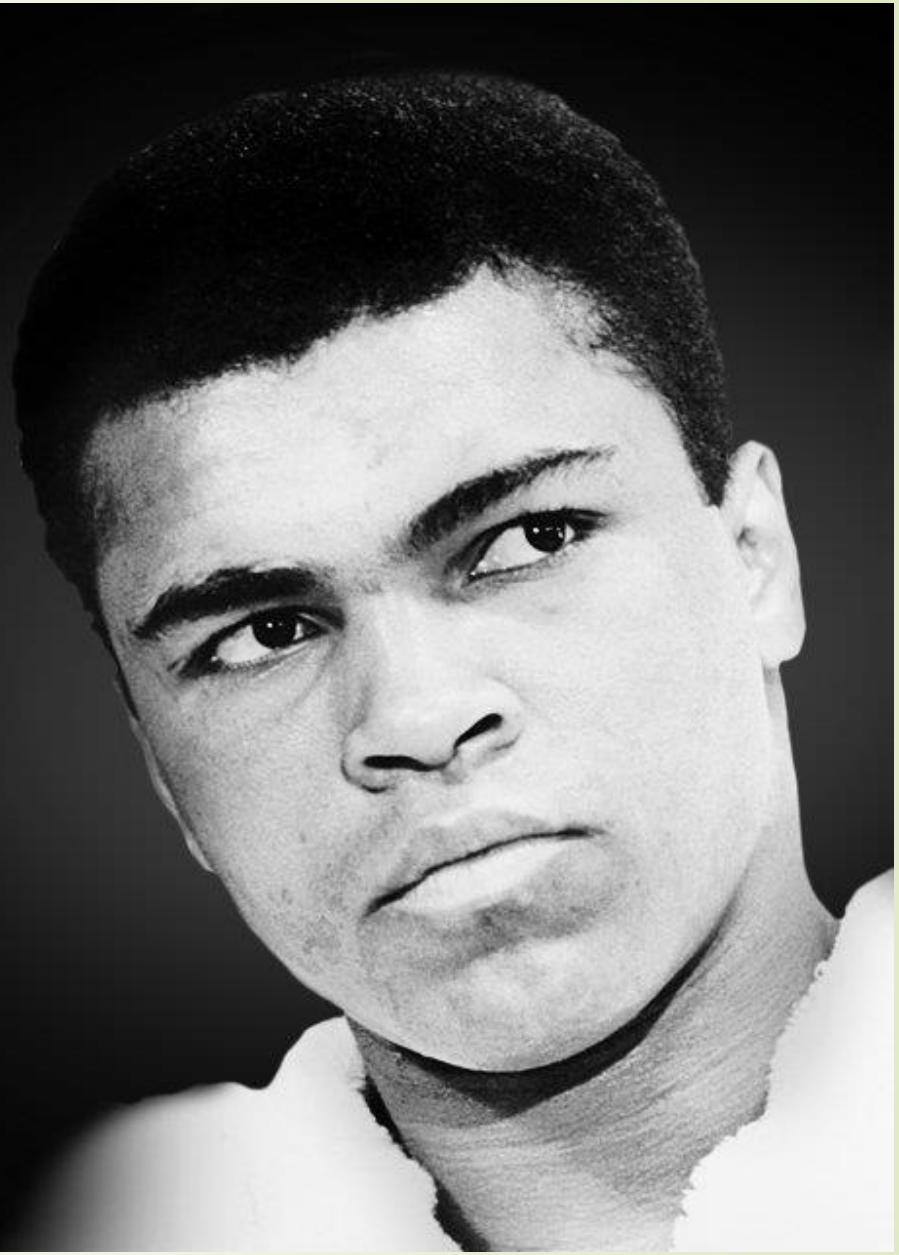
- Interstitial brachytherapy for liver mets upto 3 cms.

- APBI
- MUPIT
- Soft tissue sarcoma
- Head and neck carcinoma
- Keloids

Impossible is just a big word thrown around by small men who find it easier to live in the world they've been given than to **explore the power** they have to change it.

– *Muhammad Ali*

AZ QUOTES




Thank You !