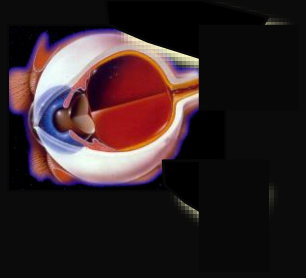
Plaque Brachytherapy

Indications and Outcome in Ocular Tumors

Dr P Vijay Anand Reddy



Management of Eye tumors

Surgery : Enucleation / Exentration

Advantage

- Tumor is completely eliminated

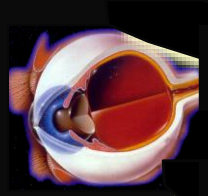
Disadvantage

- Loss of Vision
- Loss of globe

VijayAnand


…the Goal
Cancer Management
Not just the survival…
Organ & Function
Preservation


EYES make World Beautiful

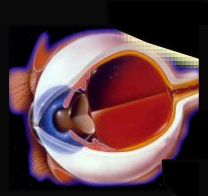


The Goal… ophthalmic tumors

- ✓Preservation of Vision
- ✓Preservation of Eye ball
- ✓Preservation of Life

Radiation can achieve this !!

VijayAnand



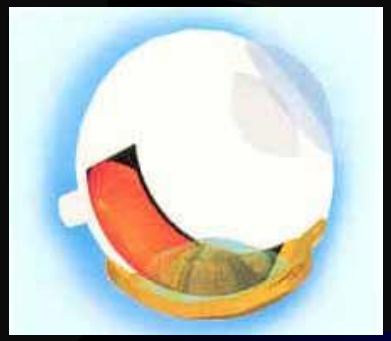
External Beam Radiotherapy

Advantage

- Globe is saved
- Visual potential possible

Disadvantage

- Radiation Retinopathy, Cataract, Dry Eye
- Facial deformity, Growth retardation
- Secondary tumors



Plaque Brachytherapy

Advantages

- High dose
- Precisely & selectively to the tumor
- Minimal dose to the surrounding structures
- Selective dose distribution
- Minimization of EBRT complications

VijayAnand

Ocular Brachytherapy sources

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

VijayAnand

Iodine 125 vs Ruthenium 106

Gamma rays	Beta rays
Half life 60 days	✓ One year
✓ Customized	Uniform (Round, notched)
Needs protection	✓ Hardly any
Recurrent maintenance	✓ Least – Once in 2yrs

Plaque Brachytherapy

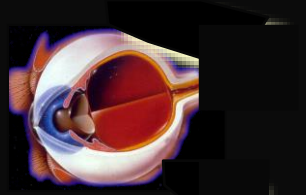
Ruthenium 106

Eckert & Ziegler **BEBIG**

VijayAnand


राष्ट्र की सेवा में परमाणु
भा प अ कें
BARC
ATOMS IN THE SERVICE OF THE NATION
Development of Ru-106 Plaque
for Treatment of Eye Cancer
00:00:03
00:02:54

VijayAnand



MAKE IN INDIA

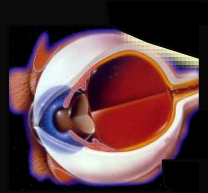
राष्ट्र की सेवा में परमाणु

भा प अ कें

BARC

ATOMS IN THE SERVICE OF THE NATION

VijayAnand



भा प अ कें
BARC

Ru-106 Plaque by BARC

Affordable Eye Cancer Treatment in India

11 lakhs	vs	50 thousands

VijayAnand

Ru106 Plaque Configuration

- Material : Silver (99.9%)
- Outer diameter : 15.8 mm
- Active core diameter : 13.3 mm
- Spherical radius : 12 mm
- Total thickness : 1 mm
- Source strength : 15-37 MBq
- Useful life : 1 year
- Maximum uses : 50 times
- Source classification : C 43312

- Plaques are being supplied by BRIT at the nominal price of Rs. 50,000
- First plaque to each hospital is free of cost

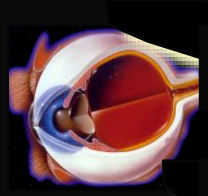
Anand

Development of Ru106 Plaque : Notched Configuration

• Material	: Silver
• Outer diameter	: 21 mm
• Active core diameter	: 18.5 mm
• Spherical radius	: 12 mm
• Total thickness	: 1 mm
• Source strength	: 20-50 MBq
• Useful life	: 1 year
• Maximum uses	: 50 times
• Source classification	: C 43312

- AERB approval received on June 2020
- Notch plaque lunched on July 2020
- Plaques will be supplied by BRIT at the price of Rs. 50,000
- first plaque will be given to each hospital at free of cost!

VijayAnand

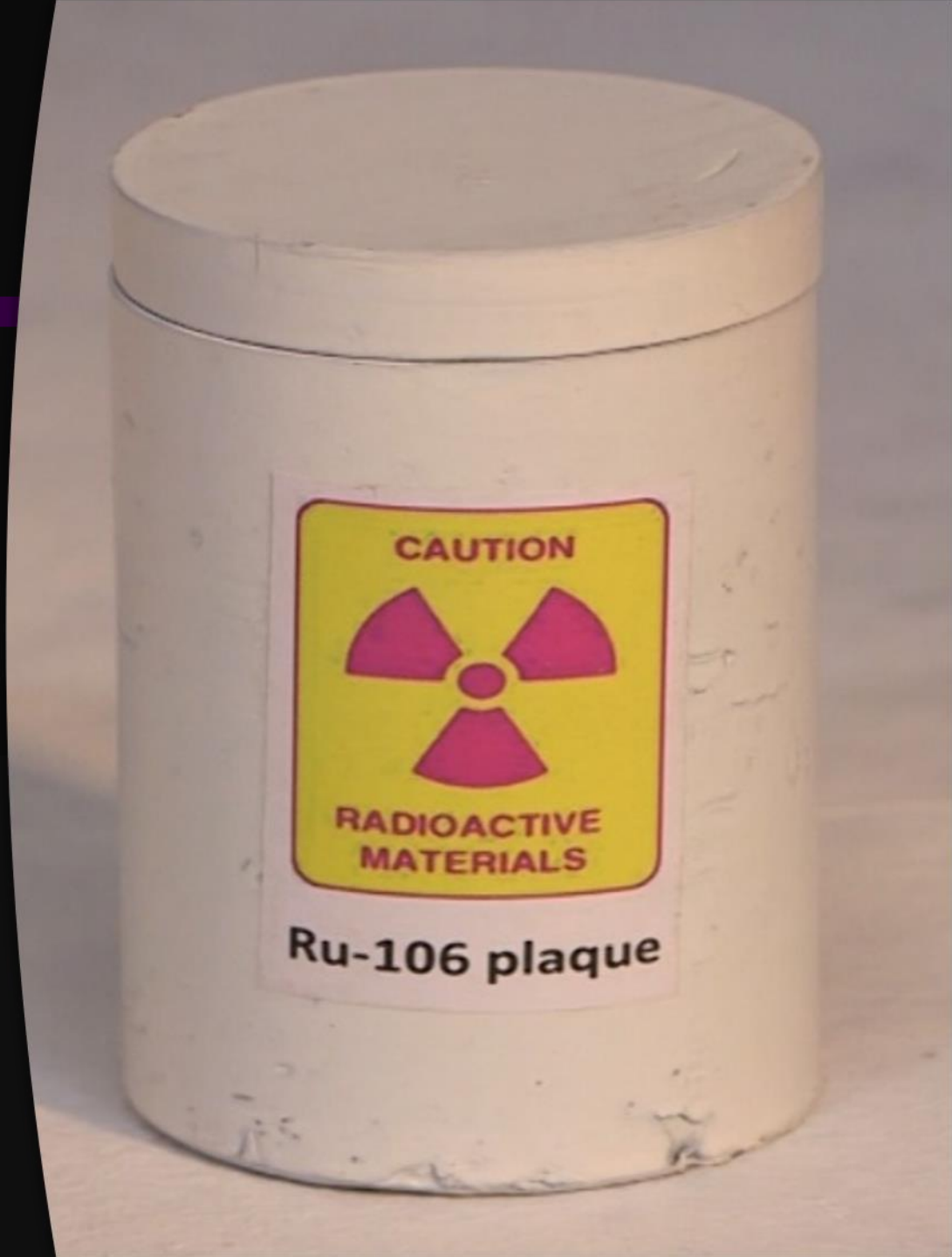


Plaque Production and Quality Assurance

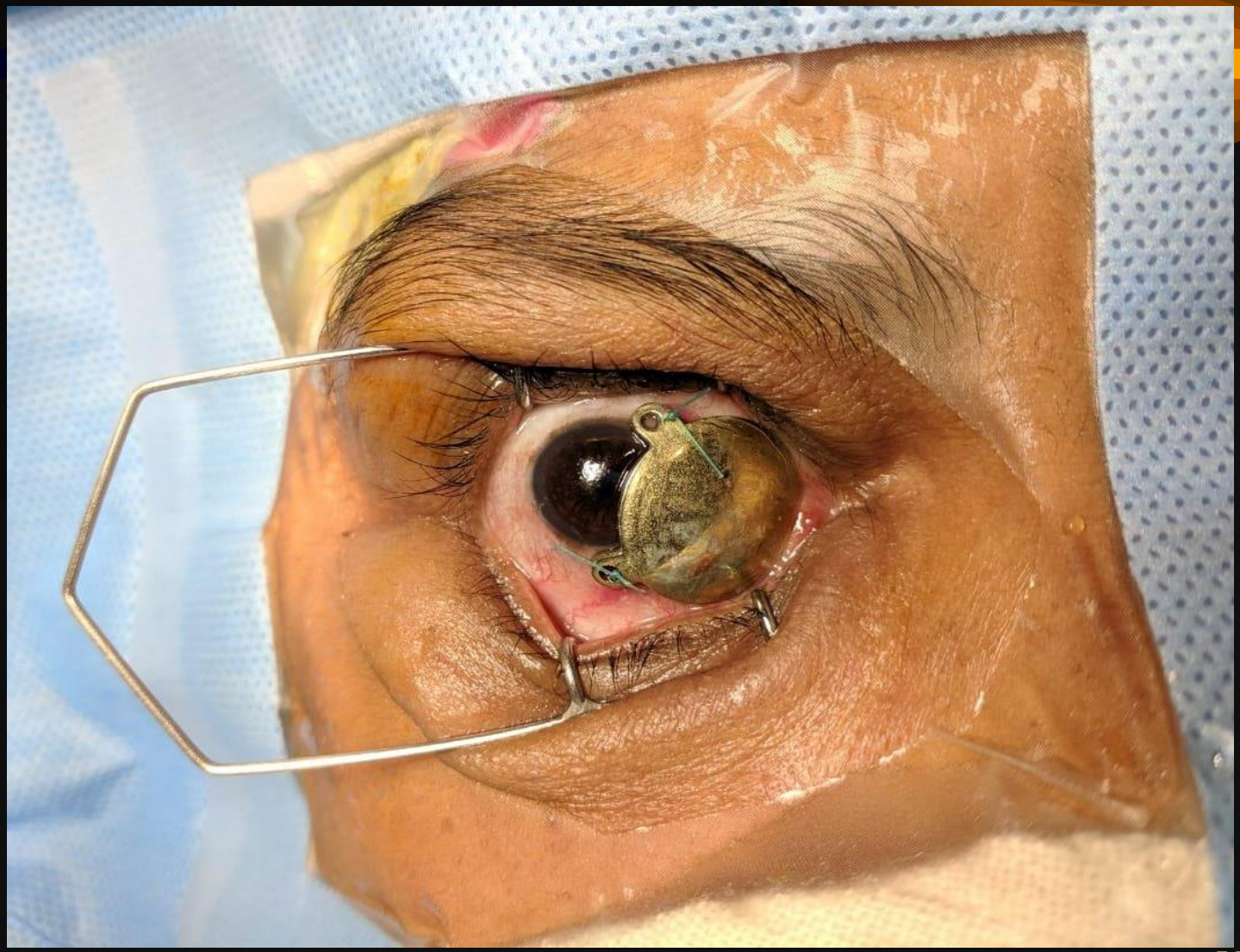
- High purity fission Ru106 is used in the plaque
- Manufacturing done under stringent regulatory guidelines
- Quality assurance tests done through third party check
- The plaque can be sterilized by autoclave after every use

Ru 106 Plaque Container

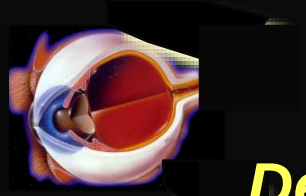
- One active source
- One dummy source
- Source certificate
- Dosimetry report
- SOP to be followed at user institute during routine use and storage.



First use of BARC Ru106 plaque on August 21, 2019 at CFS, Hyderabad

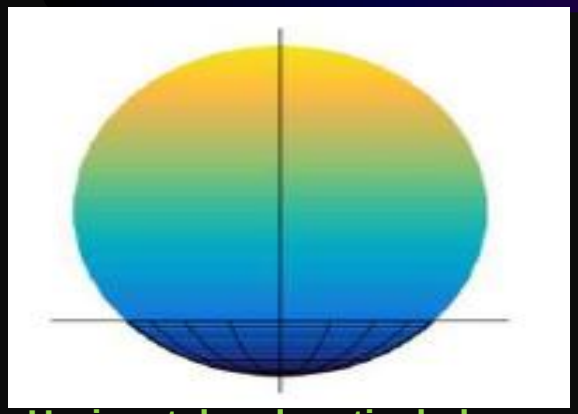


VijayAnand

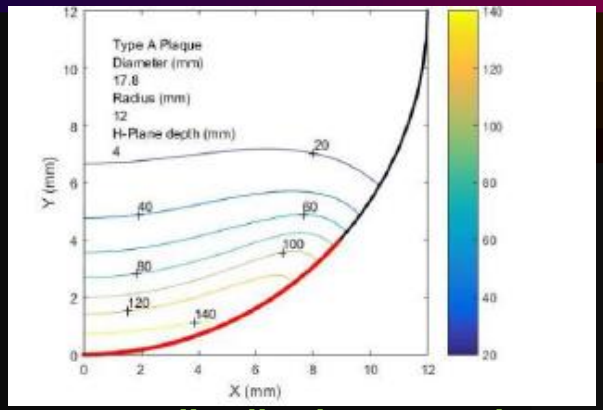


Development of Treatment Planning System

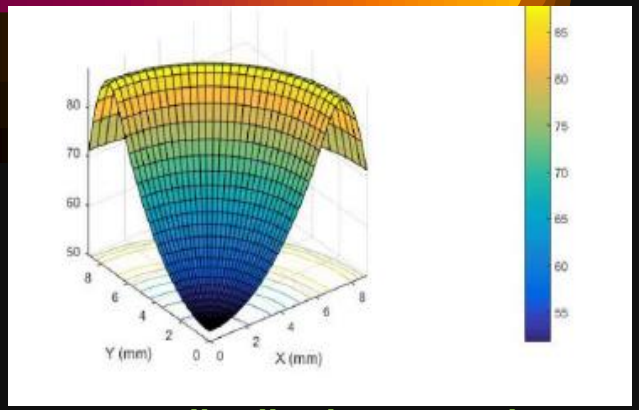
Simulation study on dose distribution has been completed



Horizontal and vertical planes

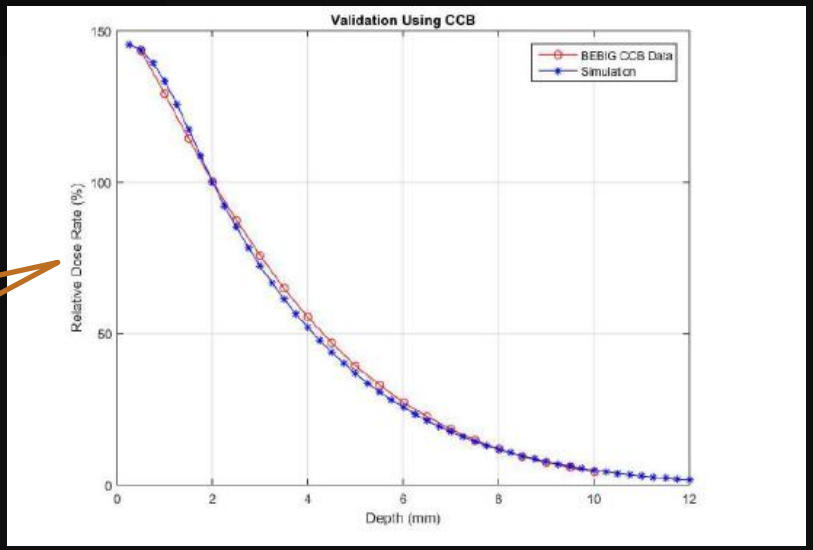


Dose distribution on V plane

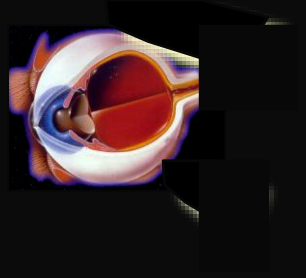


Dose distribution on H plane

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

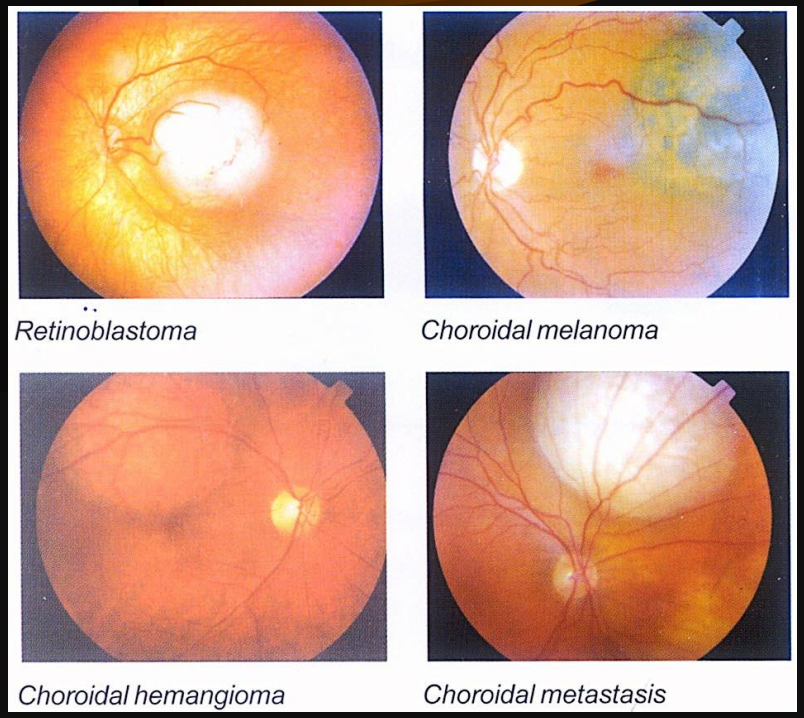


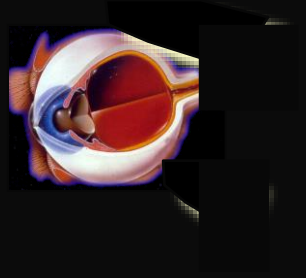
VijayAnand



Plaque Brachytherapy Indications

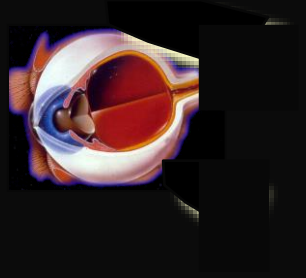
- Uveal Melanoma
- Retinoblastoma
- Choroid Hemangioma
- Choroid metastasis
- Retinal hemangioma
- Ocular Surface tumors:
  - Sq Neoplasia (OSSN),
  - Lymphoma,
  - Melanoma





Modes of treatment

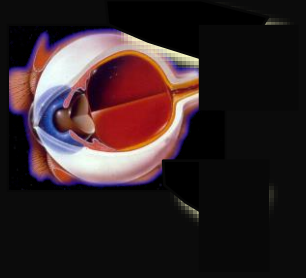
- Retinoblastoma
  - Local therapy: Cryotherapy / TTT
  - Chemotherapy (Vincristine + Etoposide + Carboplatin)
  - EBRT / Brachytherapy
- Choroid Melanoma: Enucleation / EBRT / Brachy
- Hemangioma: EBRT / PLAQUE Brachy
- OSSN: Surgery / EBRT / Plaque
- CHOROIDAL mets: EBRT / Plaque brachy



Retinoblastoma

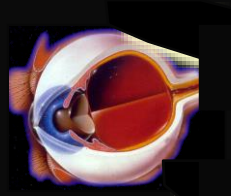
Current Concepts of Management

VijayAnand



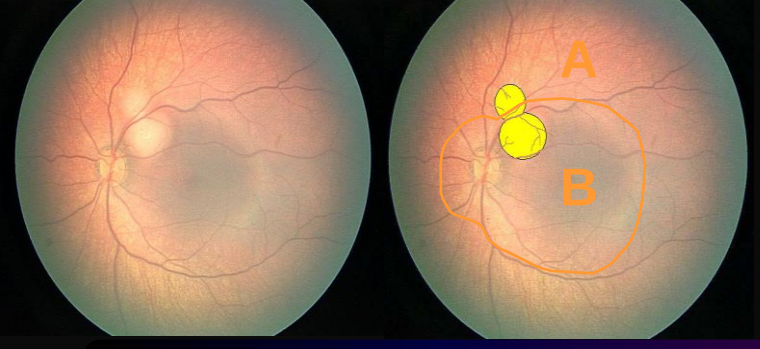
RB Classifications

- Reese Ellsworth
- St Jude’s
- Grabowosky
- Essen
- Chantada et al
- NEW International Staging System



Reese Ellsworth classification RB

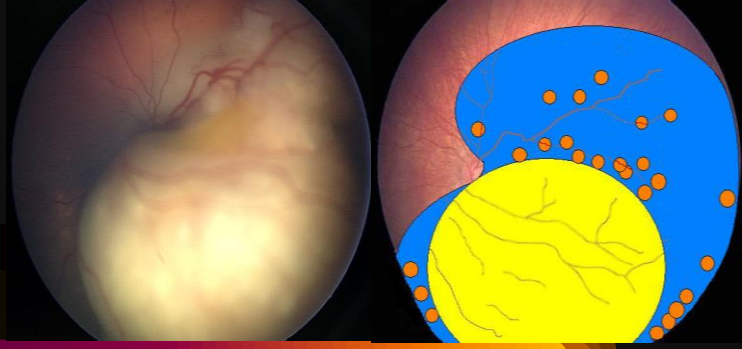
1. **Group I-Very favorable**
   - A. Solitary tumor, < 4 disk diameters, at or behind the equator
   - B. Multiple tumors, none >4 disk diameters, all at or behind the equator
2. **Group II –Favorable**
   - A. Solitary tumor, 4-10 disk diameters in size, at or behind the equator
   - B. Multiple tumors, none n4-10 disk diameters, behind the equator
3. **Group III-Doubtful**
   - A. Any lesion anterior to the equator
   - B. Solitary tumors larger than 10 disk diameters behind the equator
4. **Group IV- Unfavorable**
   - A. Multiple tumors, some large than 10 disk diameters
   - B. Any lesion extending anteriorly to the ora serrata
5. **Group V- Very unfavorable**
   - A. Tumors involving more than half the retina
   - B. Vitreous seeding

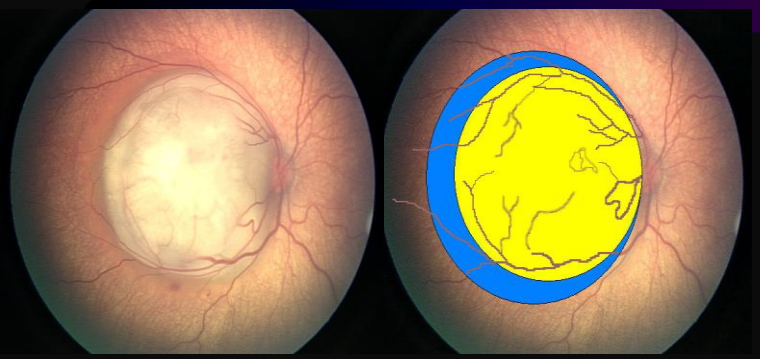


Group A
< 3 mm

Group B
macula
> 3 mm

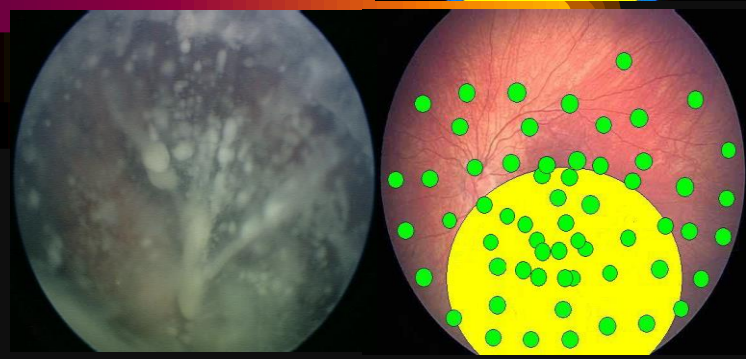
Group D
diffuse
SR
seeds

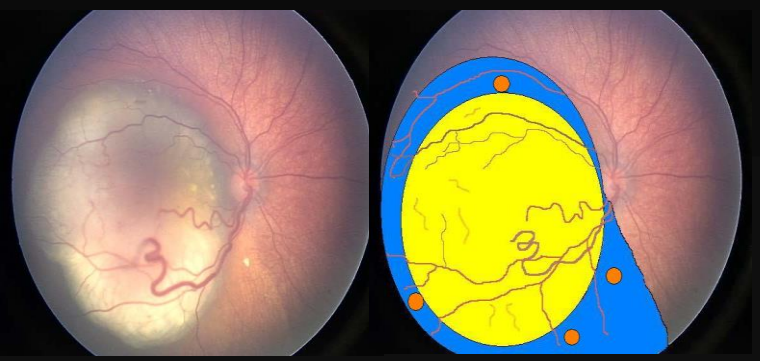




Group B
tumor +
SRF

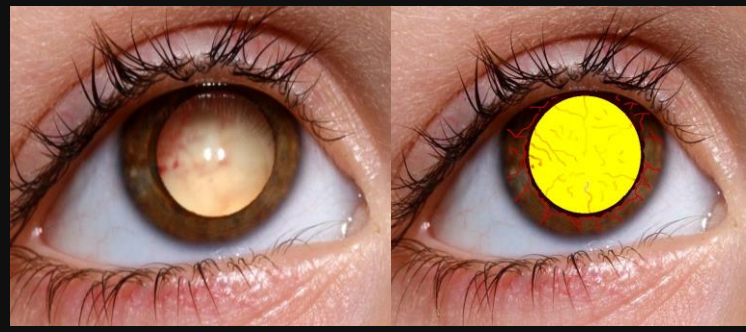
Group
D
diffuse
vitreous
seeds

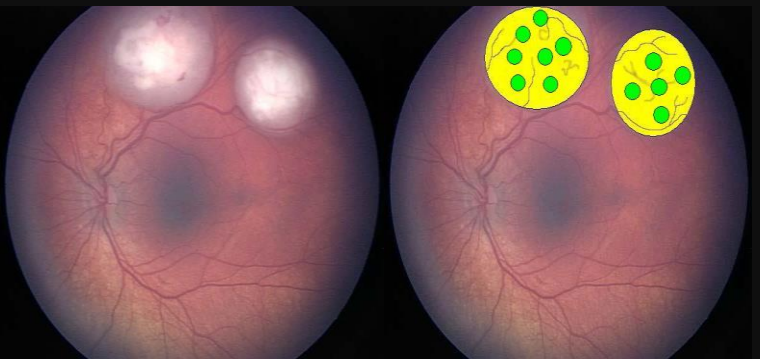




Group C
focal SR
seeds

Group E
high risk
- NVG
- blood
- invasion

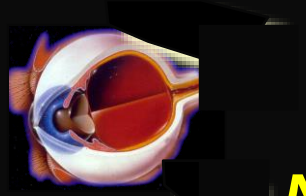




Group C
focal
vitreous
seeds

International Grouping of Intraocular Retinoblastoma

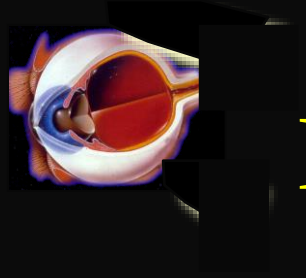
VijayAnand



NEW International Staging System

- Stage 0 — No enucleation – Intra ocular disease
  (one or both eyes may have intraocular disease)
- Stage I — Enucleation, tumor completely resected
- Stage II — Enucleation with microscopic residual
- Stage III — Regional extension
  - A. Overt orbital disease
  - B. Preauricular or cervical lymph node extension
- Stage IV — Metastatic disease
  - A. Hematogenous metastasis
    - 1. Single lesion
    - 2. Multiple lesions
  - B. CNS Extension
    - 1. Prechiasmatic lesion
    - 2. CNS mass
    - 3. Leptomeningeal disease

Chantada G, Doz F, Antoneli CB, et al. A proposal for an international retinoblastoma staging system. Pediatr Blood Cancer. 2006;47:801-803.



Intraocular Retinoblastoma

Treatment Options

Early
Grp I, II
Grp A,B

Focal
Local

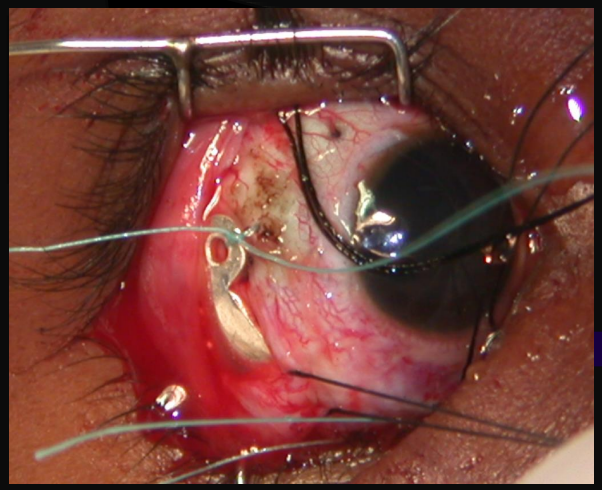
- Cryo-therapy
- Thermo-therapy
- Laser photocoagulation

Intermediate
Grp III, IV
Grp C, D

- Chemoreduction + Local Therapy
- Plaque brachytherapy
- External beam radiotherapy

Late
Grp V
Grp E

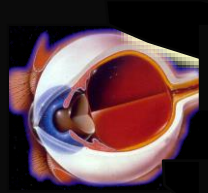
- Enucleation
- Adjuvant therapy – Chemo / EBRT
- Orbital exenteration



Retinoblastoma Plaque Brachytherapy

- Indications
  - Chemo-reduction failure or Recurrence
  - Rarely as primary therapy
- Max - 16 mm diameter, 8 mm thickness
  - 4500-5000 cGy to tumor apex
  - 90% success in tumor control

VijayAnand



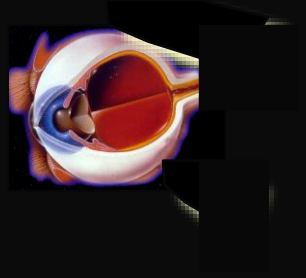
Choroidal Melanomas - Management

Small Lesions <1.5mm height: Observation

- Watch for growth
- Watch for Risk factors
  - Size > 2 mm thickness
  - Juxta papillary location
  - Presence of subretinal hemorrhage
  - Presence of orange pigment

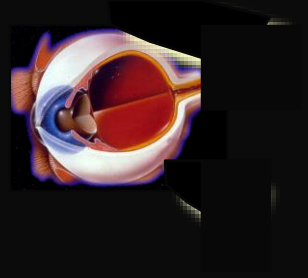
Any of the risk factors +ve : treat -- TTT

VijayAnand



Choroidal Melanomas - Management

- <1.5mm height - close observation
- 1.5 to 10 mm height
  - Peripheral lesions: Local excision
  - Central, mid peripheral, <4 mm: T T T
  - > 4 mm : Plaque therapy
  - Ext. RT- photons or protons
- >10mm in height
  - Enucleation
  - Radiotherapy (if patient has only eye)

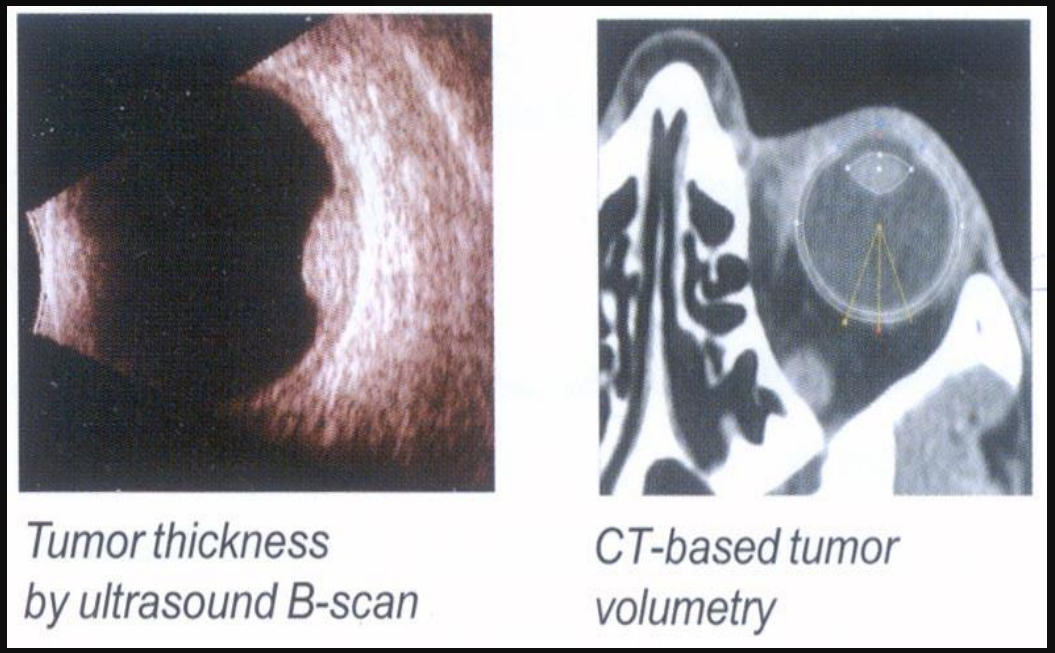


Plaque Brachytherapy - Procedure

Tumor assessment

Clinical & Radiological assessment

- Location
- Basal diameter
- Height



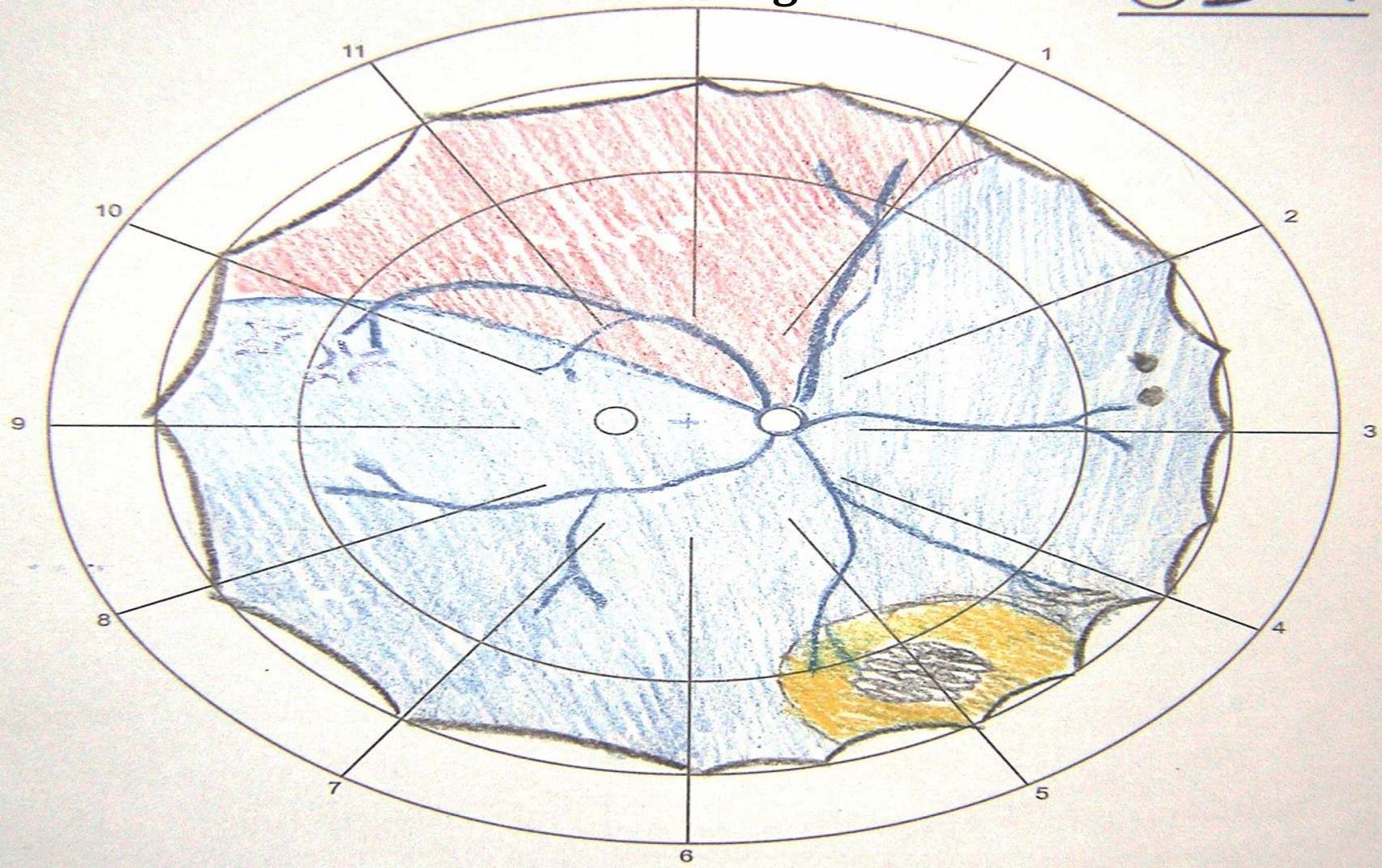
Tumor thickness by ultrasound B-scan

CT-based tumor volumetry

VijayAnand

Retinal diagram

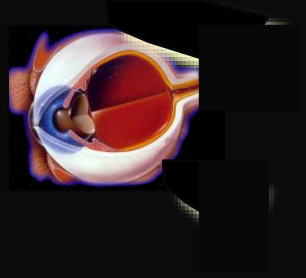
OD



Size 9.4 x 8 x 5 mm

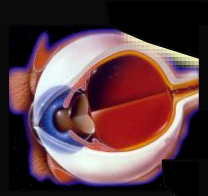
Date : 19/9/02
Number : P266185
Name : Jeevan Prakash
Signature Dr Mukund

Inv. Image



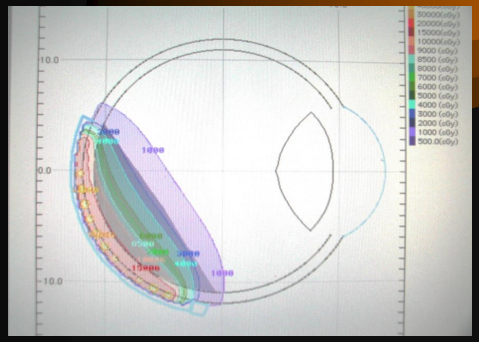
Radiotherapy Planning

- Brachy software: BEBIG, Germany
- Select the plaque size and shape
- Required dose is prescribed to base/apex
- Dosimetry: Automated dosimetry / manual
- Dose & Exposure time are calculated
- Team Work
  - Ophthalmologist, Radiotherapist, Physicist

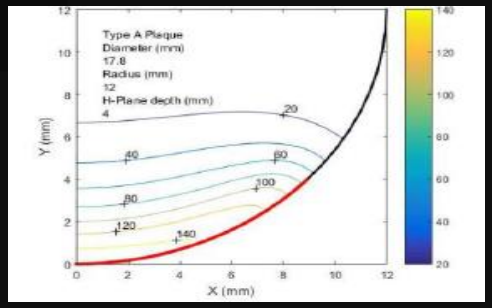


Radiotherapy Planning & Dosimetry

- BEBIG Plaque Simulator 4.12

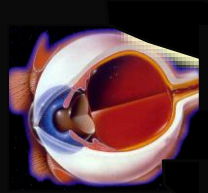


- BARC plaque

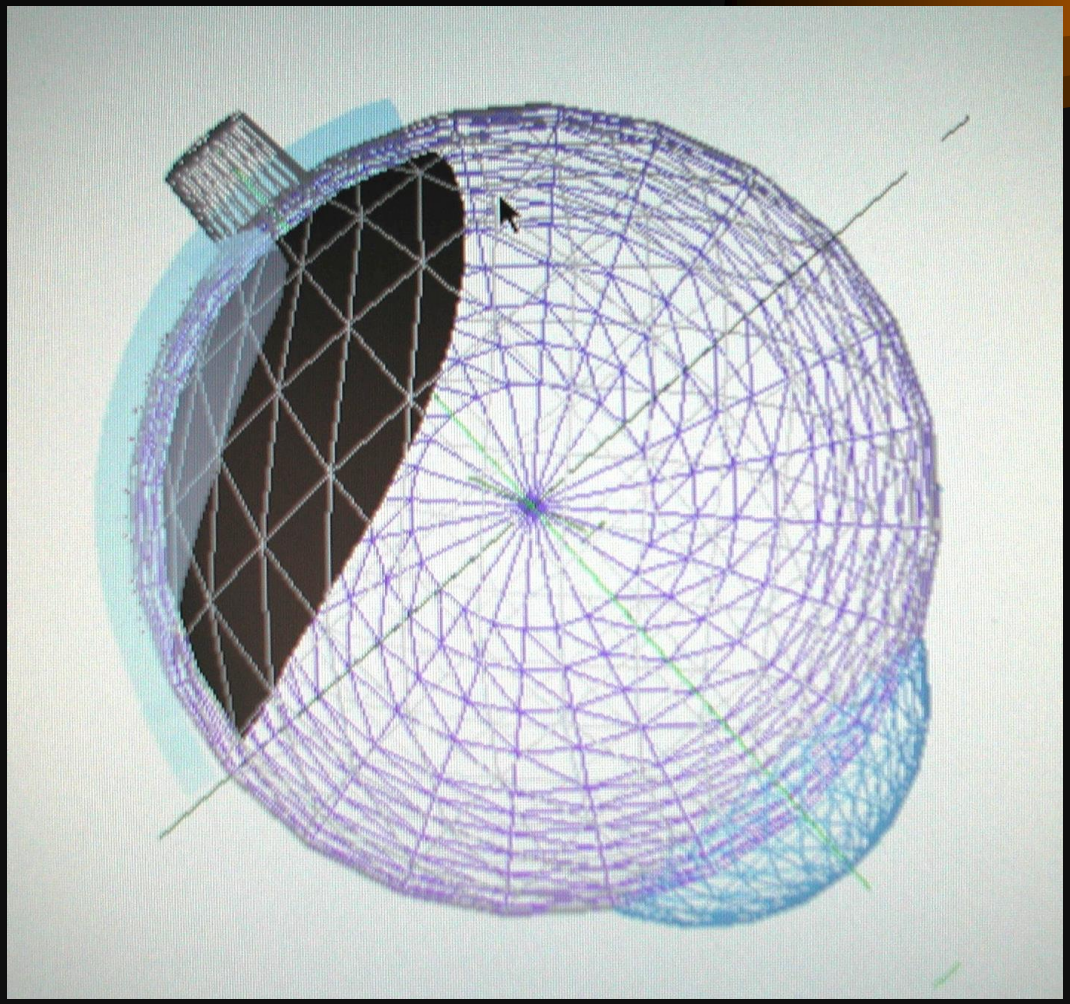


- Manual Calulation

VijayAnand

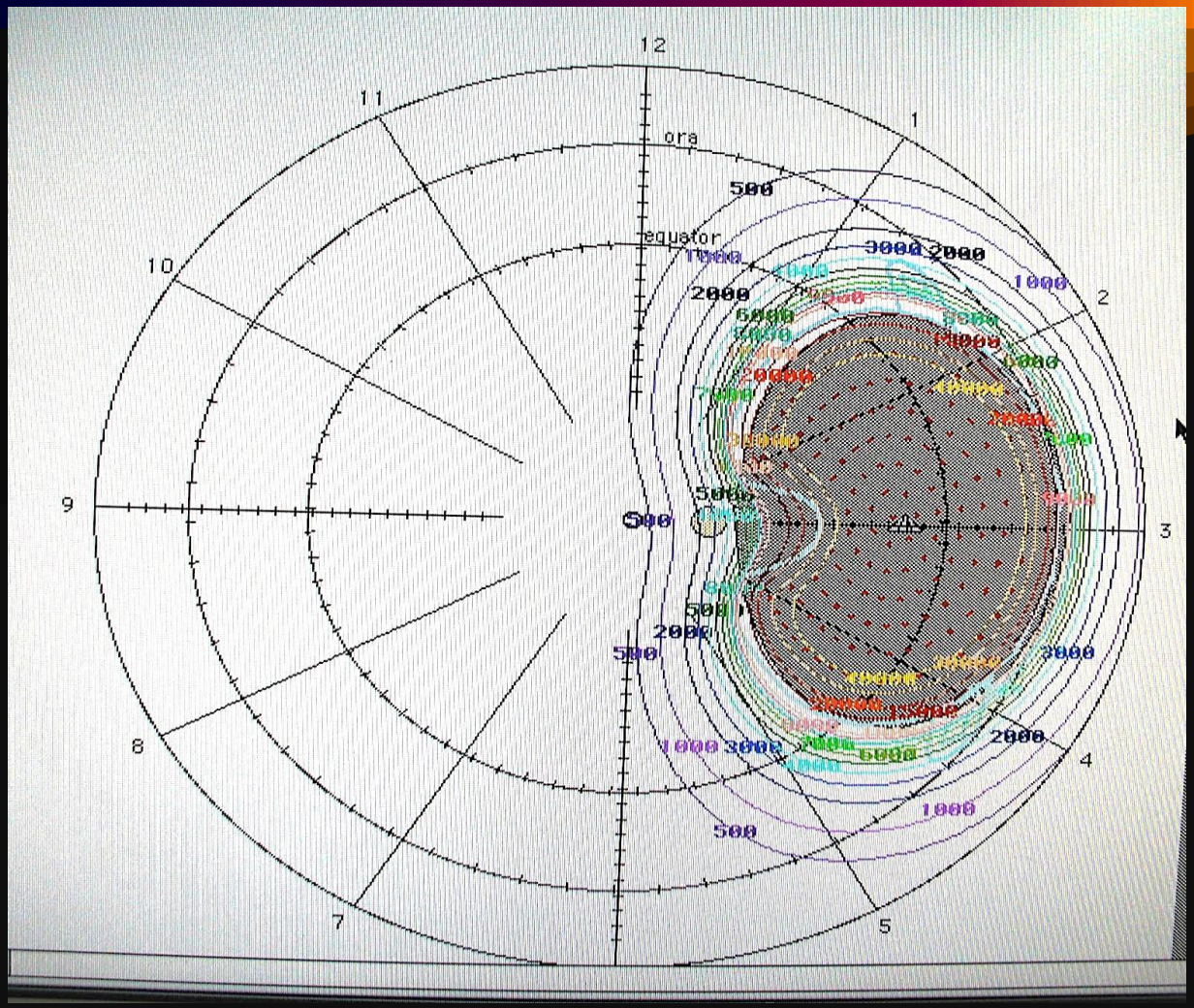


Plaque placement

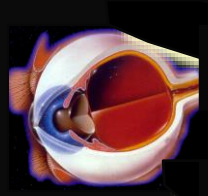


VijayAnand

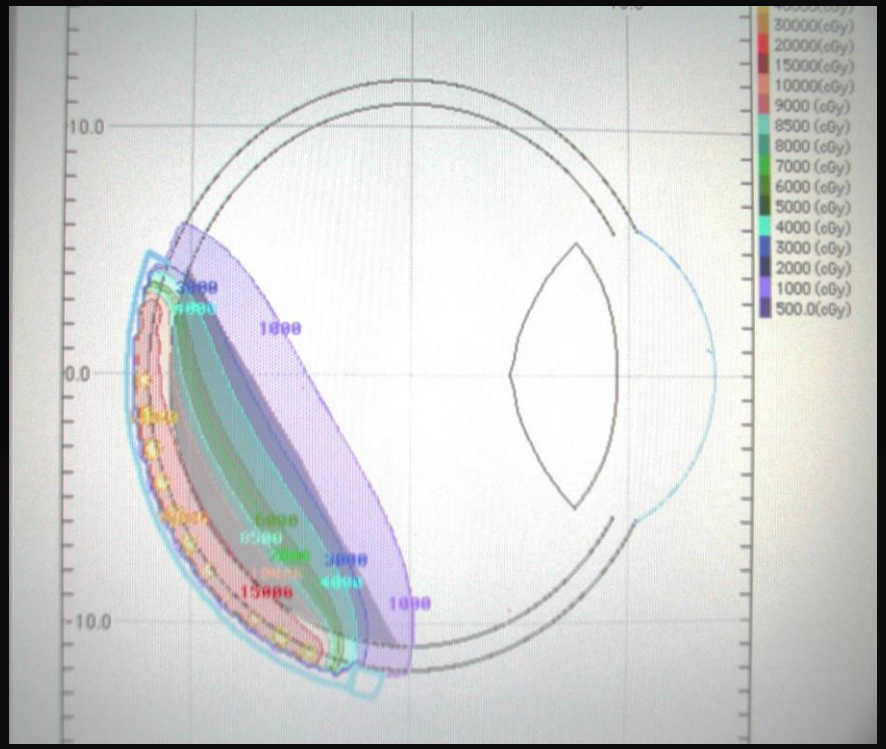
Dosimetry

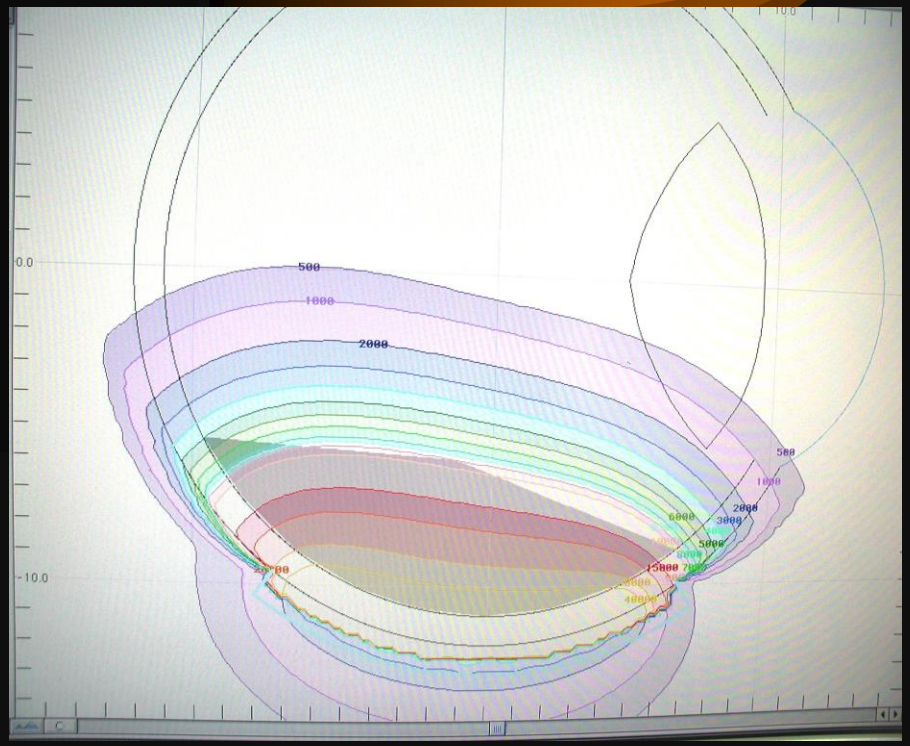


VijayAnand



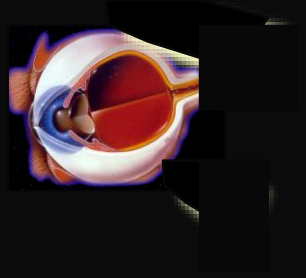
Dose distribution





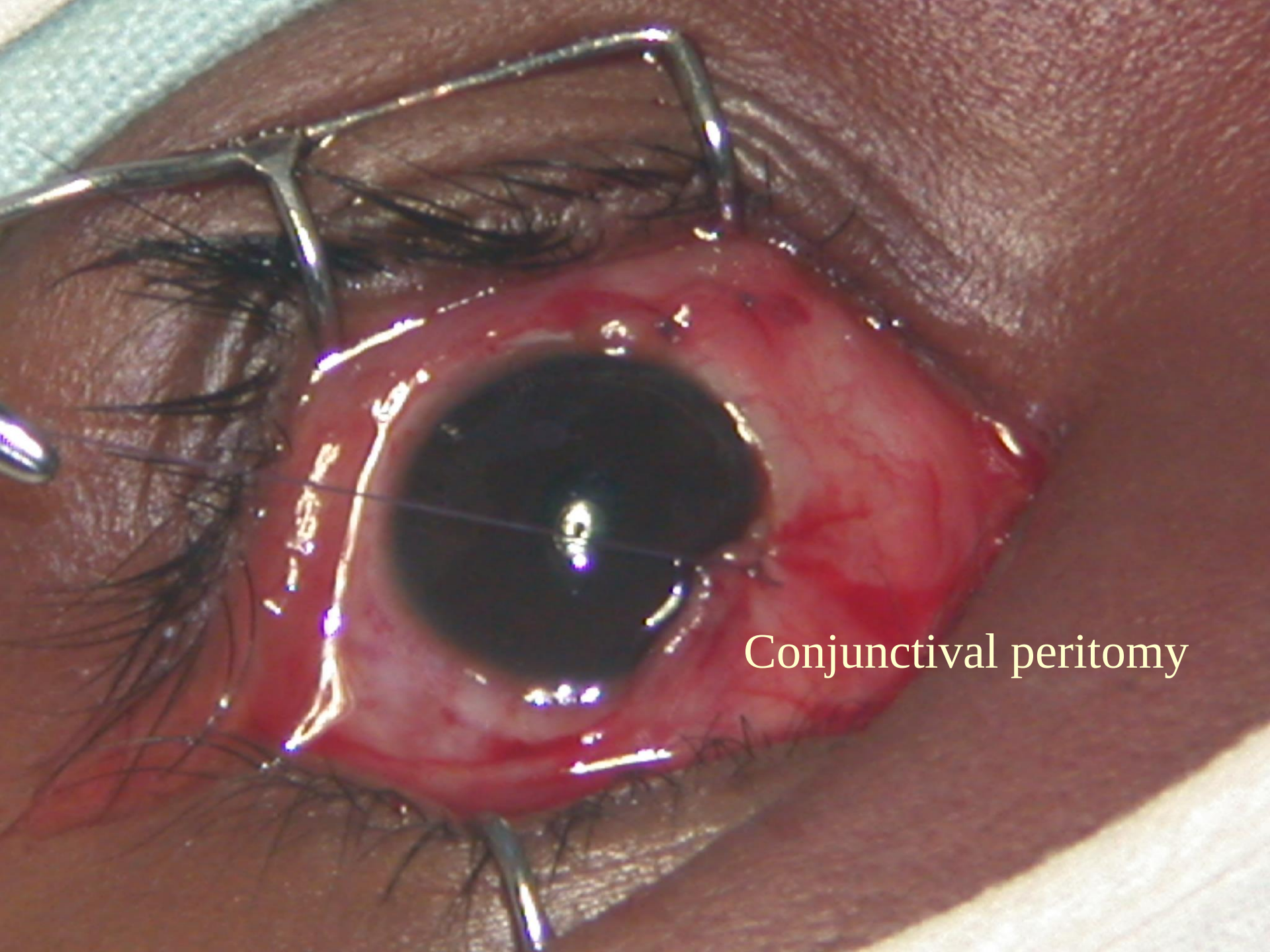
Dose rate 60 – 200 cGy / hr

VijayAnand

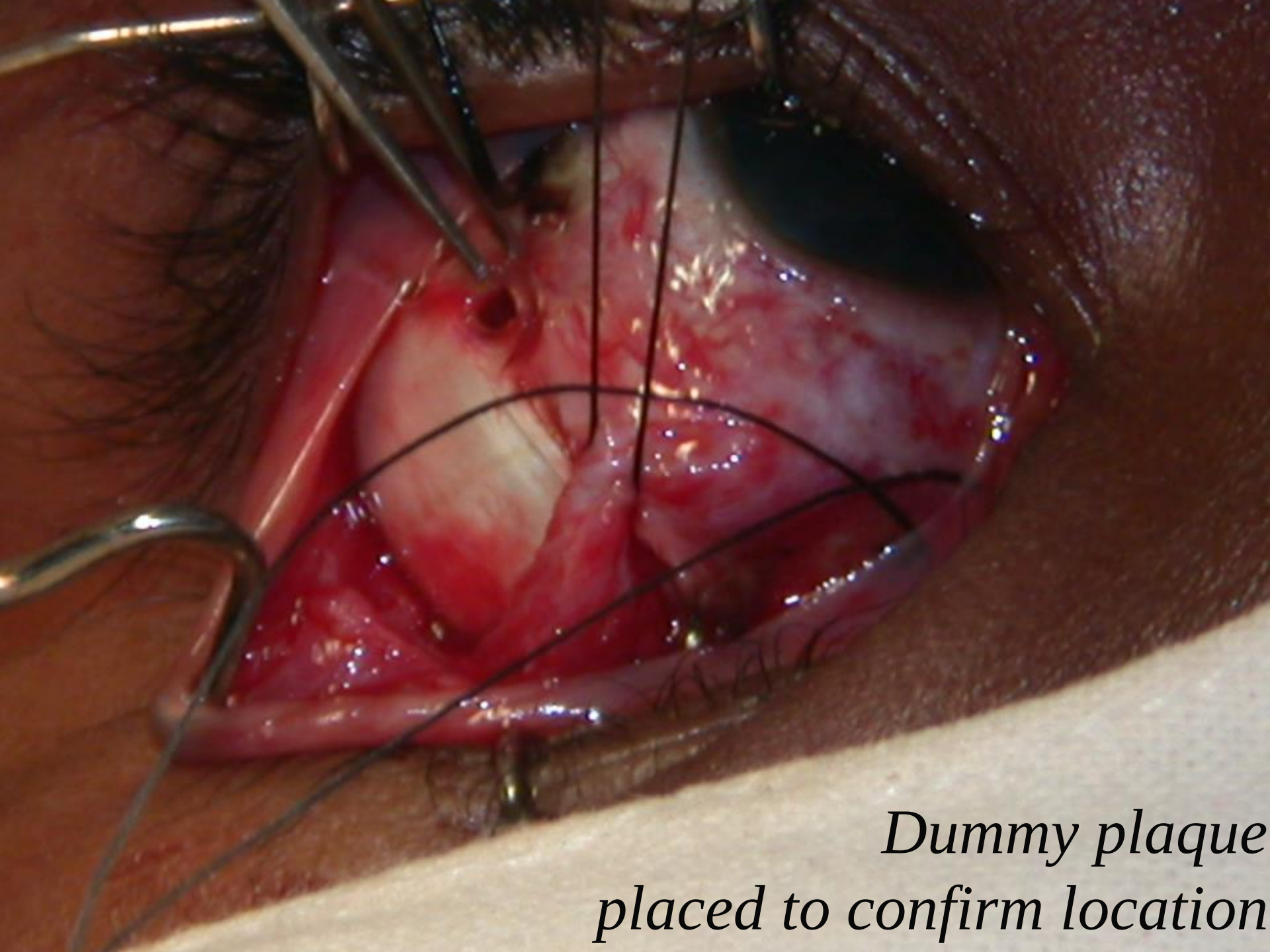


Plaque placement

- Under GA / LA
- Conjunctival peritomy
- Tumor location marked on sclera
- Dummy plaque used to confirm location
- Rh Plaque placed & sutured to sclera
- Conjunctiva sutured
- Patient is kept in isolation


Conjunctival peritomy

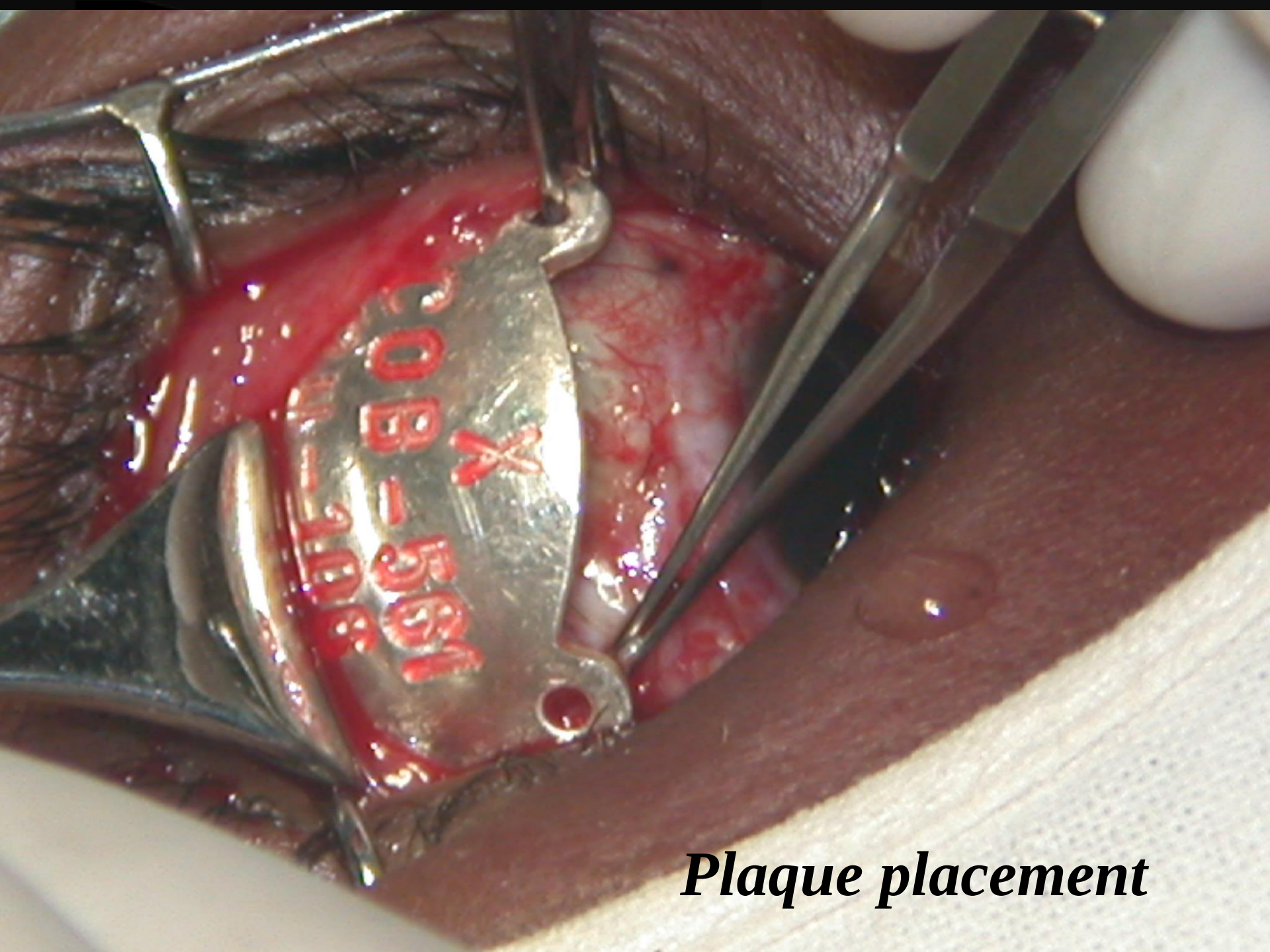
Dummy plaque to confirm location

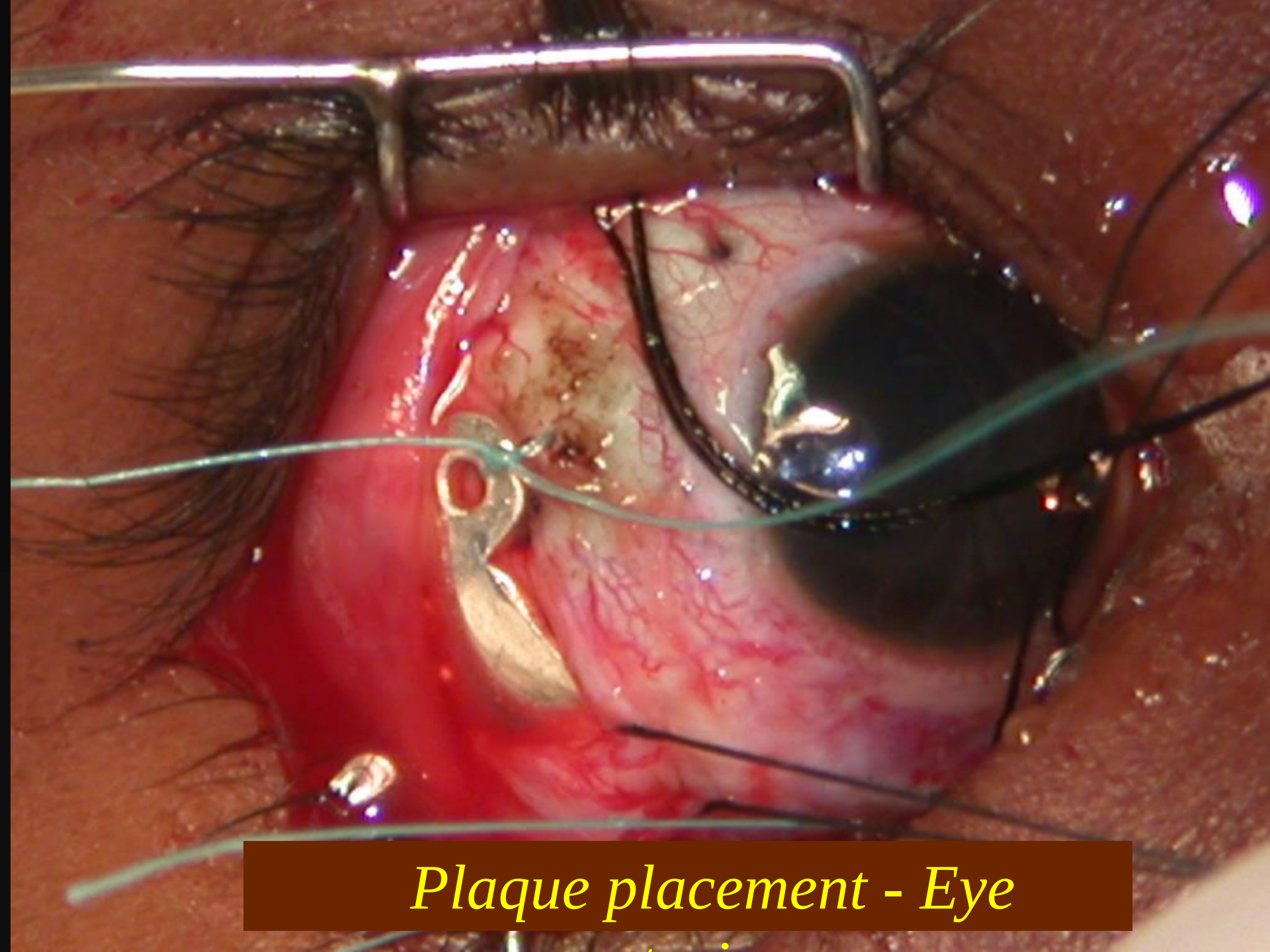


Dummy plaque placed to confirm location

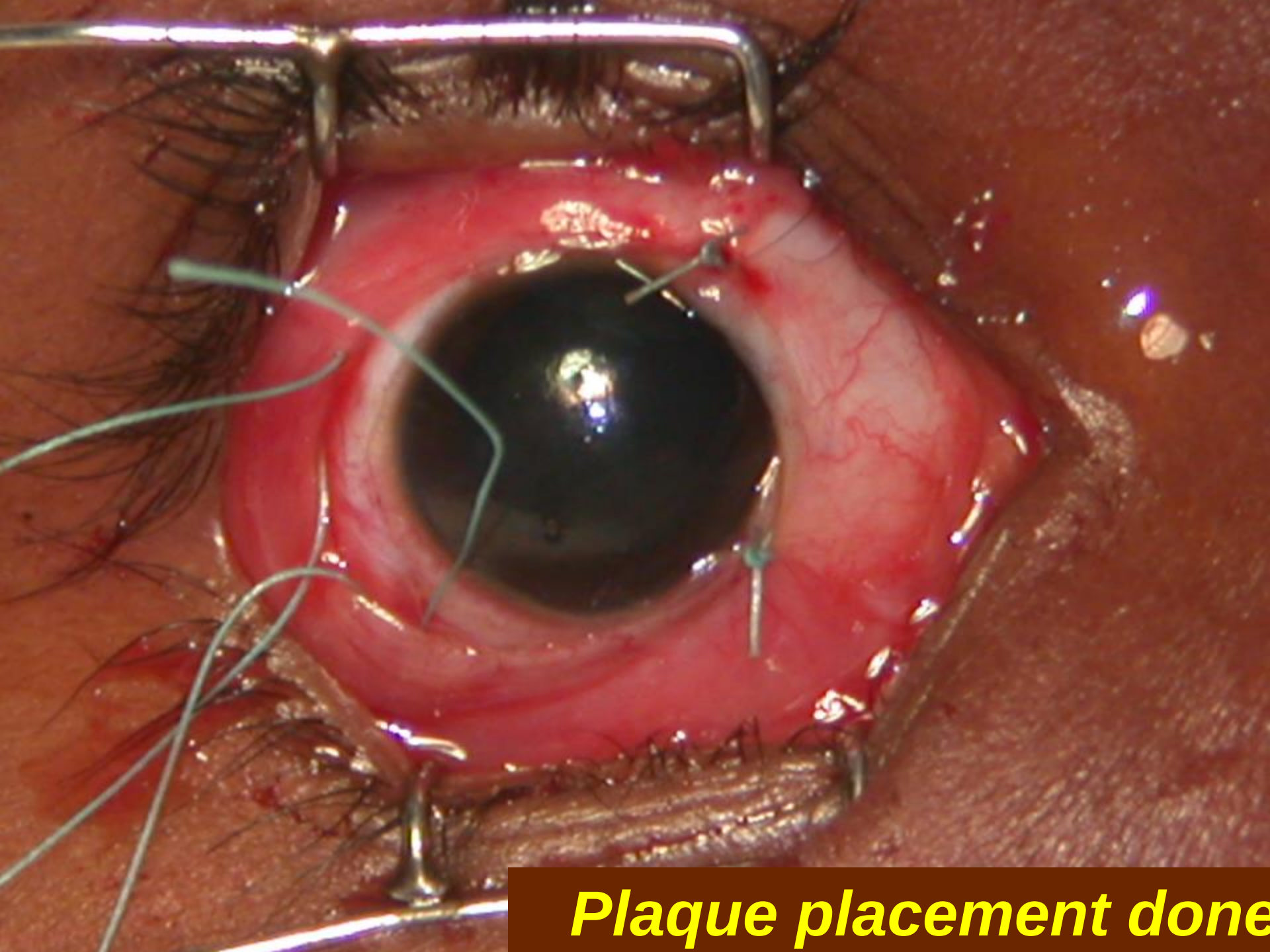
Ruthenium plaque in a lead container

Ruthenium plaque

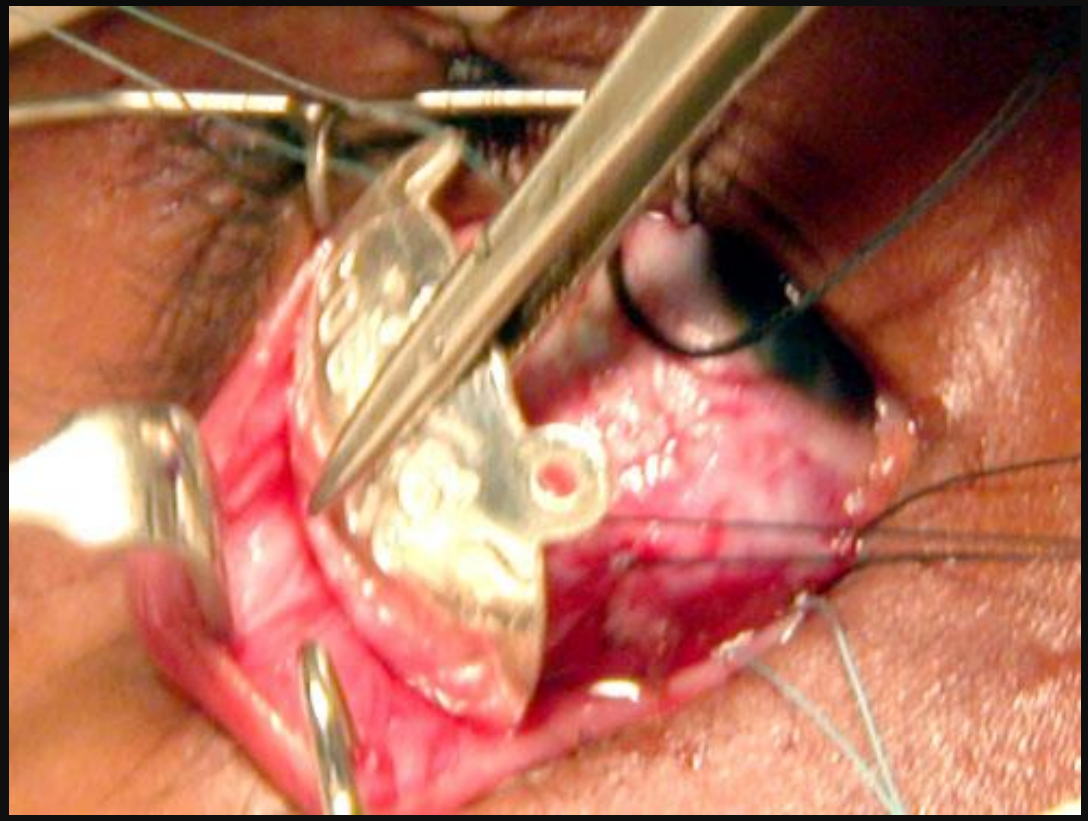

Plaque placement



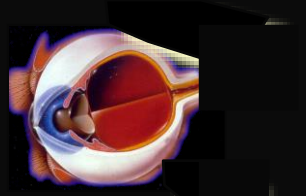
Plaque placement - Eye


Plaque placement done

Plaque is removed after the exposure time



Few hours to few days (15 hrs to 90 hrs)

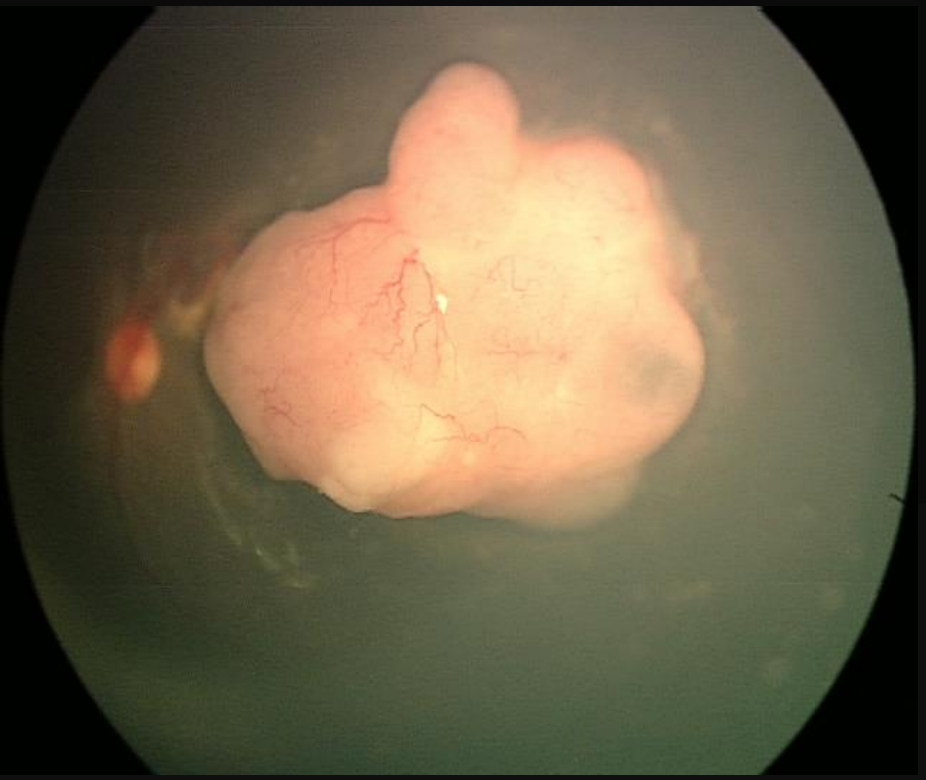


Follow -up

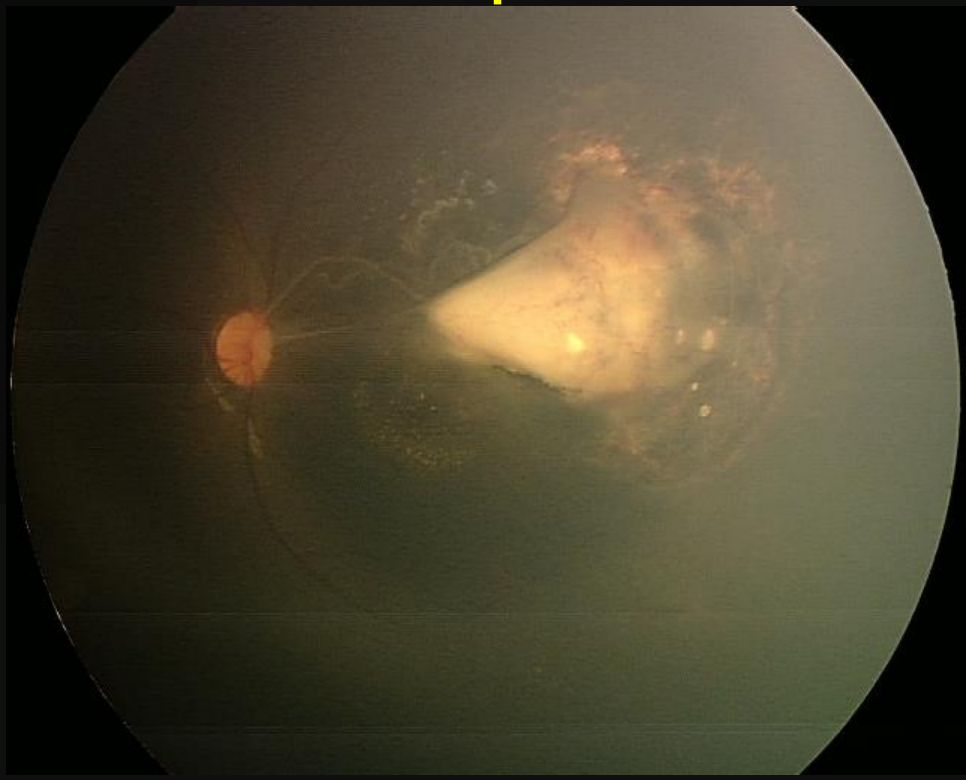
- Every 4-6 weeks
- Until regression of the tumor occurs

Results : Retinoblastoma

Pre



post



TTR 2-3 mo, Calcified scar, Fish flesh appearance,

80-90% Resp

Choroidal Hemangioma

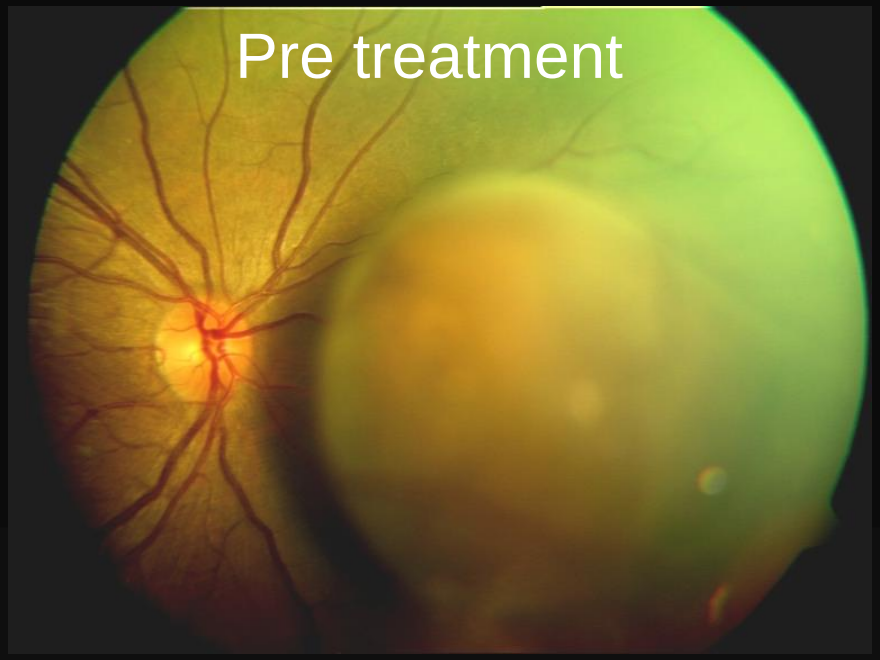
Pre-treatment

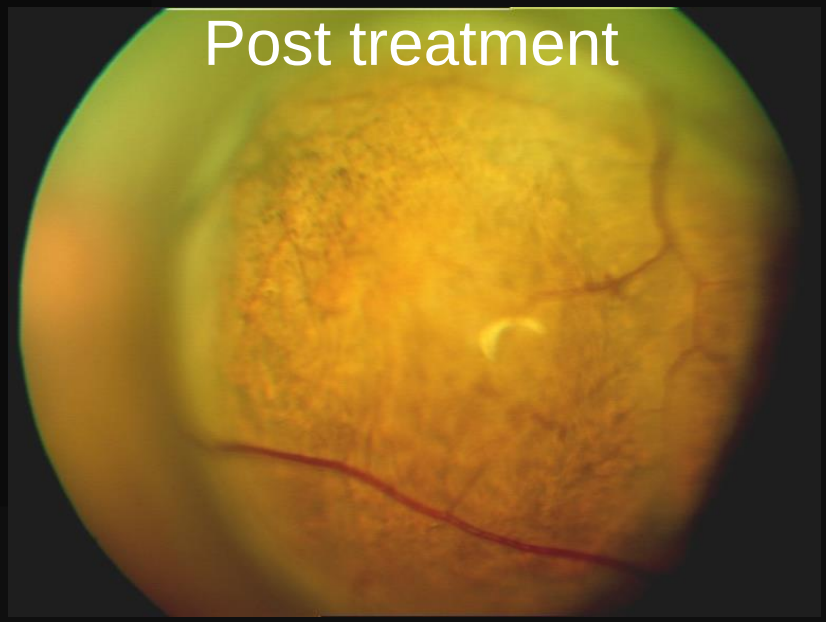
Post treatment

TTR 6 wks, Improved vision, > 90% Response

Flat, reduction in ht, Sub retinal fluid reduction

Choroidal Melanomas

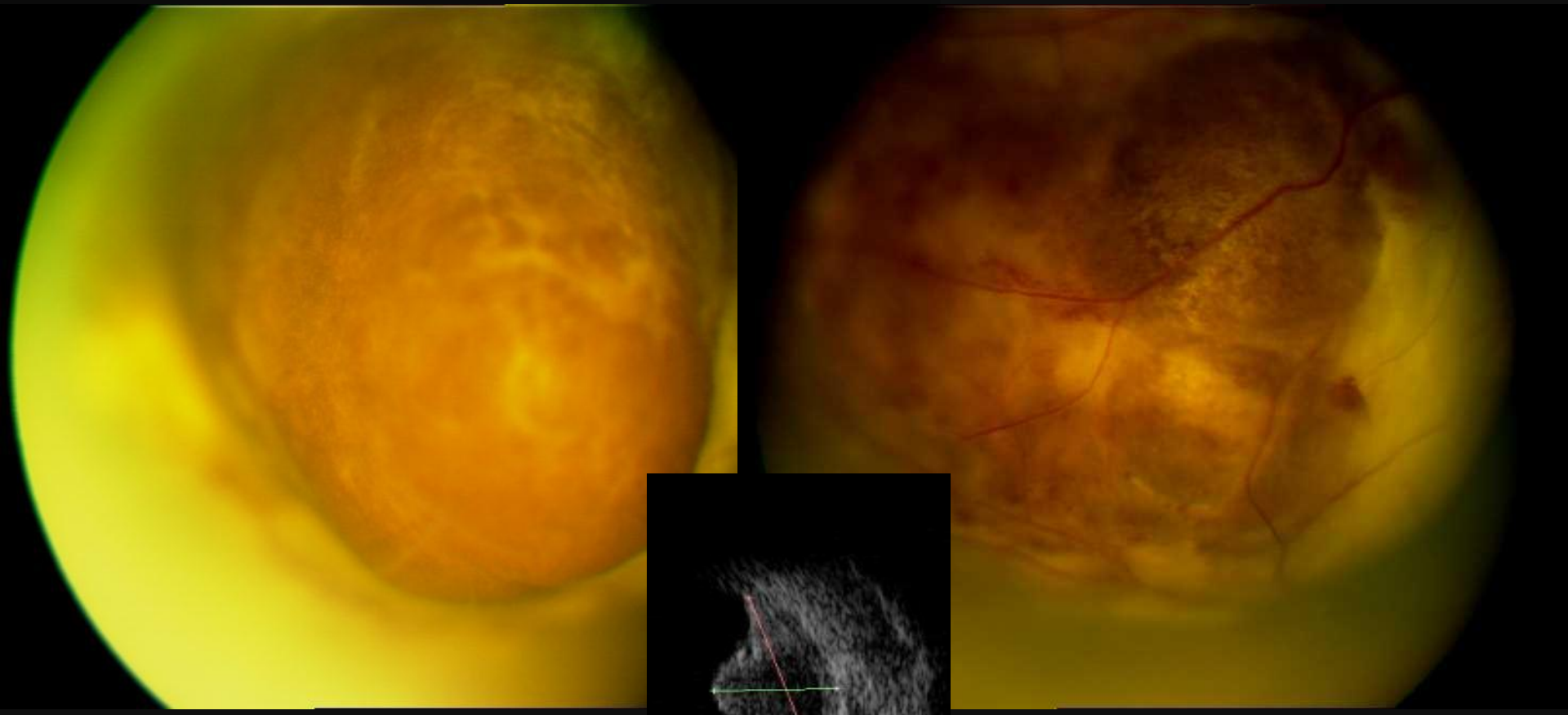




TTR: 6 months, 80% response

Flat, less vascular, color change, Reduction in SRF

Results: Uveal Melanoma

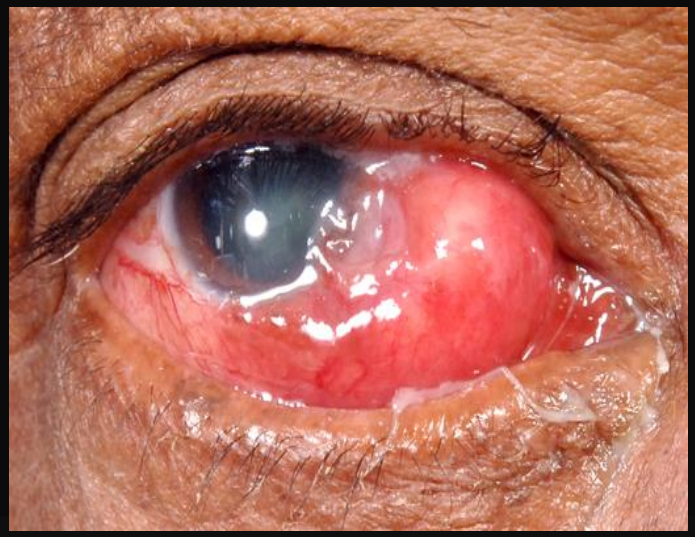


Pre

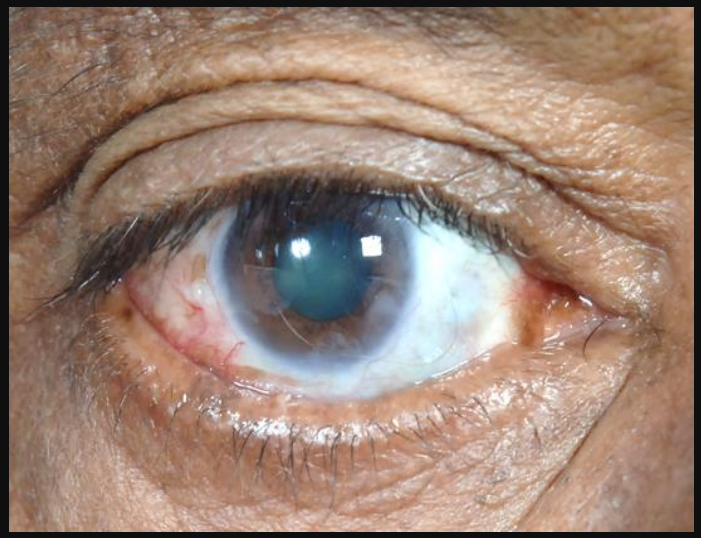
post

Ocular Surface Sq Neoplasia

TTR: 6-8 wks, Flat



PRE

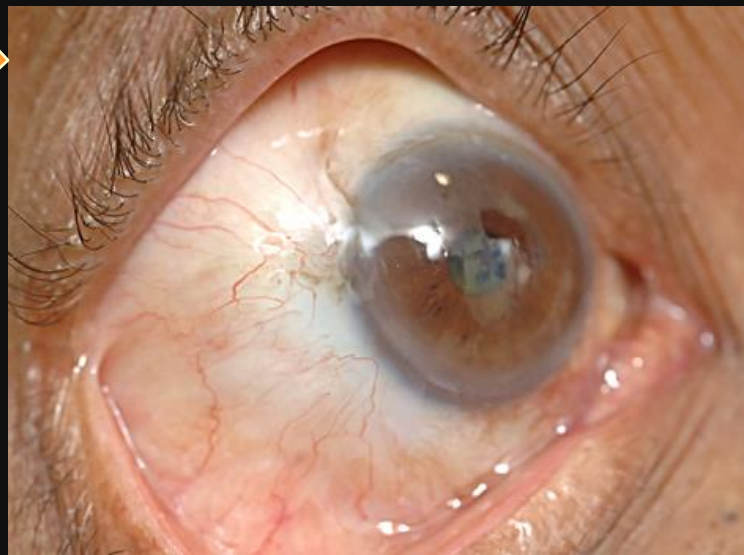


POST

Results: OSSN

Pre

Post

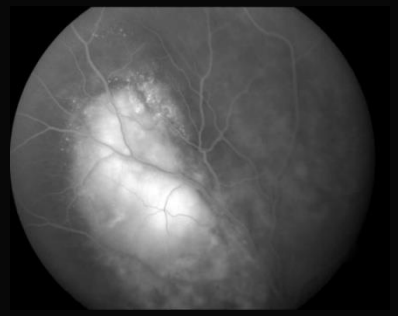


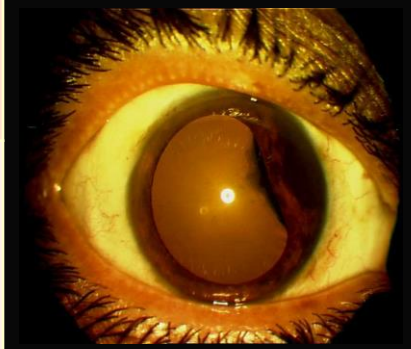
Ru 106 Plaque - Outcomes

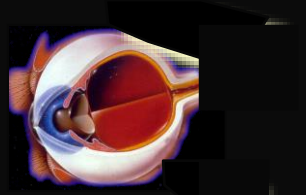
Brachytherapy in Ocular Tumors
Our experience - 232 cases

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)







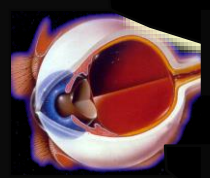
Dose Rate….

- **Minimum acceptable 60 cGy /hr**
- **Ideal 100 - 400 cGy / hr and above**
- **With Rh106 we get 60- 600 cGy/hr**

ICRU report #38

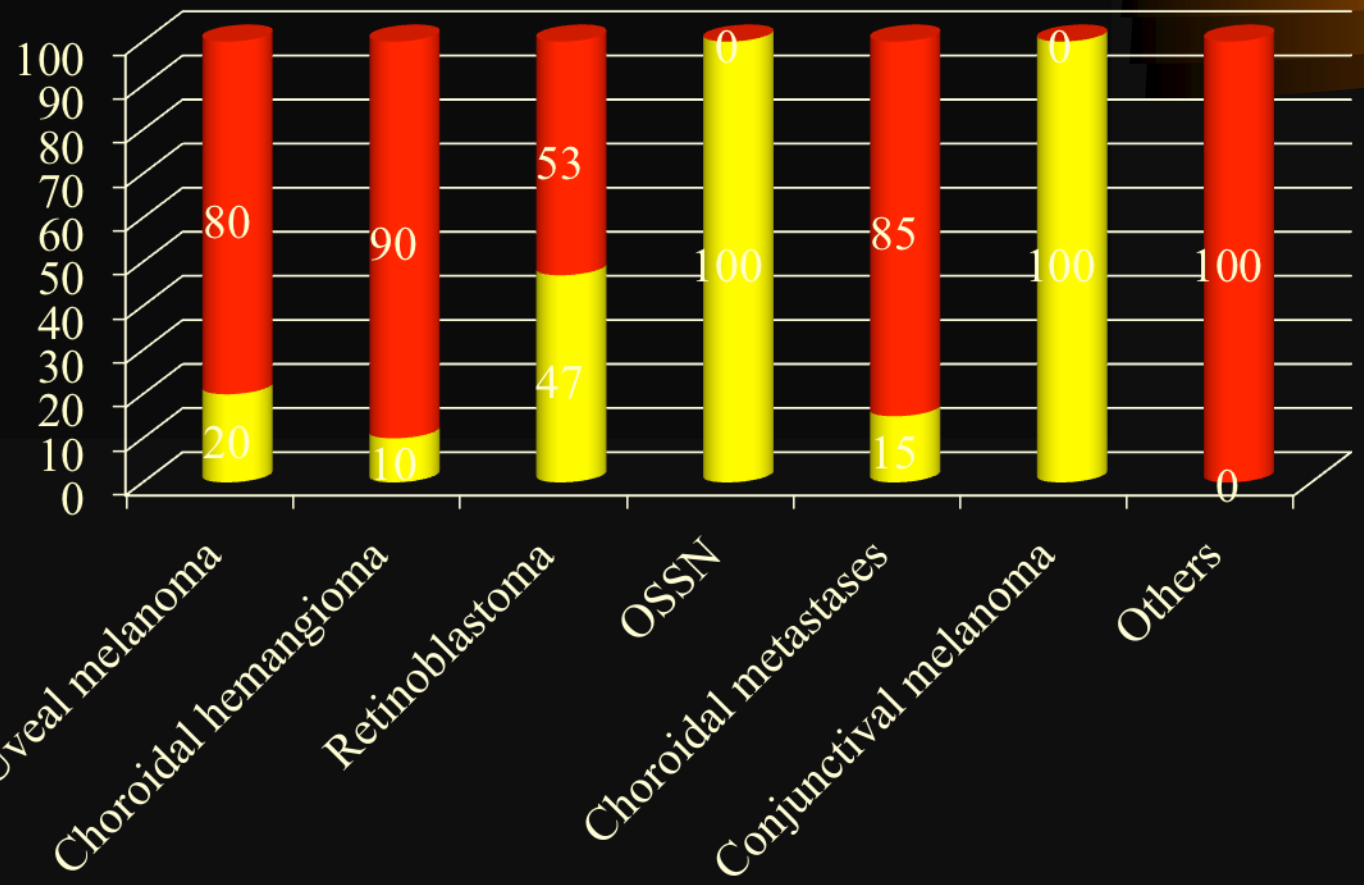
- Low Dose rate 0.4 to 2 Gy / hr
- Medium dose rate 2 -12 Gy / hr
- High dose rate 12 Gy / hr

VijayAnand

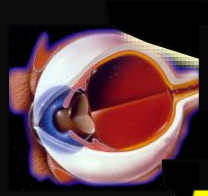


Type of Plaque

(n=232)

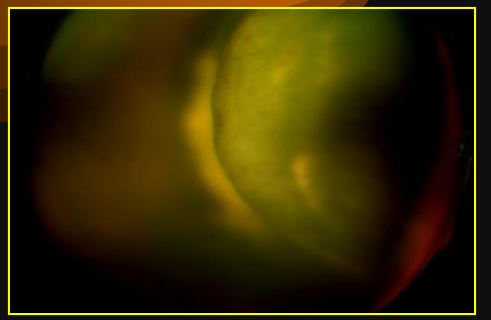


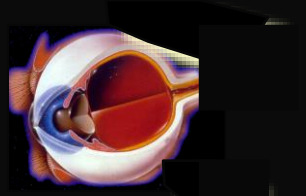
VijayAnand



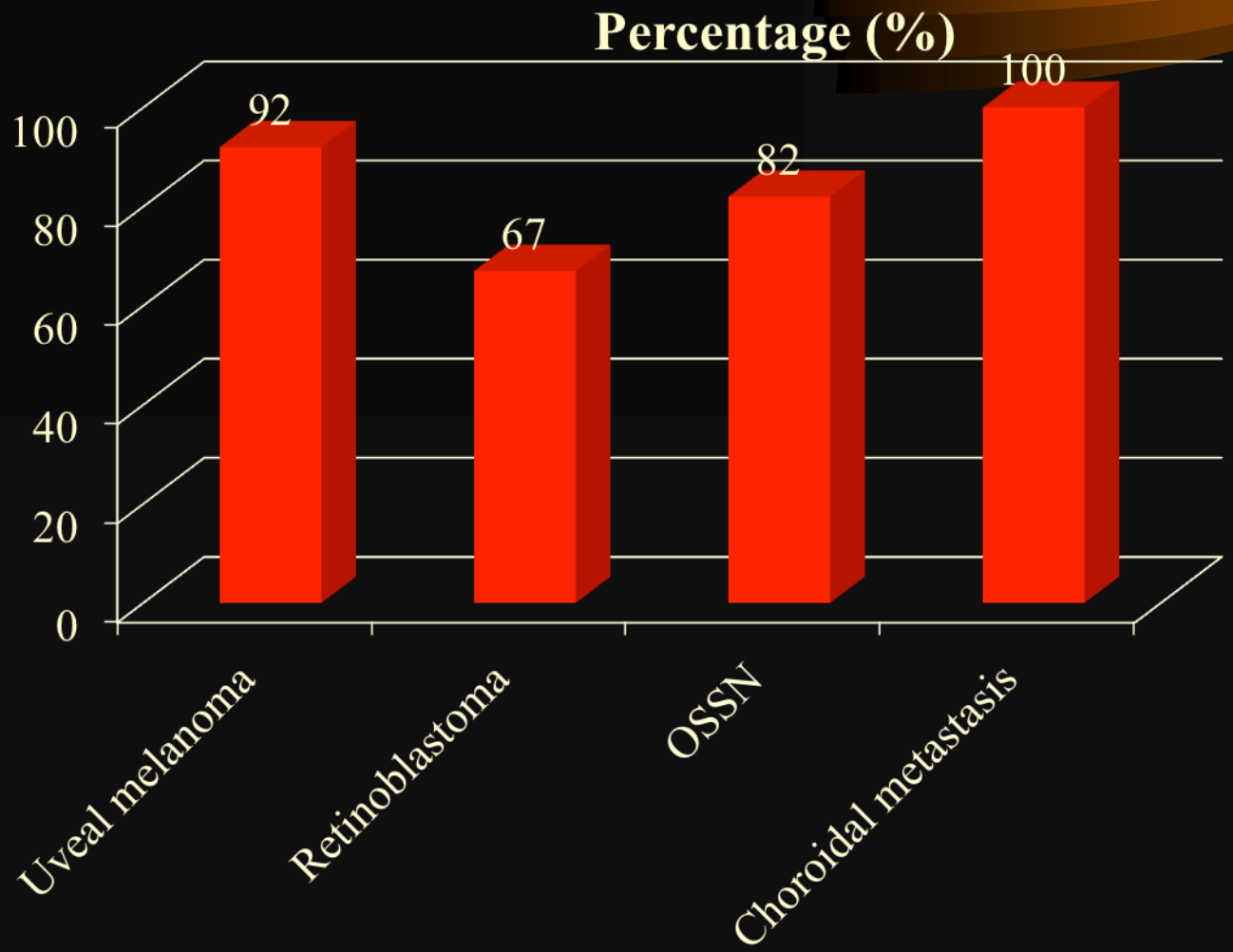
Results: Tumor regression

	Tumor regression
Choroidal Hemangioma	97%
OSSN	82%
RB	67%
Uveal melanoma	92%



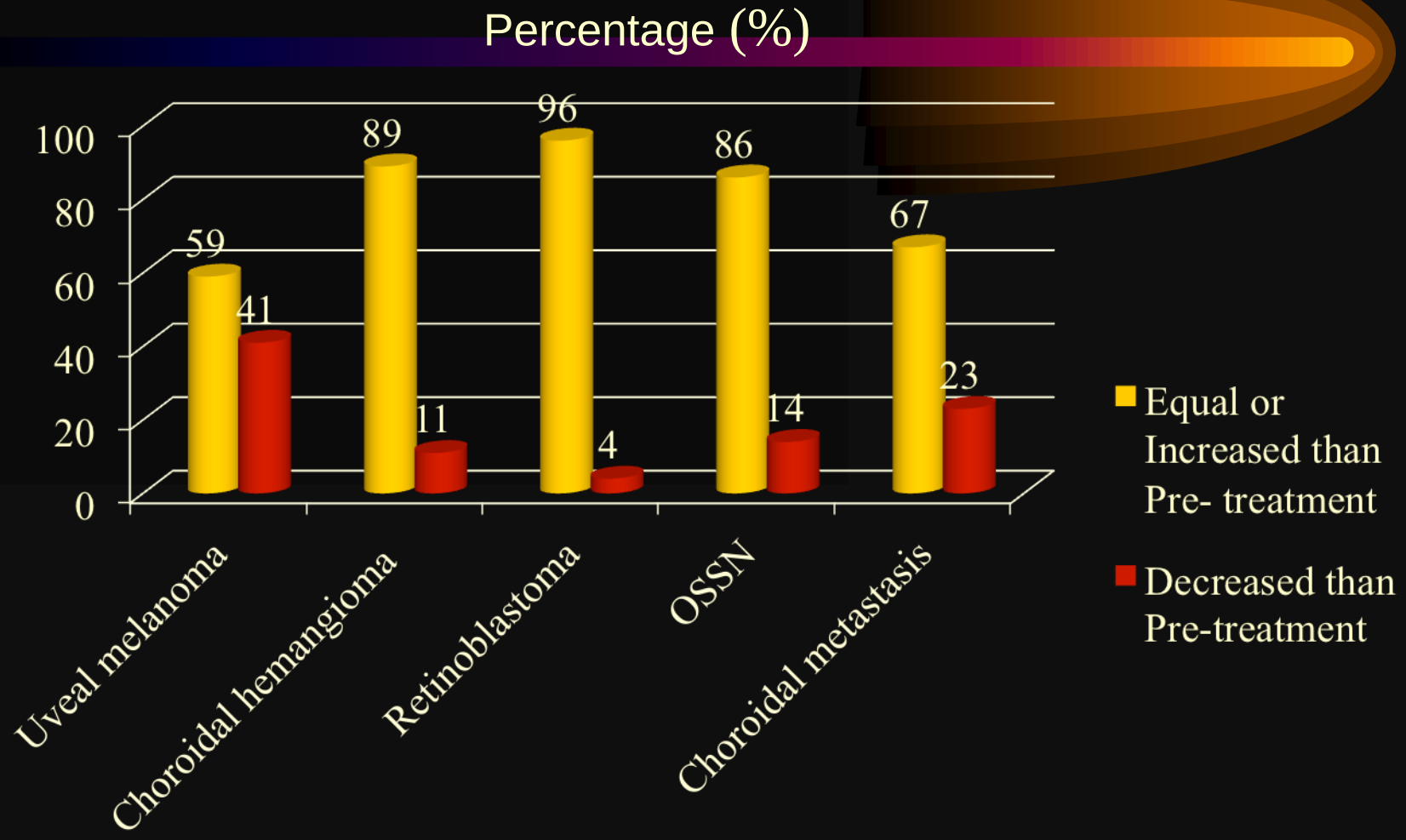


Results : Eye Salvage



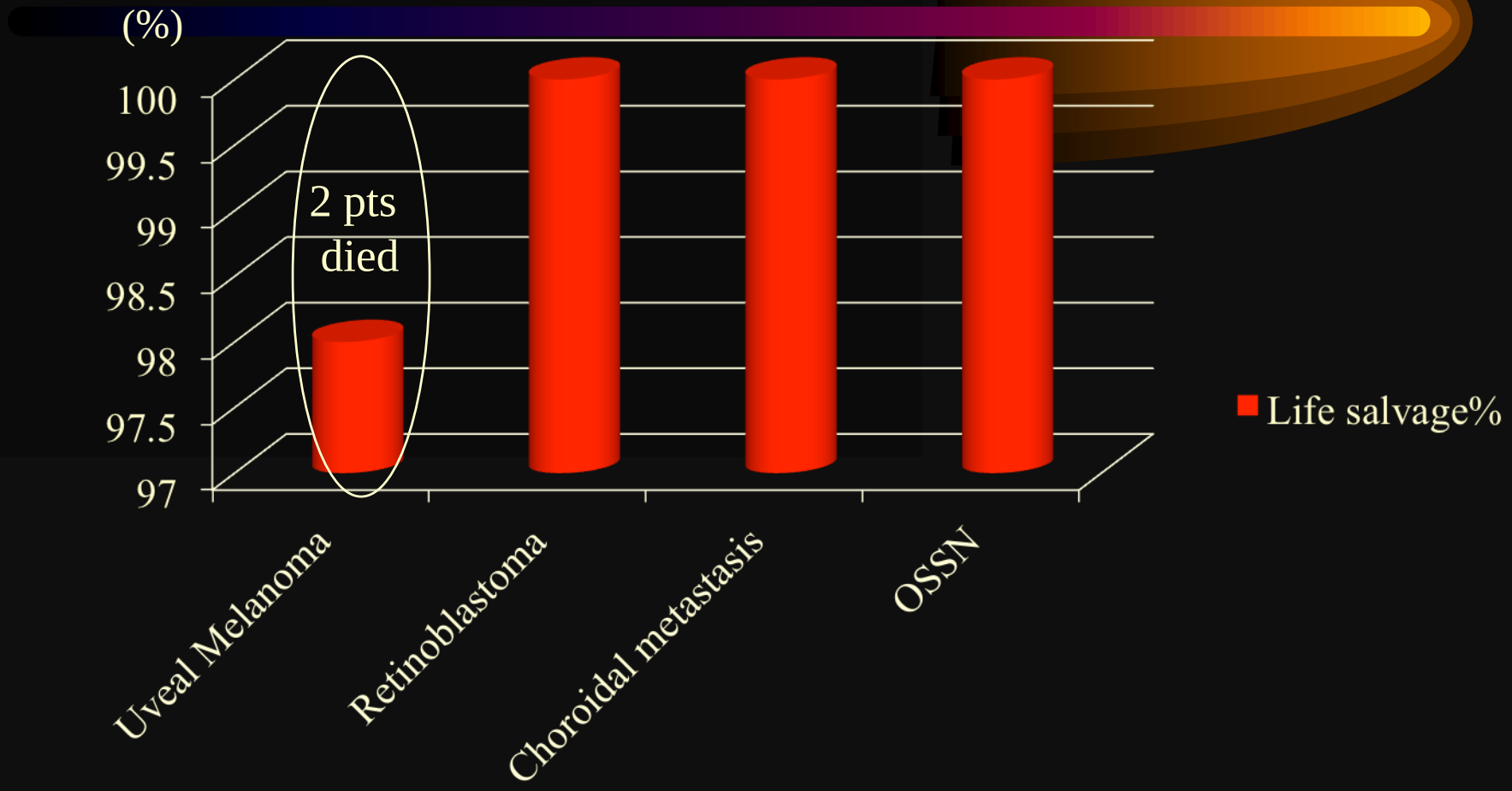
VijayAnand

Vision salvage



VijayAnand

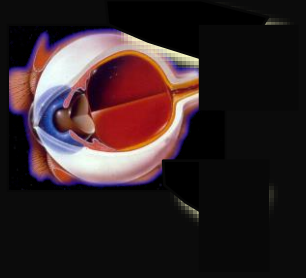
Life salvage



Note: Death in 2 cases of uveal melanoma

Complications

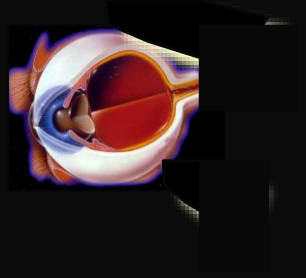
Diagnosis	Cataract	Vitreous Hemorrhage	Radiation retinopathy
Choroidal melanoma (n=82)	3 (4%)	3 (4%)	3 (4%)
Choroidal hemangioma (n=58)	-	-	1 (2%)
Retinoblastoma (n=30)	-	1 (3%)	-
OSSN & Conjunctival melanoma (n=38)	-	-	-



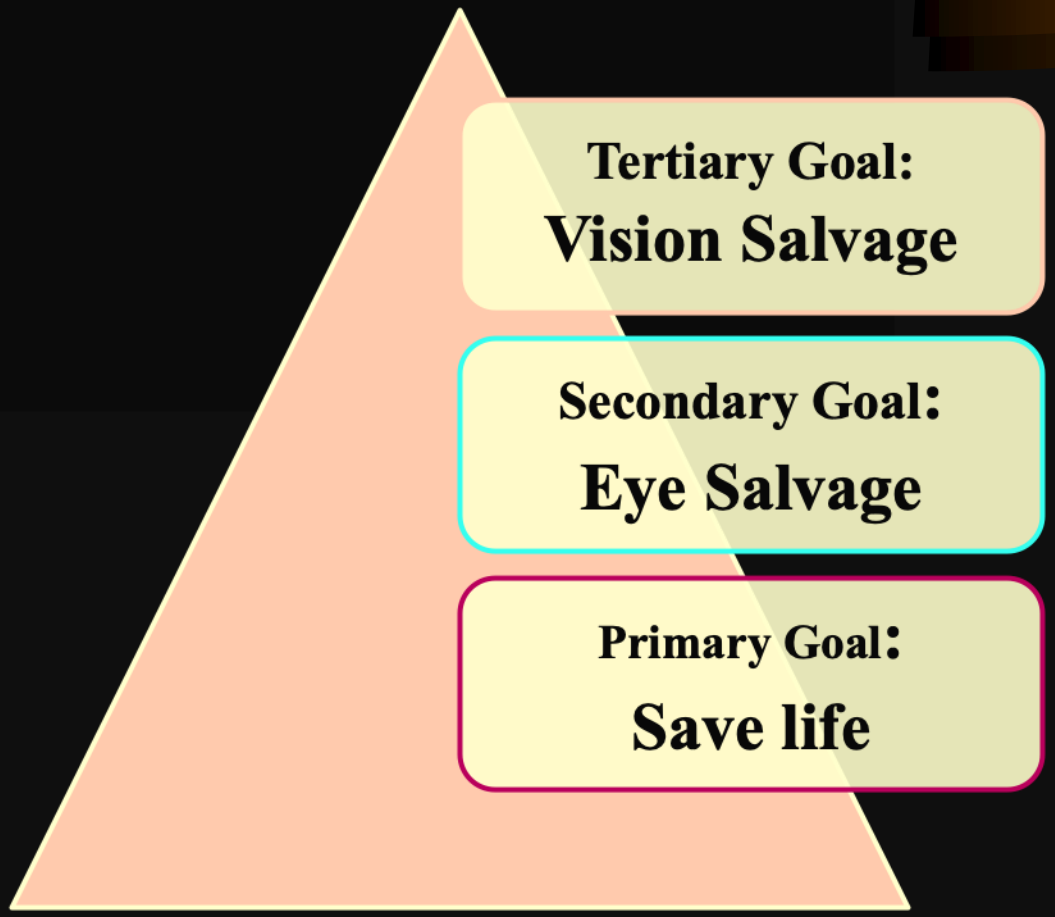
Interdependance

Radiation dose ←→ Complications

Tumor diameter — **Tumor height**



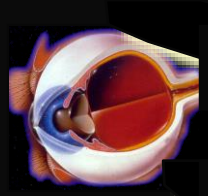
Goals achieved



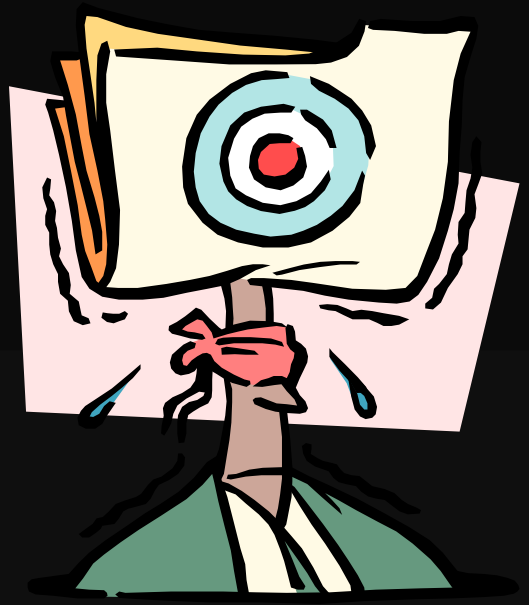
56.42%

80%

100%

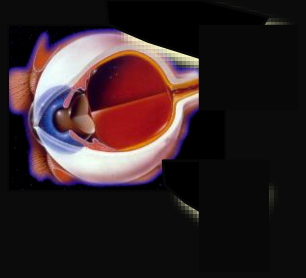


Plaque Brachy - Conclusions



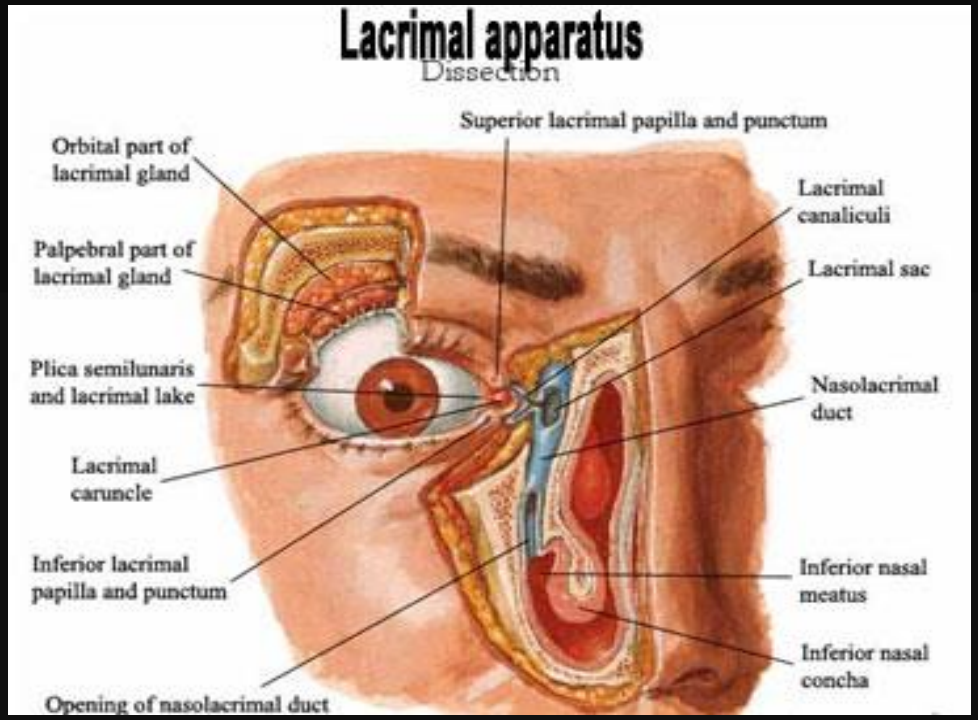
- Promising treatment option
- Good eye salvage
- Good vision salvage
- Complications low (dose dependent)

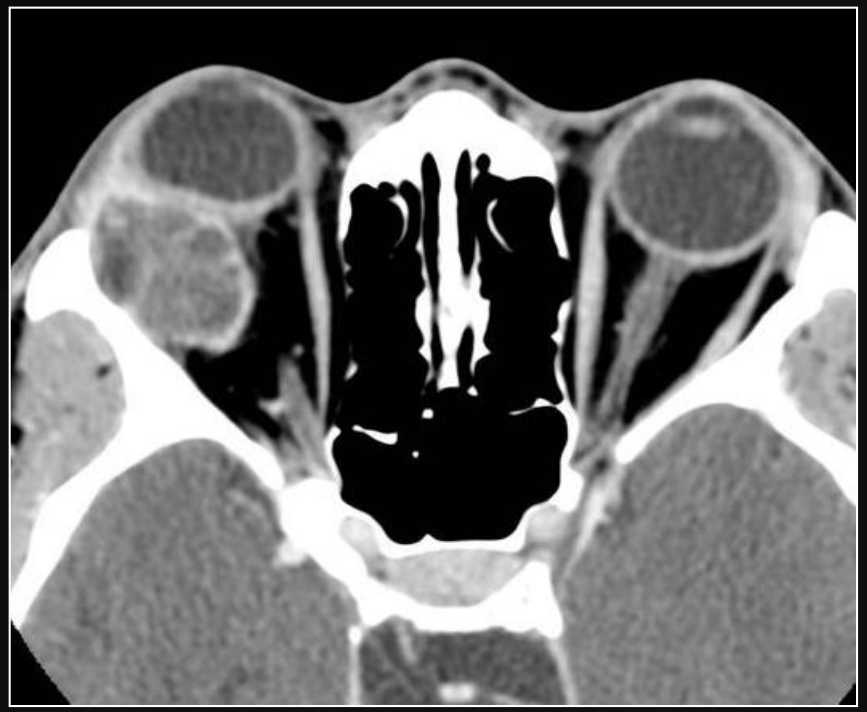
Interstitial Brachytherapy



Interstitial Brachytherapy

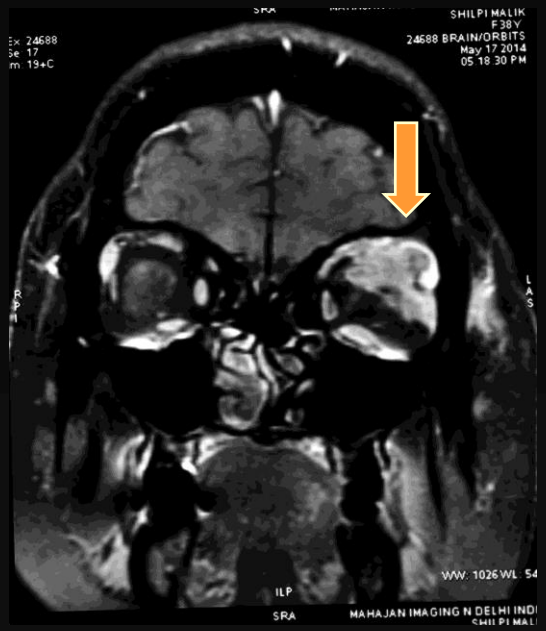
Ca Lacrimal Gland





VijayAnand

Lacrymal Gland Carcinoma



- Adenoid Cystic Carcinoma, Adeno ca
- Early invasion of adj. Structures
- Inability to excise completely
- Routine post-op Radiotherapy +/- Chemo
- Locally advanced – Neoadj chemo

Highly curable disease if properly managed !

VijayAnand

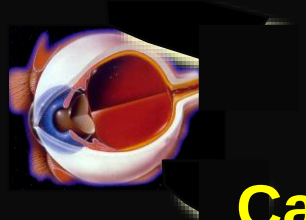
Ca. Lacrimal Gland, 12 yrs old

Surgery & post op Radiotherapy

6 mo later

8 yrs later

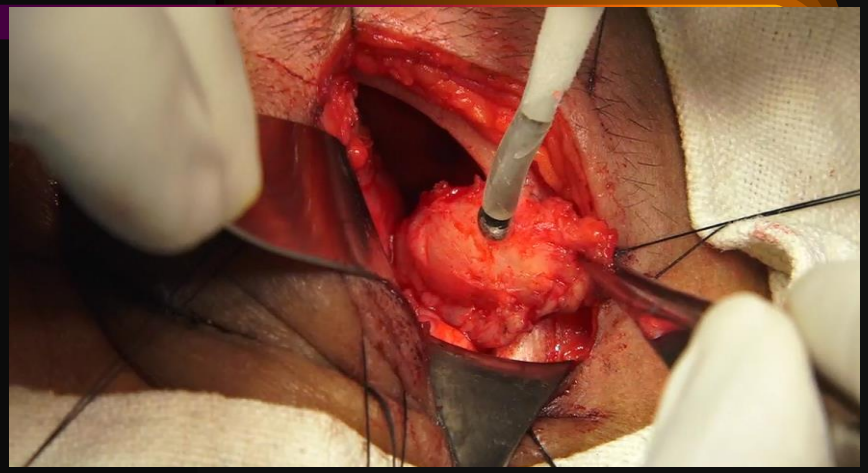
VijayAnand

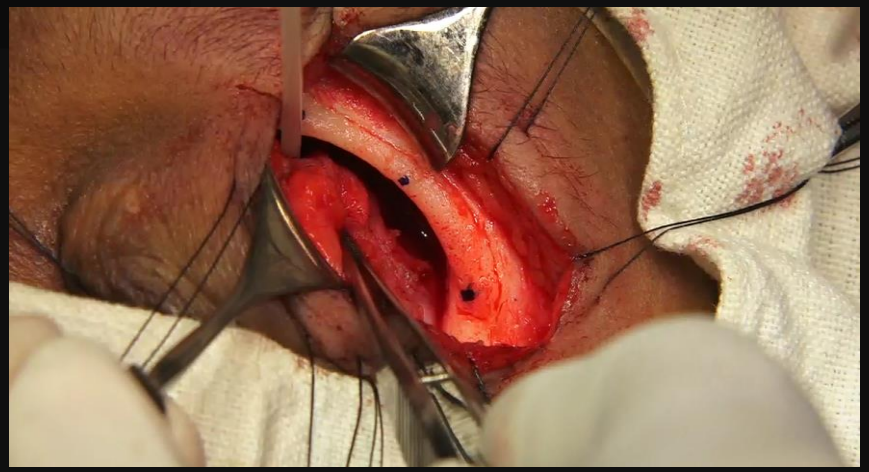


Ca Lacrimal Gland

Residual after CHEMO RT

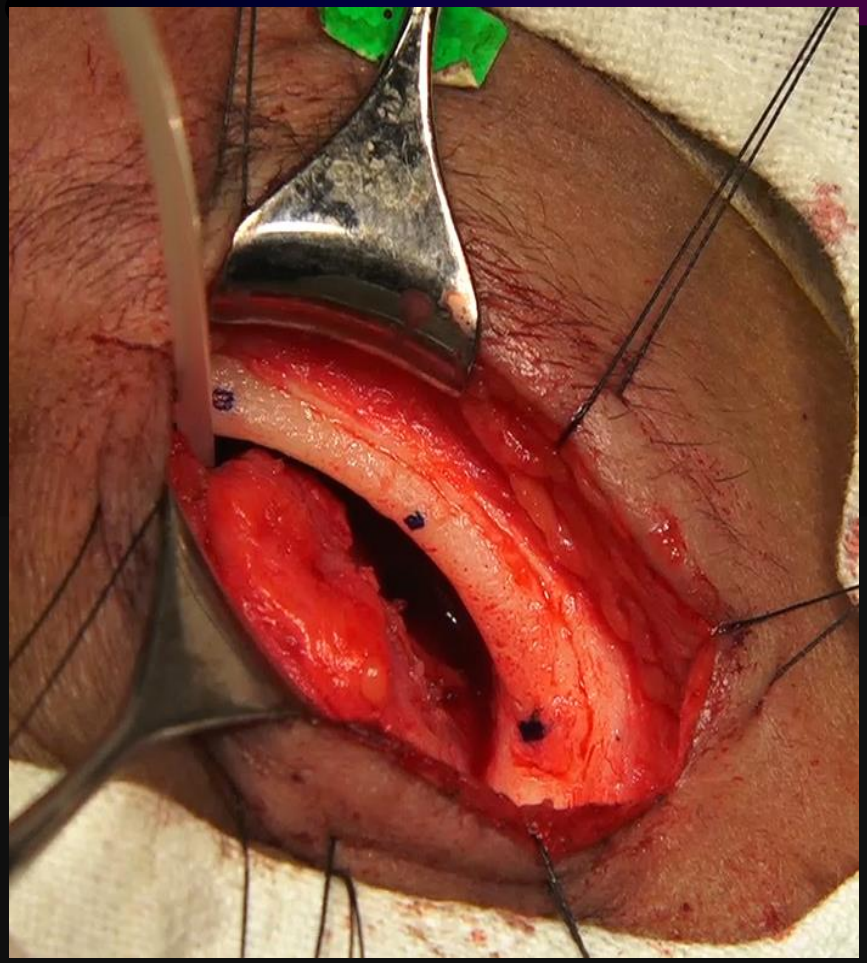
Residual after chemo RT– Ca Lacrimal gland





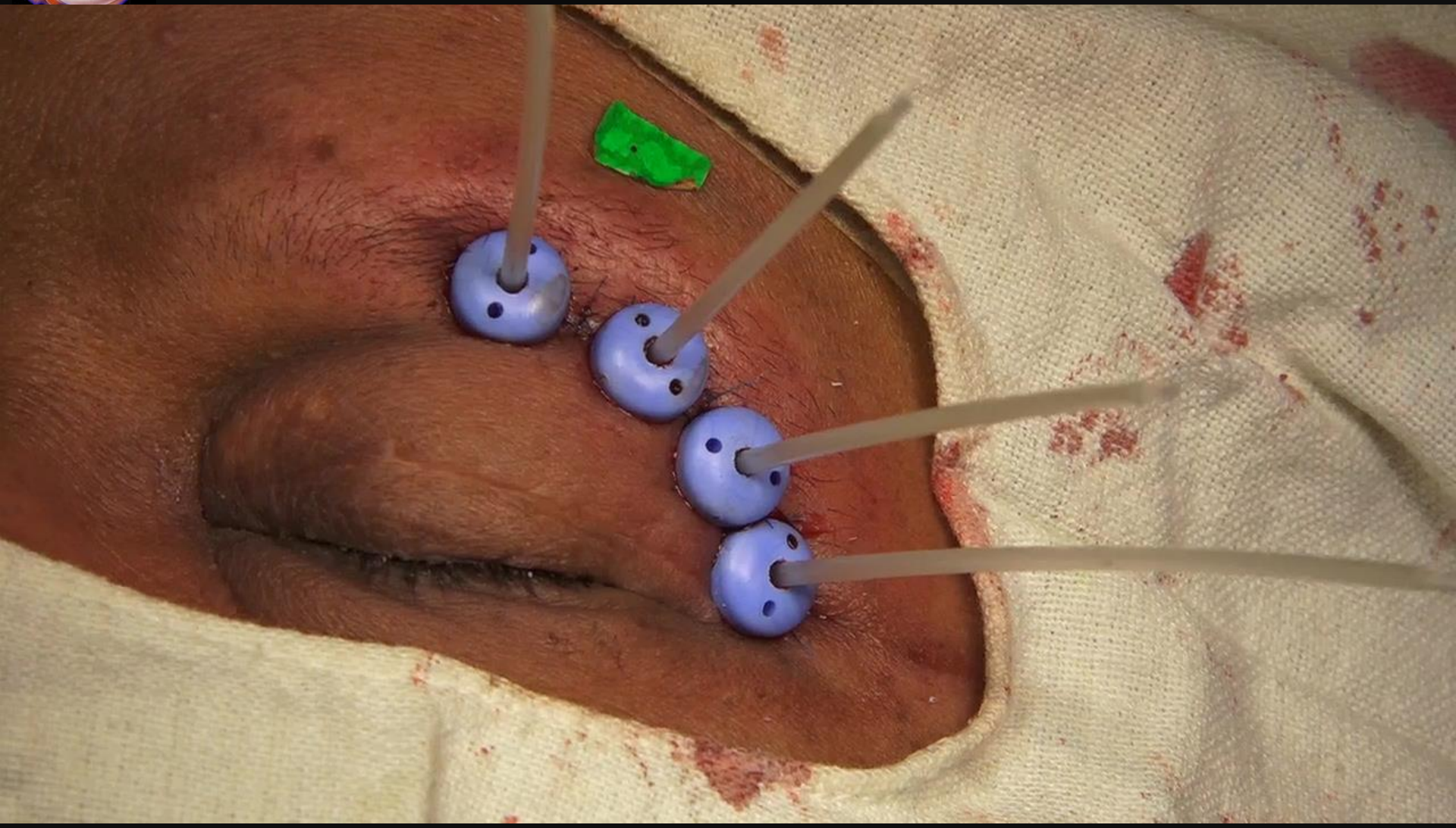
VijayAnand

Residual after primary treatment….



Interstitial implant Boost

VijayAnand

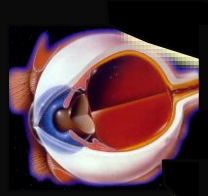


Residual lesion – Ca Lacrimal Gland

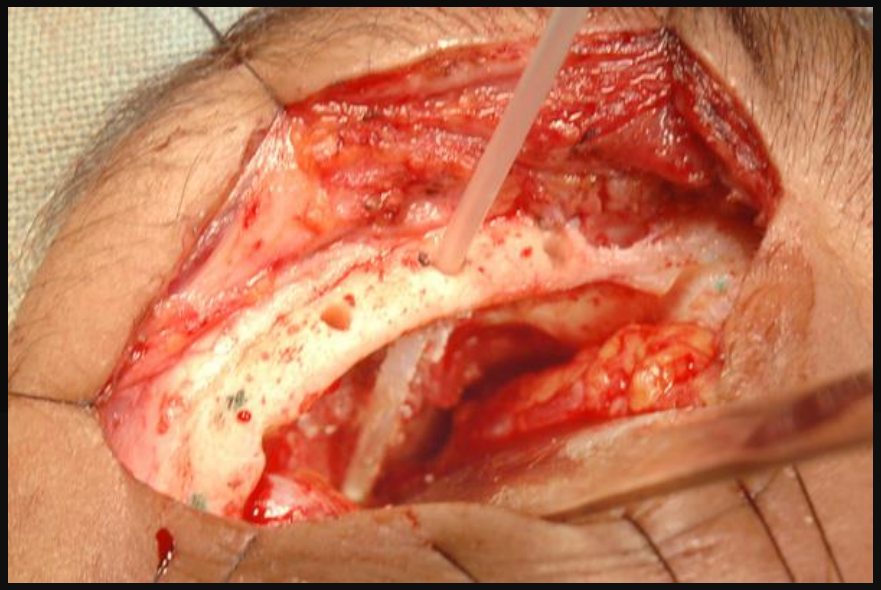
VijayAnand

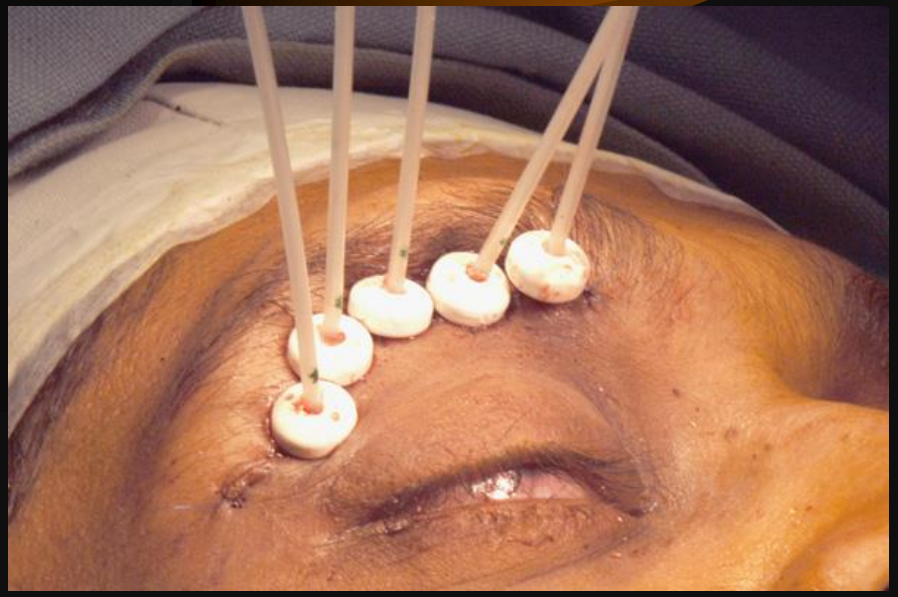
Recurrent after Surgery & RT

VijayAnand



Recurrent Lacrimal gland ca





Interstitial Brachytherapy

VijayAnand

Interstitial Brachytherapy

Rec lacrimal gland ca

VijayAnand

Interstitial Brachytherapy

After loading technique – safe to the personal

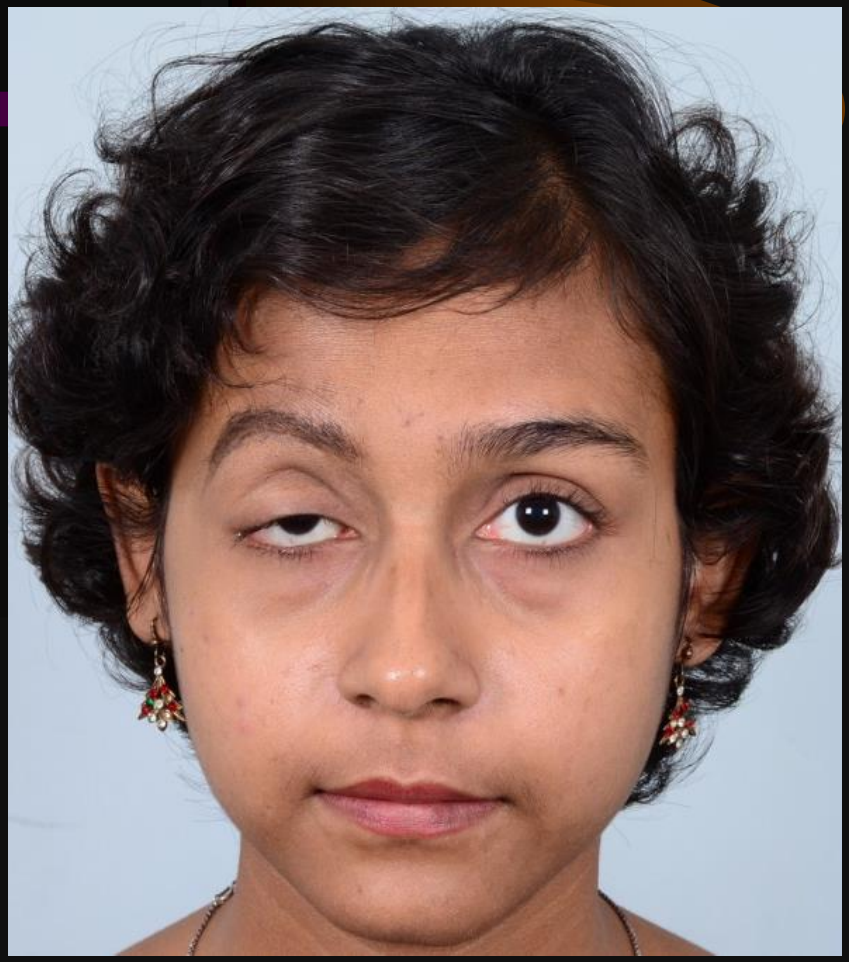
VijayAnand

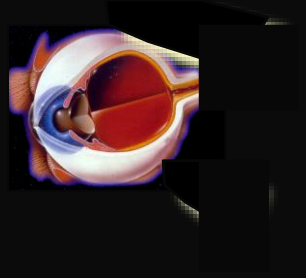
Rec Lacrimal gland ca

Interstitial Brachytherapy

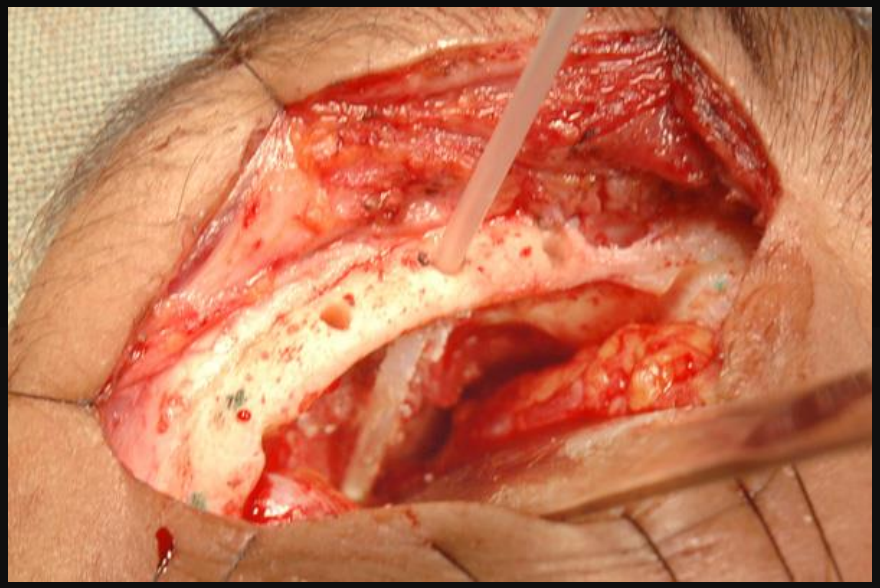
VijayAnand

Recurrent Lacrimal gland Ca





Ca Lacrymal Gland
Interstitial Brachytherapy



VijayAnand

Recurrent Ca Lacrimal gland

Re-operated. Re-irradiated . Disease free 2.5 yrs

VijayAnand

Recurrent Ca Lacrimal gland

All cheeeeeeeers !!

VijayAnand

Team Work…

…improves cure rates

Together we achieve more..!

- Ocular oncology
  - Oculoplasty surgeon
  - Radiation Oncologist

VijayAnand


Thank You
Brachytherapy
The best conformity
Dr P Vijay Anand Reddy