Plaque Brachytherapy
Indications and Outcome in Ocular Tumors

Dr P Vijay Anand Reddy
Management of Eye tumors

Surgery: Enucleation / Exenteration

Advantage
- Tumor is completely eliminated

Disadvantage
- Loss of Vision
- Loss of globe
...the Goal
Cancer Management
Not just the survival...

Organ & Function
Preservation
E Y E S make World Beautiful
The Goal... ophthalmic tumors

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

Radiation can achieve this!!
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
Ocular Brachytherapy sources

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

<table>
<thead>
<tr>
<th>Gamma rays</th>
<th>Beta rays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Half life 60 days</td>
<td>One year</td>
</tr>
<tr>
<td>✓ Customized</td>
<td>Uniform (Round, notched)</td>
</tr>
<tr>
<td>Needs protection</td>
<td>✓ Hardly any</td>
</tr>
<tr>
<td>Recurrent maintenance</td>
<td>✓ Least – Once in 2yrs</td>
</tr>
</tbody>
</table>
Plaque Brachytherapy

Ruthenium 106
Eckert & Ziegler BEBIG

Notch plaque
Notch plaque
Round plaque

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Development of Ru-106 Plaque for Treatment of Eye Cancer
Ru-106 Plaque by BARC

Affordable Eye Cancer Treatment in India

11 lakhs vs 50 thousands
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.
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!
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

- Ru 106 plaque
- 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
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
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
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 > 4-10 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
NEW International Staging System

- **Stage 0**  No enucleation – Intraocular 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

Intraocular Retinoblastoma
Treatment Options

Early
Grp I, II
Grp A, B
- 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
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
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
Retinal diagram

Size 9.4 x 8 x 5 mm

Date: 19/9/02
Number: P266185
Name: Jeeran Prakash
Signature: Dr. Milind
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 Calculation
Plaque placement
Dosimetry
Dose distribution

Dose rate 60 – 200 cGy / hr
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

Pre treatment

Post treatment

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
Ru 106 Plaque - Outcomes

Brachytherapy in Ocular Tumors
Our experience - 232 cases
## Radiation dose

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean dose</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uveal Melanoma</td>
<td>9643 cGy</td>
<td>(8726 – 15194 cGy)</td>
</tr>
<tr>
<td>Choroidal Hemangioma</td>
<td>3555 cGy</td>
<td>(2496 - 5018 cGy)</td>
</tr>
<tr>
<td>Retinoblastoma</td>
<td>4730 cGy</td>
<td>(3955 - 7568 cGy)</td>
</tr>
<tr>
<td>OSSN</td>
<td>5611 cGy</td>
<td>(4896-6736 cGy)</td>
</tr>
</tbody>
</table>
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
Type of Plaque
(n=232)

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# Results: Tumor regression

<table>
<thead>
<tr>
<th>Tumor Type</th>
<th>Tumor Regression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choroidal Hemangioma</td>
<td>97%</td>
</tr>
<tr>
<td>OSSN</td>
<td>82%</td>
</tr>
<tr>
<td>RB</td>
<td>67%</td>
</tr>
<tr>
<td>Uveal melanoma</td>
<td>92%</td>
</tr>
</tbody>
</table>
Results: Eye Salvage

- Uveal melanoma: 92%
- Retinoblastoma: 67%
- OSSN: 82%
- Choroidal metastasis: 100%
Vision salvage

Percentage (%)

- Uveal melanoma: 59%
- Choroidal hemangioma: 41%
- Retinoblastoma: 11%
- OSSN: 4%
- Choroidal metastasis: 23%

Yellow bars represent equal or increased than pre-treatment.
Red bars represent decreased than pre-treatment.

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Life salvage

Note: Death in 2 cases of uveal melanoma
## Complications

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Cataract</th>
<th>Vitreous Hemorrhage</th>
<th>Radiation retinopathy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choroidal melanoma (n=82)</td>
<td>3 (4%)</td>
<td>3 (4%)</td>
<td>3 (4%)</td>
</tr>
<tr>
<td>Choroidal hemangioma (n=58)</td>
<td>-</td>
<td>-</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>Retinoblastoma (n=30)</td>
<td>-</td>
<td>1 (3%)</td>
<td>-</td>
</tr>
<tr>
<td>OSSN &amp; Conjunctival melanoma (n=38)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Interdependance

Radiation dose ↔ Complications

Tumor diameter ↔ Tumor height
Goals achieved

Primary Goal: Save life 100%

Secondary Goal: Eye Salvage 80%

Tertiary Goal: Vision Salvage 56.42%
Plaque Brachy - Conclusions

- Promising treatment option
- Good eye salvage
- Good vision salvage
- Complications low (dose dependent)
Interstitial Brachytherapy
Interstitial Brachytherapy
Ca Lacrimal Gland
Lacrimal 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!
Ca. Lacrimal Gland, 12 yrs old

Surgery & post op Radiotherapy

6 mo later

8 yrs later
Ca Lacrimal Gland
Residual after CHEMO RT
Residual after chemo RT – Ca Lacrimal gland
Residual after primary treatment....

Interstitial implant Boost
Residual lesion – Ca Lacrimal Gland
Recurrent after Surgery & RT
Recurrent Lacrimal gland cancer

Interstitial Brachytherapy
Interstitial Brachytherapy

Rec lacrimal gland ca
Interstitial Brachytherapy

After loading technique – safe to the personal

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Rec Lacrimal gland ca

Interstitial Brachytherapy
Recurrent Lacrimal gland Ca

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Ca Lacrymal Gland
Interstitial Brachytherapy
Recurrent Ca Lacrimal gland

Re-operated. Re-irradiated. Disease free 2.5 yrs
Recurrent Ca Lacrimal gland

All cheeeeeeereers !!
Team Work...  

...improves cure rates

Ocular oncology
- Oculoplasty surgeon
- Radiation Oncologist

Together we achieve more..!
Thank You

Brachytherapy
The best conformity

Dr P Vijay Anand Reddy