Accelerated Partial Breast Irradiation (APBI)

Dr. G.K Maheshwari
MD,DNB
Professor , Dept of Radiotherapy
The Gujarat cancer & Research Institute
Ahmedabad

APBI

- Concept of APBI
- When to use it
- The different Options
- Advantages of APBI
- Contraindications
- Results

Concept of APBI

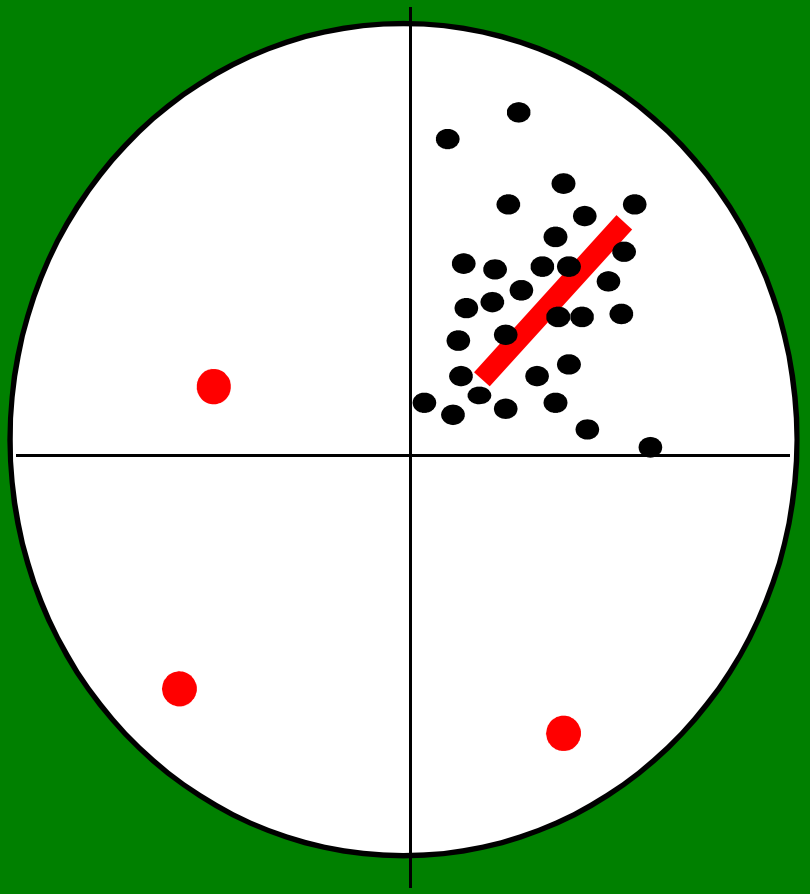
- Post BCS, whole breast radiotherapy remains the standard practice since 1990
- Purpose of WBRT:

  To eliminate the residual foci of tumour in and around the tumour bed and rest of the breast.

Why partial breast irradiation?

The vast majority of the recurrence (up to 90%) occurs in the index quadrant
Only 1% to 3% recurrence occurs in other quadrant

-- U. Veronesi (Milan III)



Treatment is focused to area of highest risk of residual occult disease/ recurrence

Accelerate Dose

- The smaller tissue volume allows larger fraction sizes and thereby shorter overall treatment time
- Hypo-fractionation schedule decrease the time period
- Radiobiological modeling predicted safety of various dose fractionation schedule

  34Gy/10 fr/5 days BD equivalent to 50 Gy

  20Gy to 22 Gy Single fraction = 55Gy to 60 Gy

Advantages of APBI

- Improved patient convenience & acceptability
- scheduling problem with systemic chemotherapy can be avoided
- Avoids the delay in Radiation treatment
- Reduced :-
  - A. Treatment time
  - B. Treatment Cost
  - C. Volume of normal tissue exposed to radiation (ribs, lung, heart)
  - D. Radiation toxicity,
- Treatment focused to area of highest risk of residual occult disease/recurrence

Inclusion criteria for APBI (ABS,ASBS,RTOG)

- Solitary breast tumour
- Invasive ductal carcinoma
- Stage TI-T2 ,No-NI
- < 3 metastatic axillary node (RTOG)
- Negative surgical margin
- No evidence of micro calcification

Exclusion criteria for APBI

- Extensive intraductal component
- Lobular carcinoma
- young patient (ABS, ASBS)

Techniques

- Invasive:

1. Interstitial Brachytherapy (IORT or PORT)
2. Mammosite
3. Intraoperative (Intrabeam) low Kv X-Rays
4. Electron Intraoperative Therapy (ELIOT)

- Non Invasive

1. External RT (3-DCRT/ IMRT)
2. Proton Beam Therapy

Intraoperative Radiotherapy

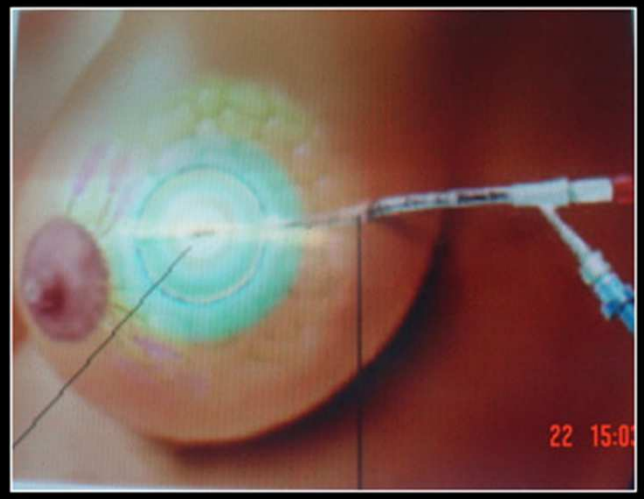
Advantage

No gap between tumour excision and PO RT so clonogenic cells don't get chance to multiply.

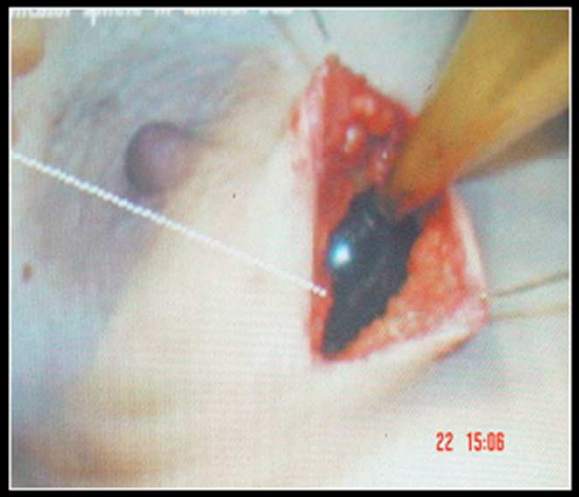
Small treatment volume

The Options for APBI

Interstitial Implant



Mammosite



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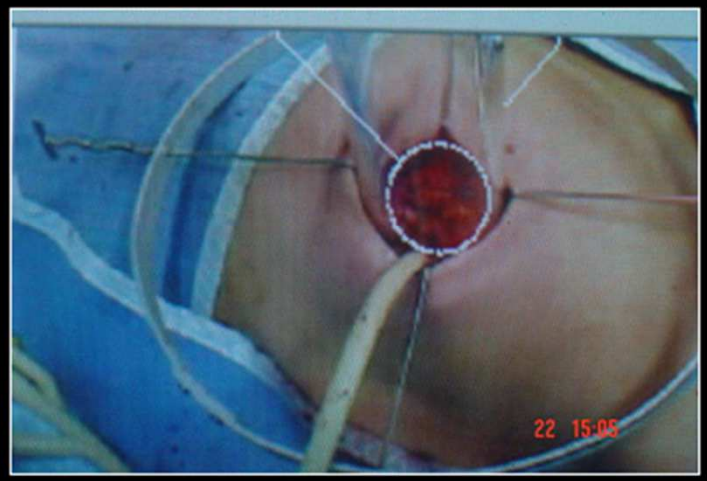
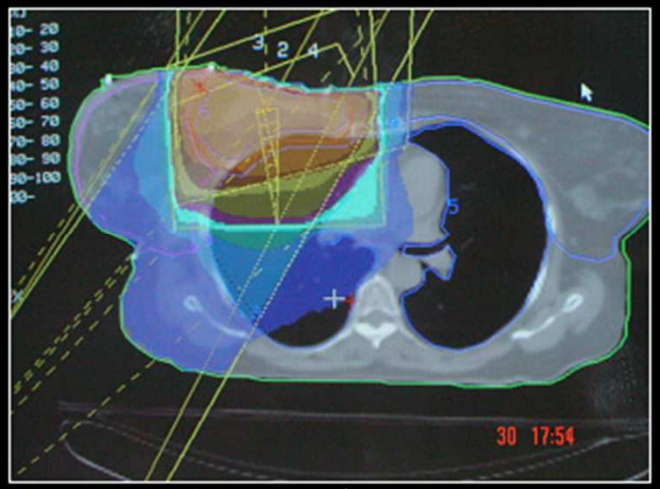


Intra op electrons [ELIOT]



3DCRT / IMRT

Interstitial Brachytherapy

- Most commonly used method of APBI .
- Started in early 1980s in England, in mid 1990s reports from US, Canada and Europe were published.
- Expertise is required
- The procedure can be done at the time of lumpectomy (Intra operative)
- Status of surgical margin and BOR may be unknown
- Post operative interstitial brachytherapy within 8 weeks of the primary surgery
- HDR and LDR

  -HDR 34 Gy/10 fractions/5 days

  - LDR 45-50 Gy/ (50 cGy/hr dose rate)

Interstitial Brachytherapy

- Method of application :

  Template guided

  or

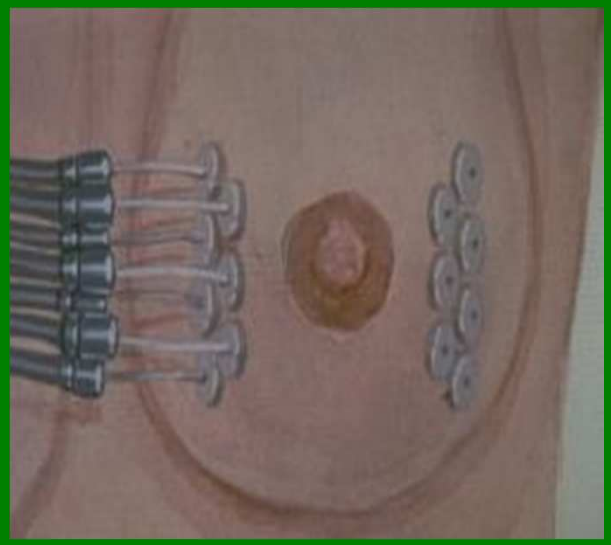
  Free hand technique.

- Single/double/three plane

- Orthogonal x-rays, CT based planning (metallic artifacts)

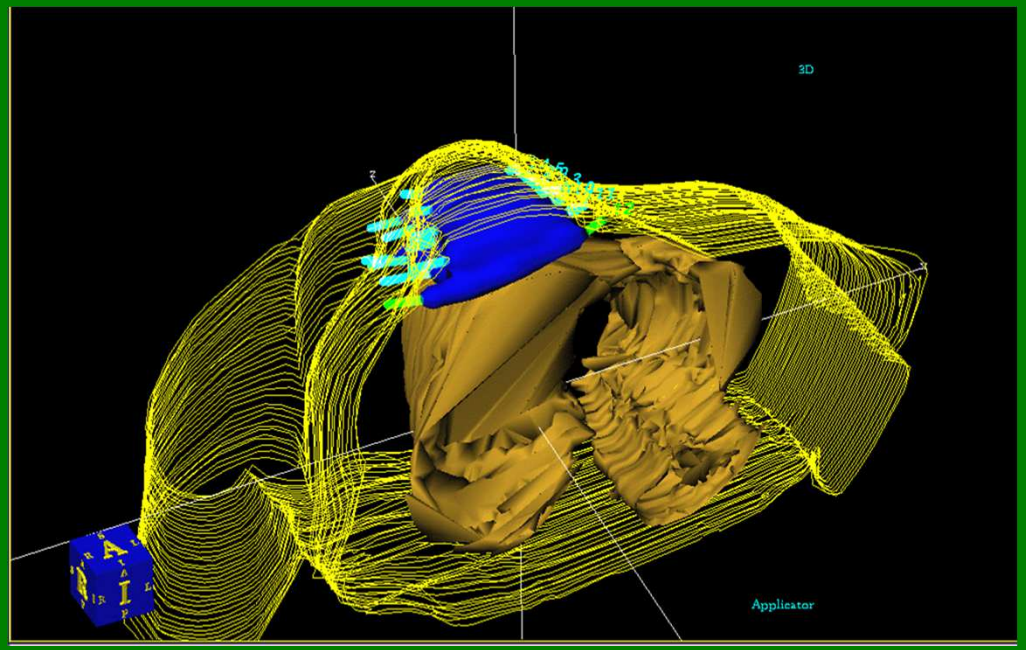
Brachytherapy with Interstitial Implant

Brachytherapy Template



Implant without Template

CT based Brachytherapy Planning



INTERSTITITAL BRACHYTHERAPY

Main drawback: Dose inhomogenity (DHI > .85)

Possible complications:

Port site infection

Abscess

Bleeding,

Tumour implantation

Fat necrosis

Breast fibrosis

RESULTS-INTERSTITITAL BRACHYTHERAPY

Local control (>90%)
Good /excellent cosmesis (>90%)

LDR: Lawdenga et al;
IJRBP 2003;56:671-680

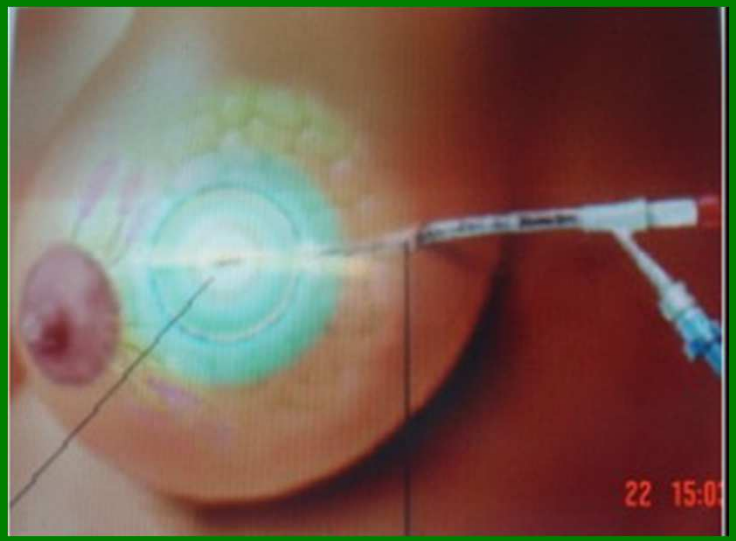
HDR : Wezer et al;
IJRBP 2002;53:889-897

HDR : Frank A vicini et al;
IJRBP 2003;56:671-680

Interstitial Brachytherapy

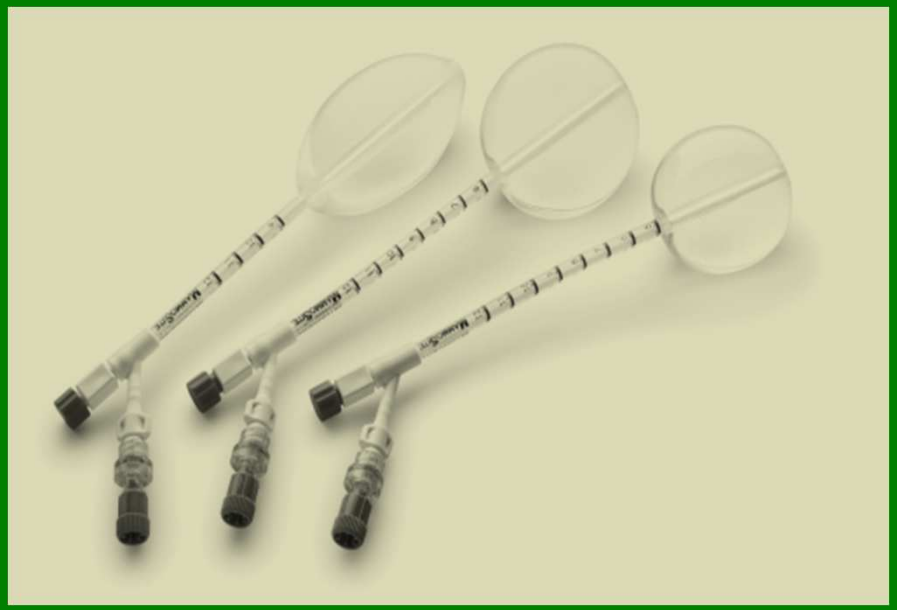
- The RTOG with NSABP in a joint phase III investigation comparing the WBI & APBI

Mammosite Brachytherapy



- Approval by the US F.D.A. in May-2002
- >4000 patients treated
- Popular method of APBI in the US

MAMMOSITE



Balloon Configuration

4 – 5 cm Sphere

5 – 6 cm Sphere

4 x 6 cm Ellipsoidal

Mammosite Radiation Therapy System

- Inflatable silicon catheter
- Contains an inflation channel and a port for radiation source.
- Closed-ended applicator which accommodates balloon inflation and radiation source placement
- Various balloon shapes/sizes offer ability to implant a wide range of cavity shapes/volumes
- Balloon is Implanted directly into surgical cavity
- The balloon is inflated by saline + contrast to add to its visualization on Orthogonal x-rays /CT scan
- Single/Multiple dwell positions optimization method used for planning
- Connects to HDR machine using Ir-192.
- Dose: 3.4 Gy/fr, twice daily x 10 fr (total dose: 34 Gy) to a point 1 cm from the balloon surface .

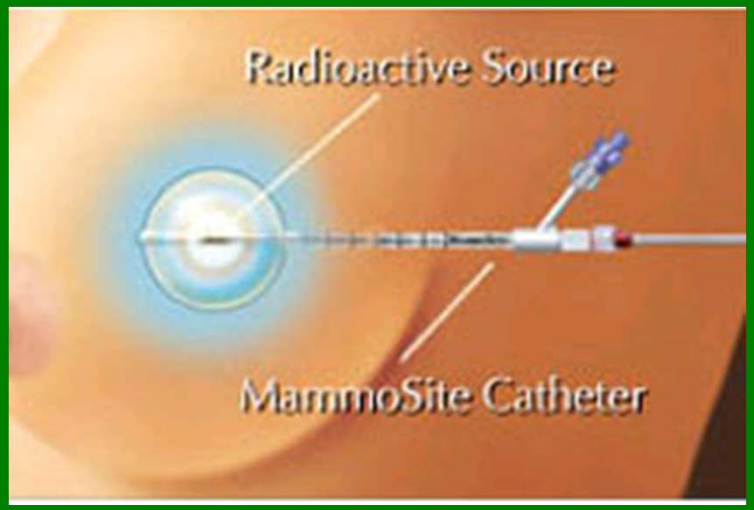
KEY CRITERIA FOR PATIENT SELECTION

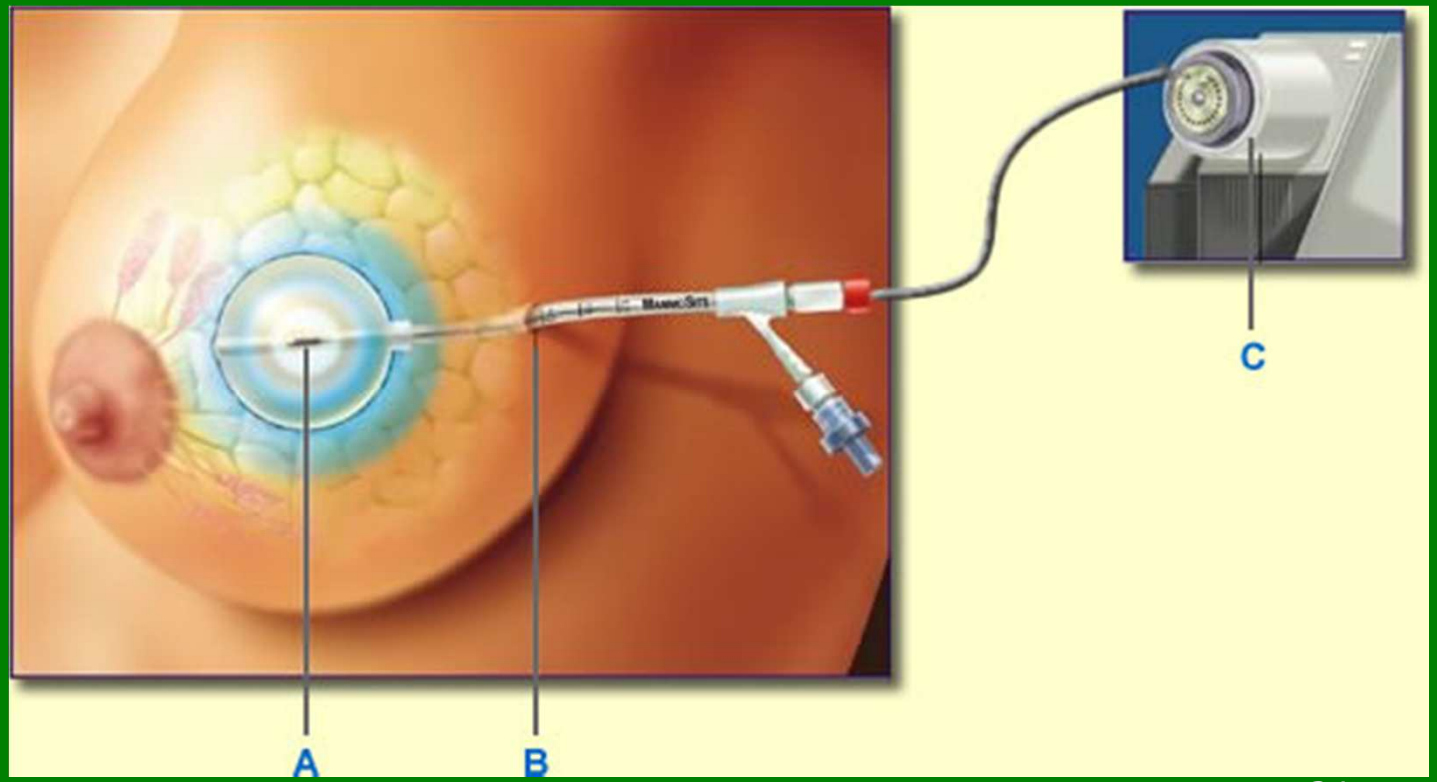
Primary group

- T1, < 2 cm, N0, M0 AJC Classification
- Be at least 45 years of age
- The edge of the post-surgical cavity must be more than 5-7mm from the skin surface
- Cavity size greater than 3cm
- Negative surgical margins

Post-Lumpectomy Mammosite Placement

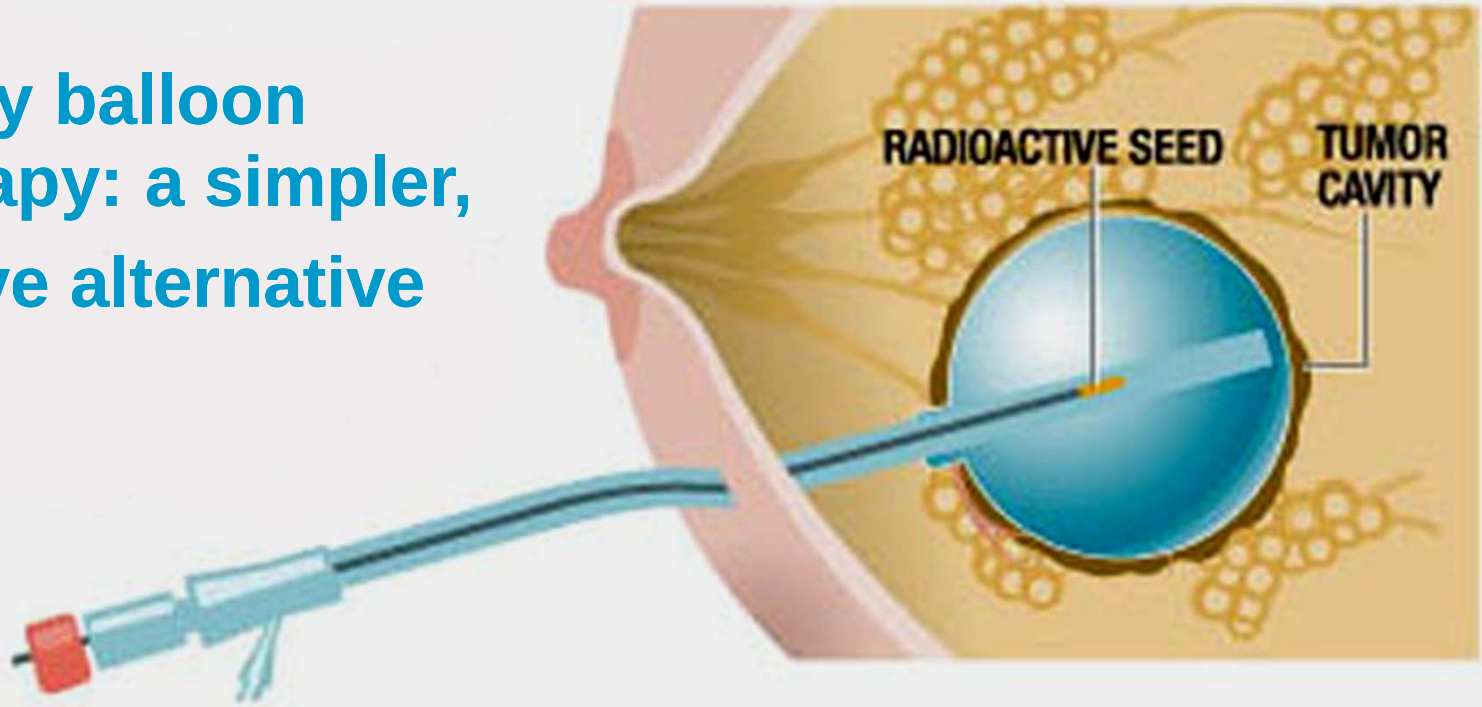
- Local anesthesia
- Confirm cavity size by ultrasound
- Open narrow section of lumpectomy scar - expand opening and track as needed
- Drain seroma from cavity
- Insert MammoSite catheter


Radioactive Source
MammoSite Catheter

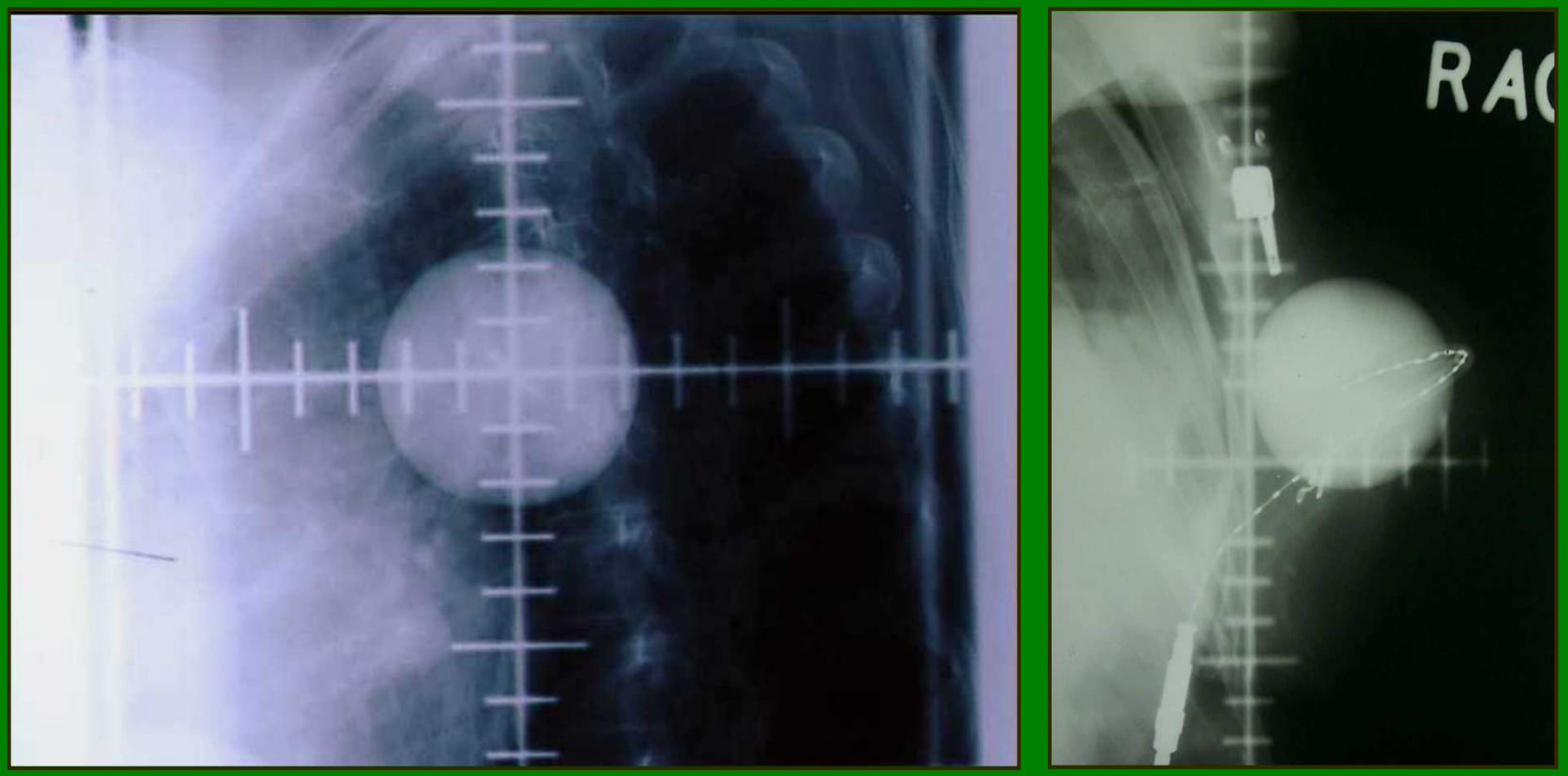

A
B
C

MammoSite

Intracavitary balloon brachytherapy: a simpler, less invasive alternative

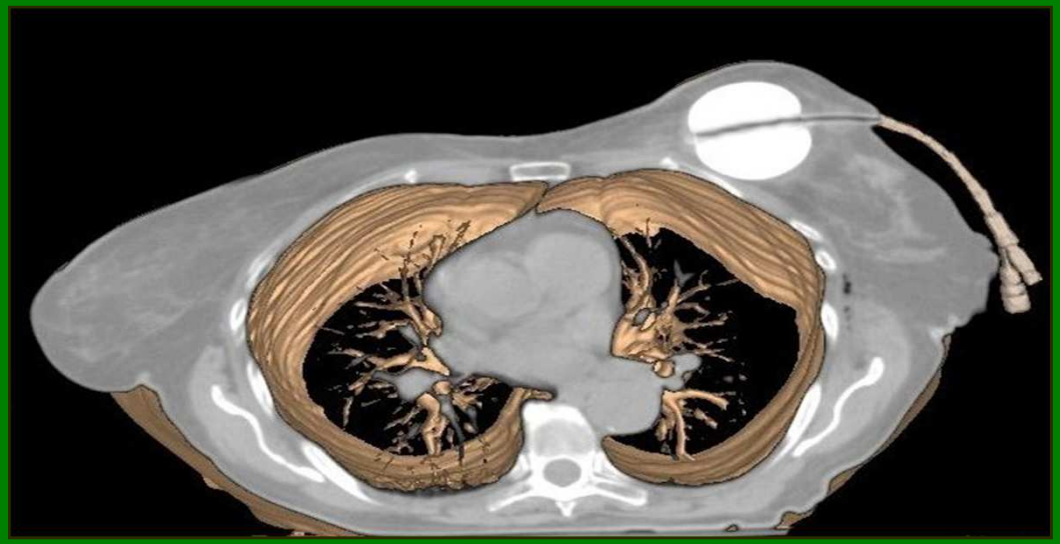


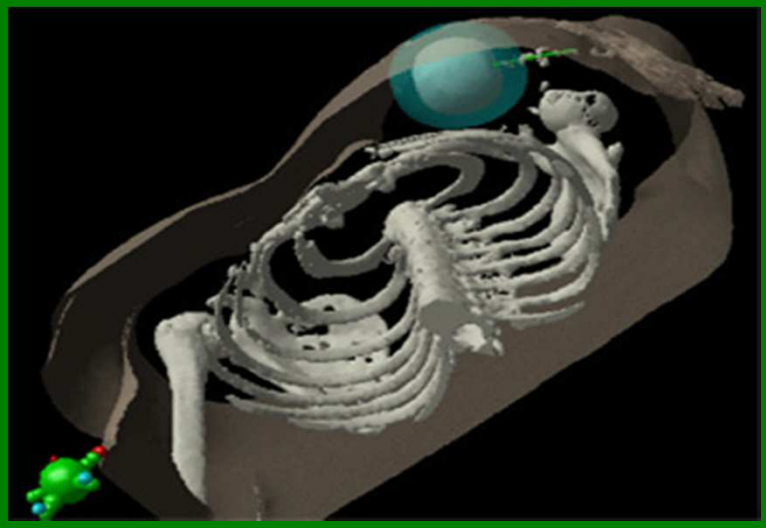
Orthogonal X-Rays

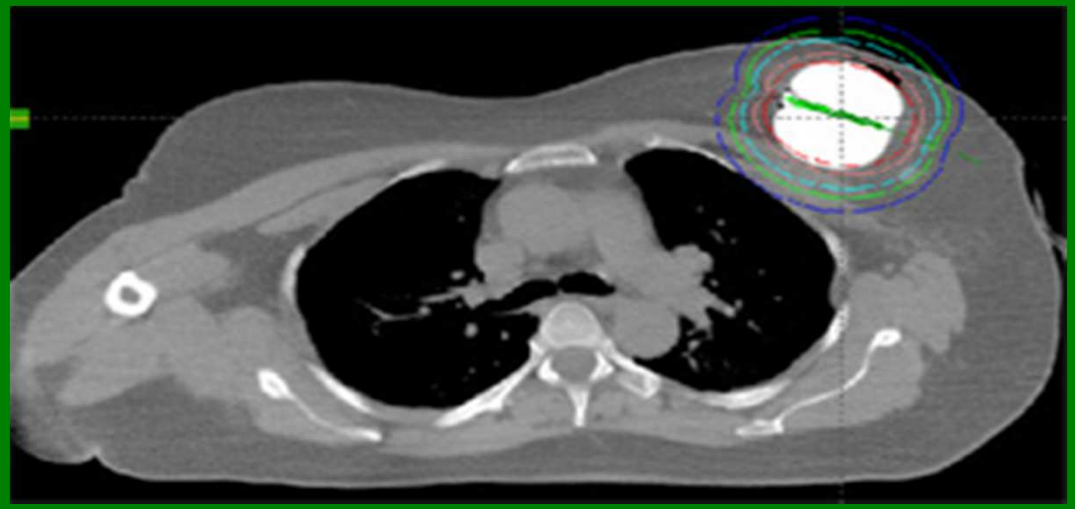


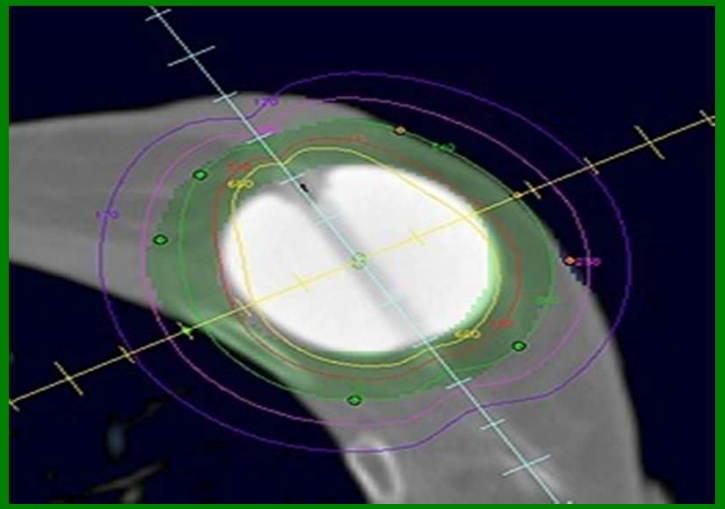
Orthogonal x-ray films obtained in the simulator room prior to patient treatment.

CT Image of MammoSite









3-Dimensional rendering of applicator surface

MammoSite Implant Placement

HDR radiation treatment

MammoSite Removal

RESULTS OF MAMMOSITE

1. Patterns of Failure after MammoSite Brachytherapy Partial Breast Irradiation
   -Chen S et al: IJROBP 2007; 60(1): 25-31

   70 patients,
   26 months F/u (median)
   5 Treatment failures (local failure (4/70)

2. Analysis of Treatment Efficacy, Cosmesis, and Toxicity using the MammoSite Breast Brachytherapy Catheter
   Chao et al: IJROBP 69(1): 32-40,2007

   80 patients, 22 months F/u (median)
   Local recurrence =2,
   Cosmesis (Good/excellent) >90%.
   Fat necrosis 9%

Mammosite problems

1. Suboptimal conformance of surgical cavity to applicator balloon
2. Inadequate skin sparing due to poor spacing
3. Infections (16%)
4. Recurrent Seroma
5. Balloon rupture

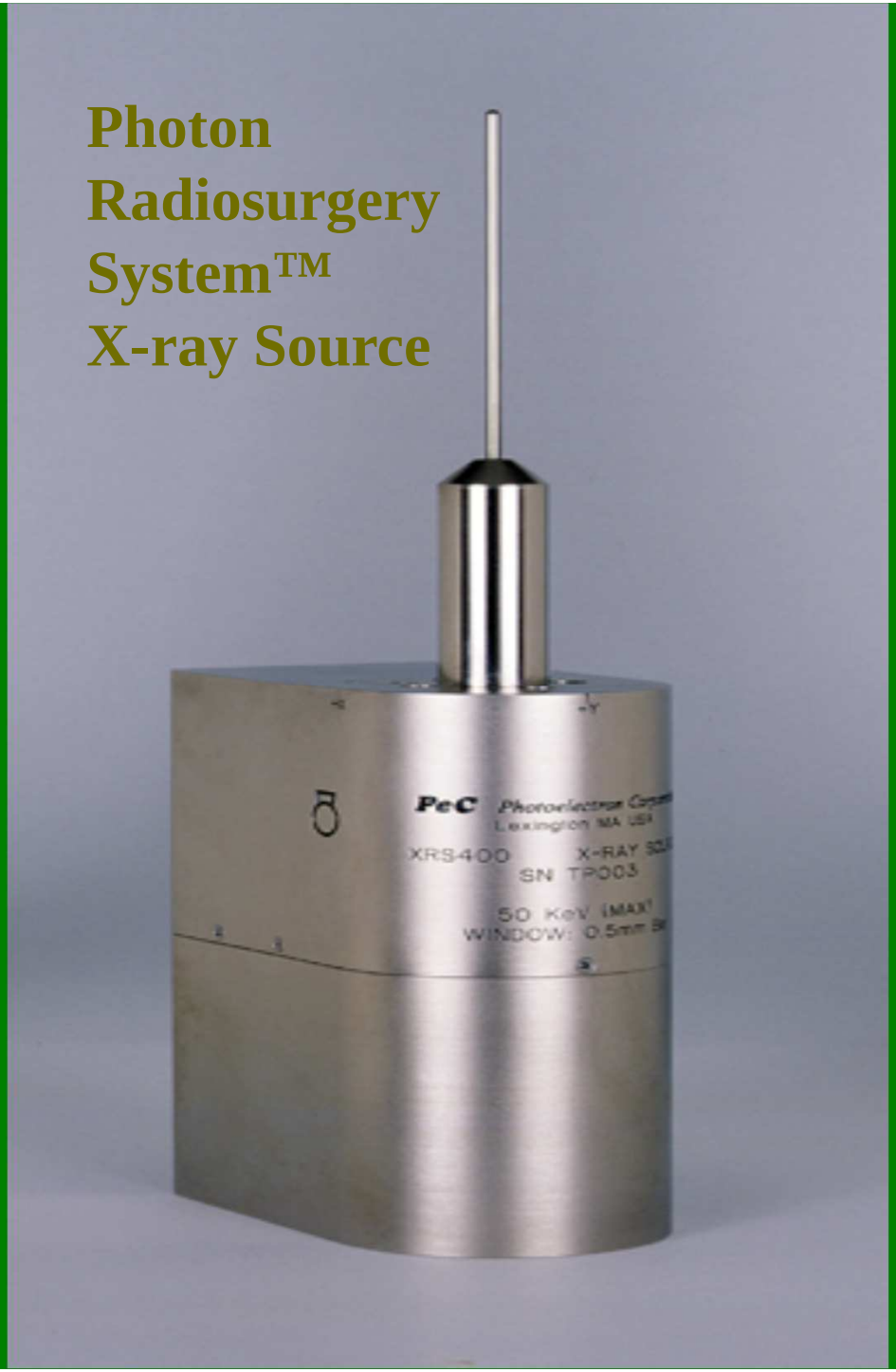
INTRABEAM

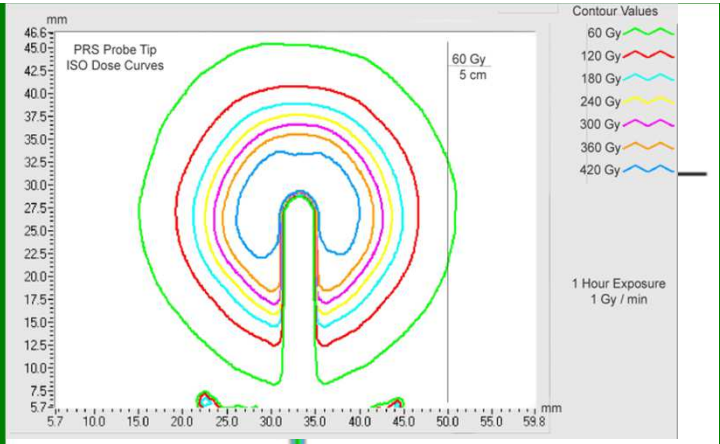
- First device to be used for IORT.
- X-ray up to 50 Kv (Weight of machine: 1.8 kg)
- Gold target, 10 cm long tube , Diameter 3 mm
- Various sizes (1.5 cm to 5 cm in dia.) of spherical applicators to suit the size of the lumpectomy cavity
- Dose rate depends upon applicator size and energy of the beam.
- Dose: 20 Gy at the surface of applicator.
- Treatment time: 20 minutes
- RBE : 1.5 (Brenner and co-workers)
- Isotropic dose distribution around tip of the tube

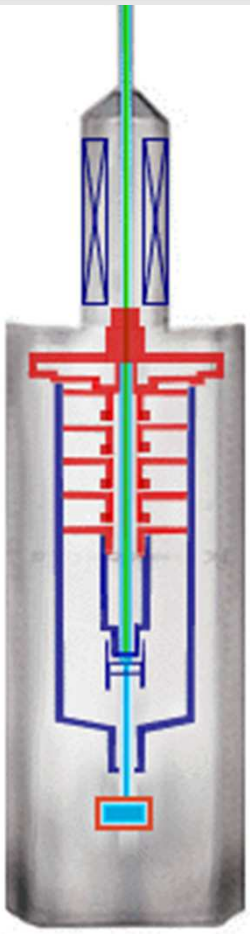

INTRABEAM™


PeC
XRS400
SN TP003
50 KeV (MAX)

Photon Radiosurgery System™ X-ray Source







Electron Accelerator

Electron Gun

The T A R G I T trial

- Targit (Targetted intra-operative RT): started in 1998
- International multicentric trial using Intrabeam x-ray unit in OT

  Vaidhya J. et al.,

  Lancet Oncology 2004;5:339-340
- Number of patients recruited: >1000
- (APBI+WBEBRT) and APBI
- Results: excellent local control
- Excellent cosmesis

I.O. Electrons L.A.

Dedicated mobile LA

Mobetron & Novac-7

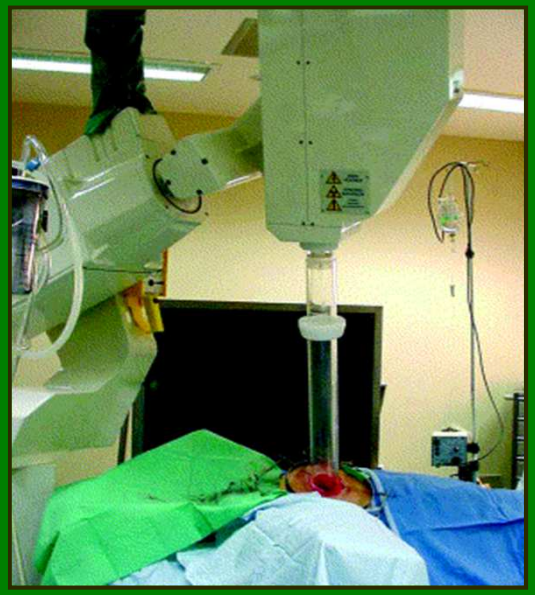
4-12 Mev Electrons are generated

No special building design needed

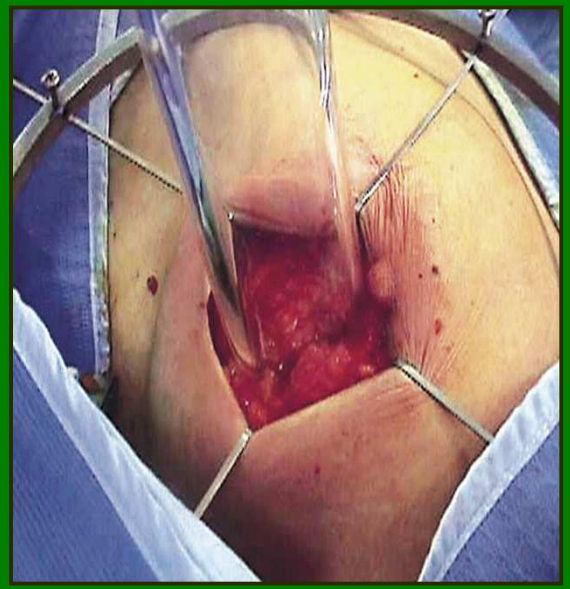
European Institute of Oncology
"ELIOT"

ELectron IntraOperative Treatment

Radiation Barrier



Linear Accelerator



Collimator

Umberto Veronesi et al.

ELIOT

- **ELIOT (Electron Intraoperative Treatment)- The Milan trial**
- **Veronesi et al., European Institute of Oncology, Milan, italy**
- **started phase III trial in 2000. EBRT v/s ELIOT**
- **Dose for IORT: 21 Gy in single fraction is equivalent to >50 Gy of conventional fractionated RT.**
- **ELIOT: 590 patients completed**
- **3% breast fibrosis reported**

External Radiotherapy for APBI (3 DCRT/IMRT)

- Many studies are ongoing
- Vicini et al. (IJRBP 2003) 3-5 non-coplanar beams IMRT

- Massachusetts Gen. Hosp. (IJRBP 2006) (3 field 3 -DCRT, 20% electrons, PTV dose: 32 Gy in 8 Fr (4Gy BD)
- Fermeni et al. (IJRBP 2004) parallel opposed mini tangents in prone position to minimize movements during breathing, exceptional sparing of heart and lung.
- Surgical clips/USG/CT guidance for target delineation
- Advantage| excellent dose homogeneity
- Disadvantage: Difficulty to visualize cavity after 8 weeks of surgery
  Immobilization may be an issue
  Intrafraction motion of target

External Radiotherapy (3DCRT/IMRT)

- RTOG criteria for target delineation
- Delineation of the cavity : GTV
- GTV + 1 cm margin: CTV
- CTV+ 1 cm margin : PTV
- PTV+ set up margin : final PTV

Proton Beam APBI

- Positively charged particles produced by cyclotron
- Advantage of Brag peak effect, high RBE of proton
- Proton beam 3-D PBRT
- Improves PTV coverage- 15% dose inhomogenity
- Non target breast tissue, lungs and heart saved
- IJRBP 2006;66(3):691-698 (Kevin Kozak et al.)
- Francis H. Burr proton therapy unit, Massachusetts General Hospital, Boston, USA
- Study period:, March 2004-June -2005, 20 pts,T1N0 prone position, multiple fields(1-3)
- PTV =Lumpectomy cavity+1.5-2.0 cm, 5mm deep to skin
- Dose: 32 Cobalt Gray Equivalent dose (CGE)
- 4 CGE twice daily x 4 days
- Adverse reaction, severe skin toxicity

Limitations of APBI studies

- Highly restrictive selection criteria
- No long term follow-up data

CONCLUSION

APBI is an emerging radiation technology challenging standard whole breast radiotherapy and may become standard of care in selected early breast cancer patients.


THANK YOU