Brachytherapy

The Dawn

SK Shrivastava et al.

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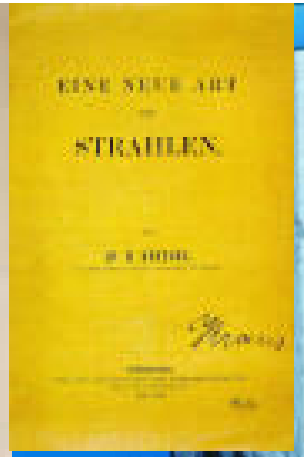
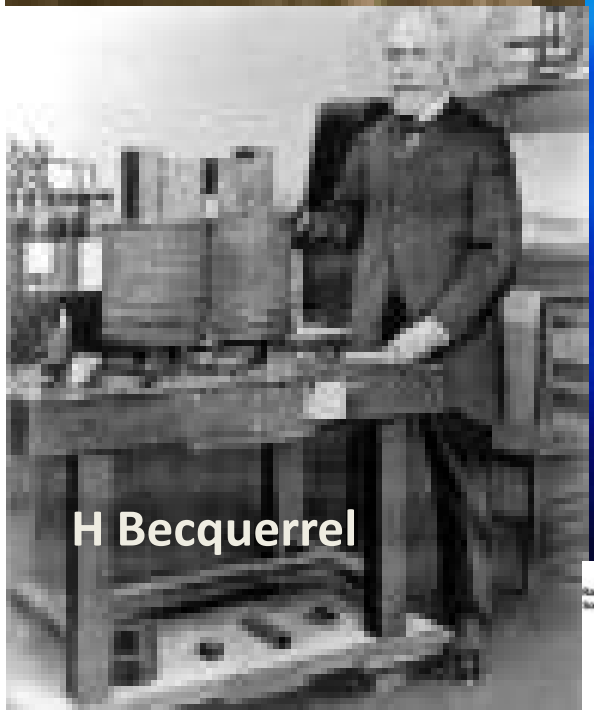
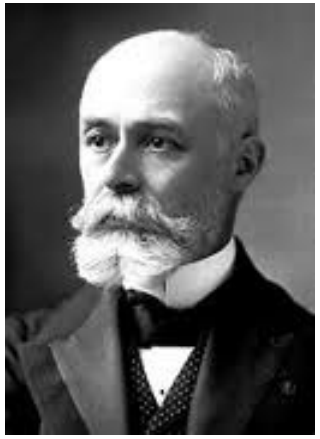
WC Roentgen





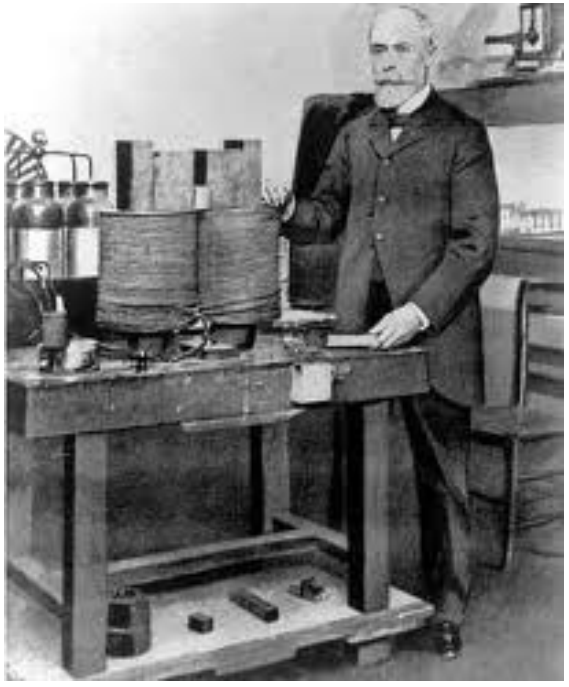
H Becquerrel

Marie and Perie Curie



1896

"Henry Becquerel, a French physicist accidently discovered radioactivity. Uranium caused black spot on photographic film"



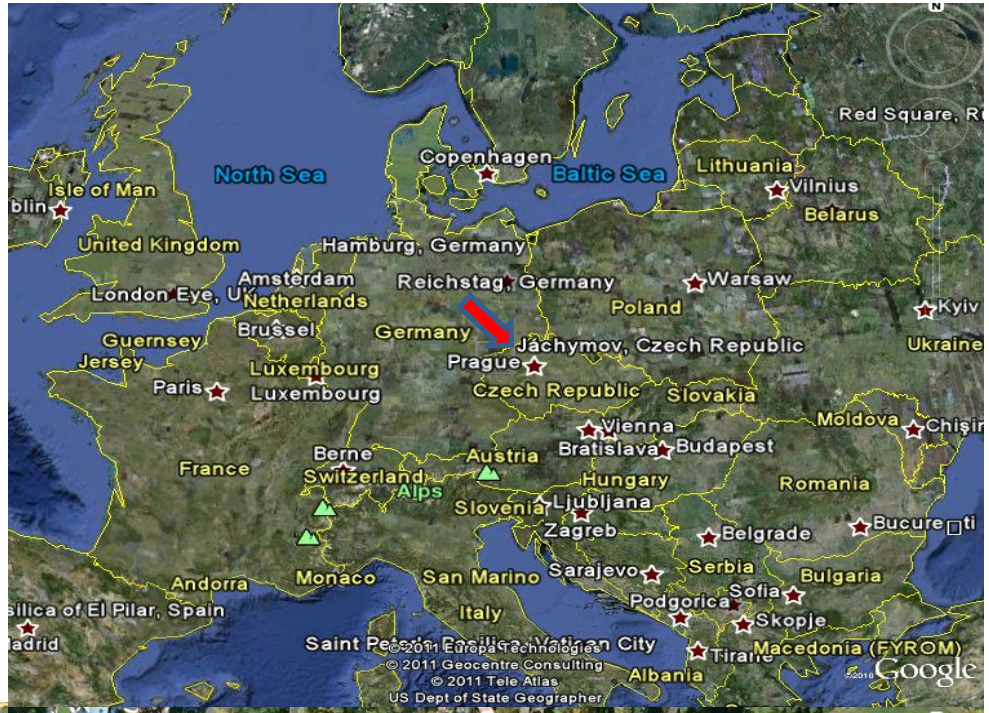
1898

"The various reasons we have just enumerated lead us to believe that the new radioactive substance contains a new element to which we propose to give the name of RADIUM"

…was announced by Marie and Pierre Curie at the meeting of the Academy of Science in Paris on December 26, 1898. It took another 45 months, however, before the Curies were able to prepare a tiny amount of pure radium and determine its atomic weight to be 226.

St. Joachimstal mines, Bohemia

- 1523+ Silver coin (Thaler = $),
- 16+: Ni, Bi, Uranium
- 1873: Great Fire
- 19+: Ra & Radon Spa
- WW2: Germans to Czechs
- Uranium mining ceased 1964
- Radioactive thermal springs Rheum.
- Average life expectancy 42 years



Pitchblende at Jáchymov (Czech)

Early Publications

1896: UK **–** ***British Medical Journal*** –
1897: US **–** ***Bulletin of John Hopkins Hospital*** –
1998: Fr **–** ***Comptes rendus de l'Académie des Science*** – Curies et al.
1900: Gr **–** ***Photographische Rundschau*** – F. Walkoff & F. Giesel

1901: Fr **–** ***Comptes rendus*** – Pierre Curie
1903: US **–** ***Colorado Medical Record*** – George Stover
1903: Fr **–** ***Annales Dermatologie et Syphilogie*** – Henri Danlos & Paul Bloch
1903: Gr **–** ***Deutsche Medizinische Zeitung*** – Herman Strebel
1903: Rus **–** ***Dermatologischa Zeitschrift*** – Semen Goldberg
1904: US **–** ***New York Medical Record*** – Robert Abbé
1904: US **–** ***JAMA*** – Williams Rollins
1905: US **-** ***Boston Medical & Surgical Journal (NEJM)*** – Francis Williams
1905: Gr **–** ***Archives of Roentgen Ray*** – F. Giesel

Lesions treated: lupus vulgaris, eczema, keloid, rodent ulcer, epidermoid & breast ca.

1910: Fr **–** ***Radiumtherapy (textbook)*** – Louis Wickham & Paul Degrais

Entitlements

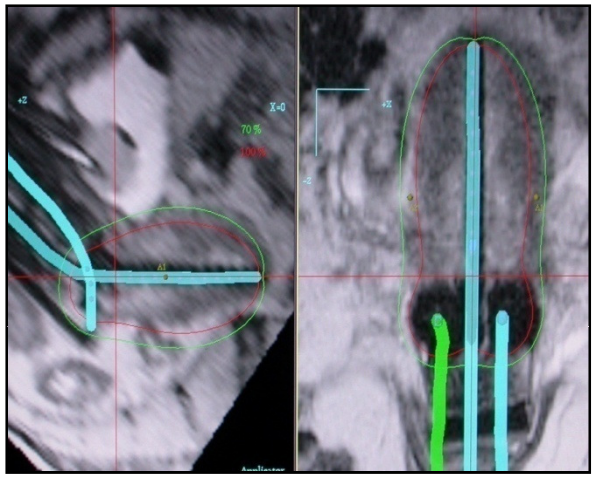
- German Radium *(Buchler Company, Brunschweig)*
- French Radium *(Armrt de Lisle, Paris)*

- *The Rarest Substance* (sold with title in UK)
- *Dawn of a Miracle* (sold as title in USA)

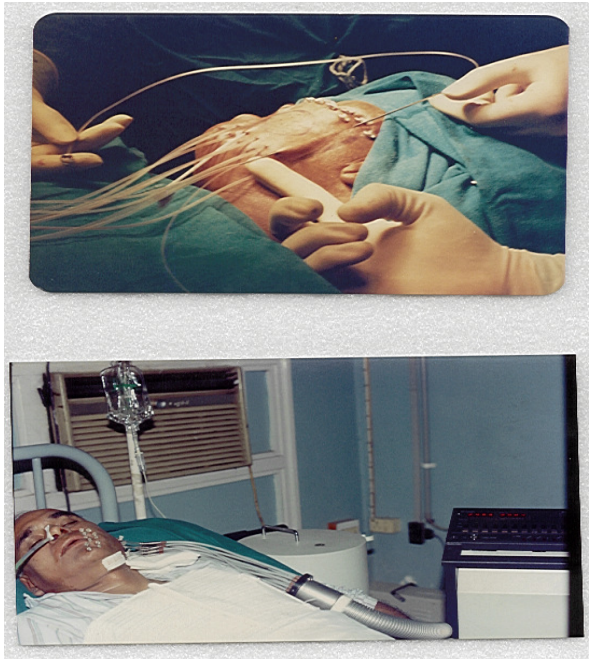
- The Romance of Radium (Movie) 1937
- The Trail of Invisible Light (Book) 1965

1898

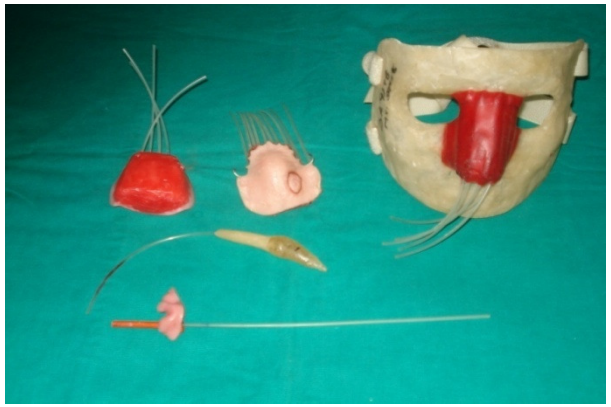
Brachytherapy



Intracavitary



Interstitial



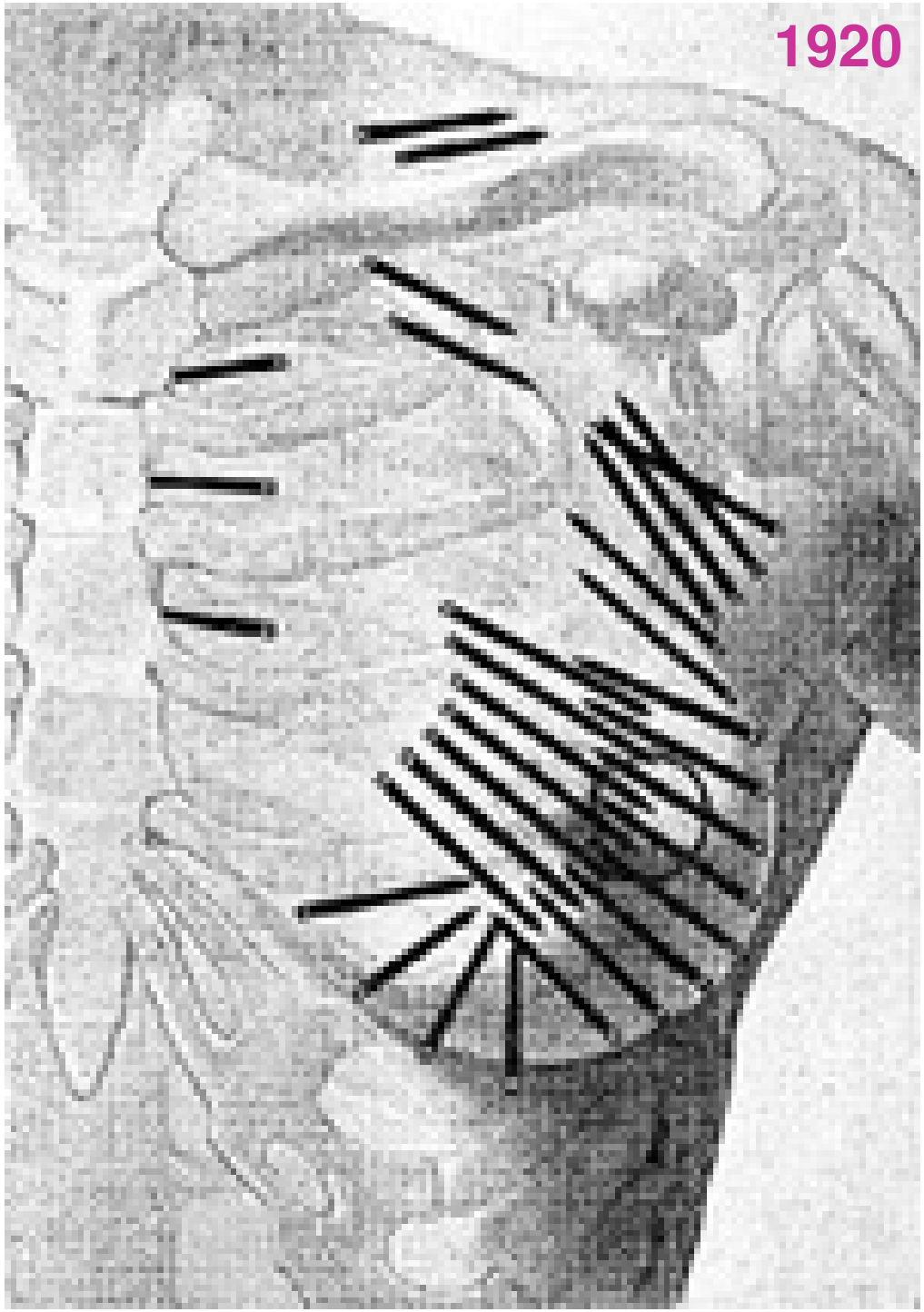
Surface Moulds

Madame Marie Curie discovered radium in 1896.

Just two years later, a vial of radium salt was placed on the breast of a woman with cancer, and the tumor was observed to shrink.

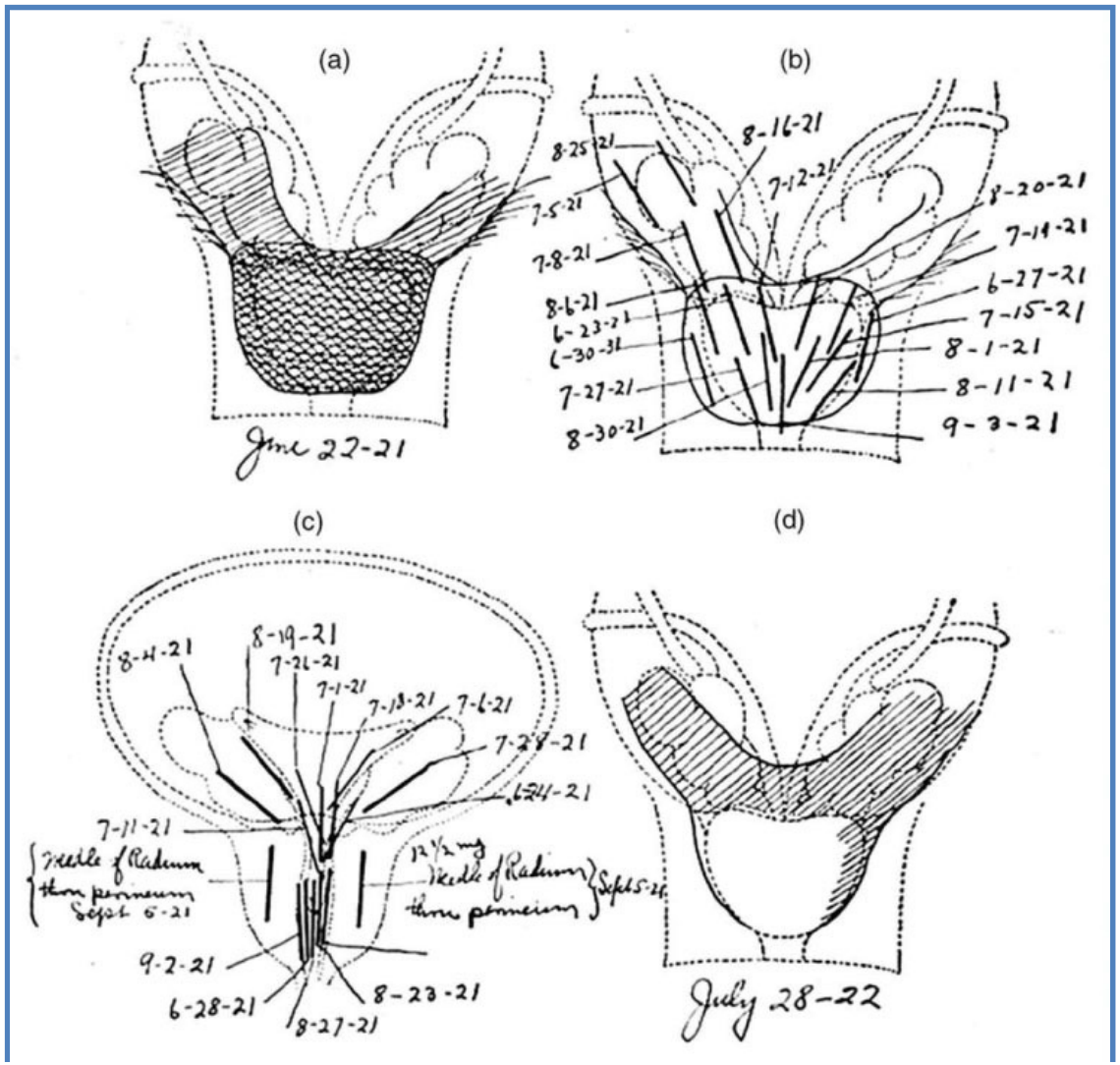
This was the first use of interstitial brachytherapy.

Dr. Keynes' technique of inserting radium 1920.



1904

A Record of a Course of Intracavitary Brachytherapy as delivered by Hugh Hampton Young

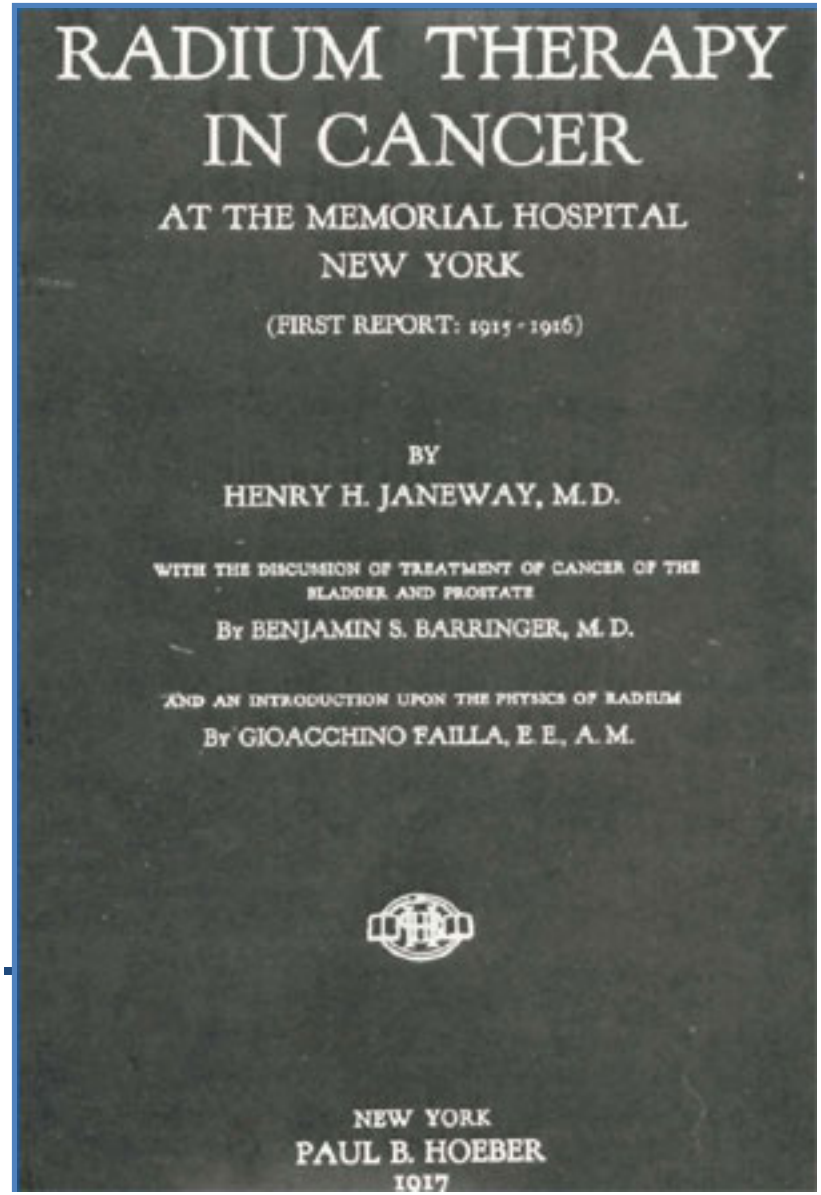


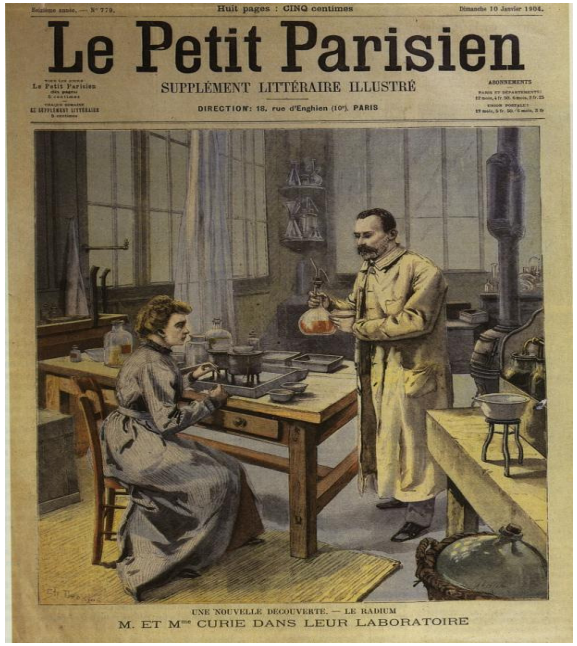
1914

In 1914, Stevenson and Joly improved the technique.

Using pure radium sulphate, thus manufacturing the first radium “needles” made from steel or platinum.

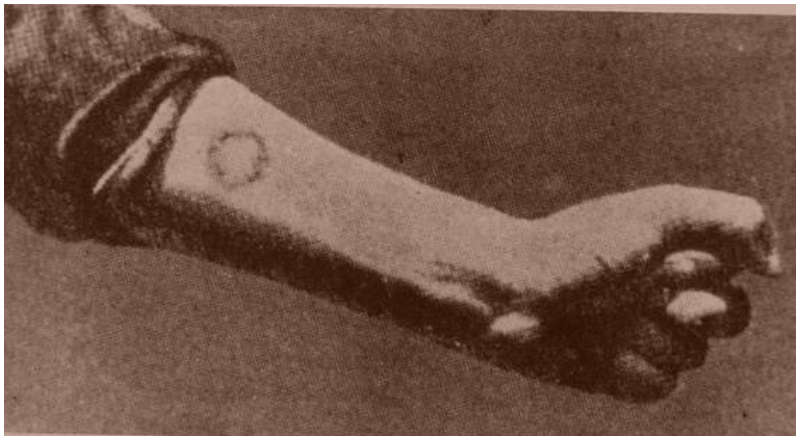
Dr Failla at Memorial Hospital, collected radon gas in tiny glass tubes that were then inserted into tumours and left there indefinitely..





1901-1950

- Pierre Curie studied the effect of radiation



- 1900: Friedrich Walkoff & Friedrch Giesel (Germany) radiation burn
- 1901: Dr Henri Danlos & Paul Bloch, French doctor (St Louis Hospital,Paris) 0.39 Gm Radium treated lupus skin lesion& Dr Robert Abbe, Surgeon (St Lukes & Memorial Hospital, New York) used radium for patients
- 1903-1950: Margaret Cleves (Ca Cervix), Hugh Young (Ca Prostate), Geoffrey Keynes (Ca Breast)
- 1960: After-loaders (E. Henschke)
- 1990: Imaging – CT, MRT
- 2000: Advanced computerized - 3D presentations
- 2005: Robotic delivery of prostate seed

Mile stones - Brachytherapy

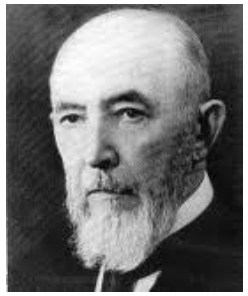
1896 – Becquerel - Radioactivity
1898 – Madam Curie / Pierre Curie - Radium
1903 – Nobel Prize for Curie's & Becquerel
1903 – First successful case of malignancy basal cell carcinoma of face
1920 – Patterson & Parker tables for Radium
1920 – Paris system of IC Rx / Stockholm System
1934 – Manchester System
1953 – Tod & Meridith point A & B defined
1957 – Ir–192 in implants
1960 – Preloaded applicators Stockholm, Paris & Manchester
1960 – After-loading applicator - Henchke / Fletcher-suit
1962 – First Remote after-loading machine
1965 – Paris system – Interstitial
1970 – Co-60 HDR
1985 – HDR Ir-192
2000 – 3D Brachy planning, CT/MR Compatible appl., Inverse planning

BRACHYTHERAPY DOSIMETRY

Early treatments of Radium - No physical or biological basis, empirical

INTRACAVITORY BRACHYTHERAPY

1911: Stockholm System - Forsell
2 -3 applications at 3 weekly intervals, each lasting 27-30 hrs.



1919: Paris System - Regaud
1 application over 6-8 days

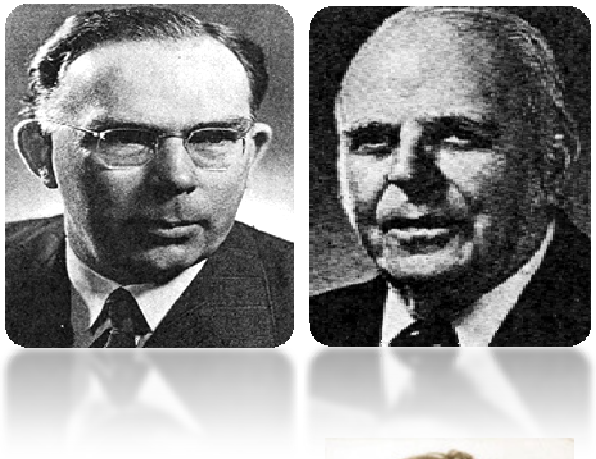
1934: Manchester System - Paterson & Parker
8000 R to point A, over 140 hrs. divided in 2 equal applications

BRACHYTHERAPY DOSIMETRY

INTERSTITIAL BRACHYTHERAPY

Manchester System (Paterson - Parker):

milligram hours of Radium needed to deliver 1000R
planar & volume implants
surface moulds
differential activity



Paris System (Pierquin- Deuterix):

Iridium-192 as isotope
Reference isodose: 85% of basal dose rate
Equidistant, parallel, rectilinear radioactive lines
Equal linear activity

BRACHYTHERAPY DOSIMETRY

INTERSTITIAL BRACHYTHERAPY

Quimby System:

Uniform distribution of sources of equal linear activity
non uniform distribution, higher in the central region of the treatment volume

Memorial System:

Extension of the Quimby System
Complete dose distributions around lattices of point sources of uniform strength spaced 1 cm. Apart
Computer generated dose distributions

BRACHYTHERAPY DOSIMETRY

INTERSTITIAL BRACHYTHERAPY

Computer Dosimetry System:

Development of advanced treatment planning computers
Flexibility to deviate from established dosimetry systems
Optimise isodose distributions according to clinical needs
May try to compensate for poor implant geometry

Stepping Source Dosimetry Systems:

Evolution of HDR & PDR systems
High activity, single, miniaturised source
Dwell time is a function of prescribed dose, geometry of the application and source strength on the day of application.

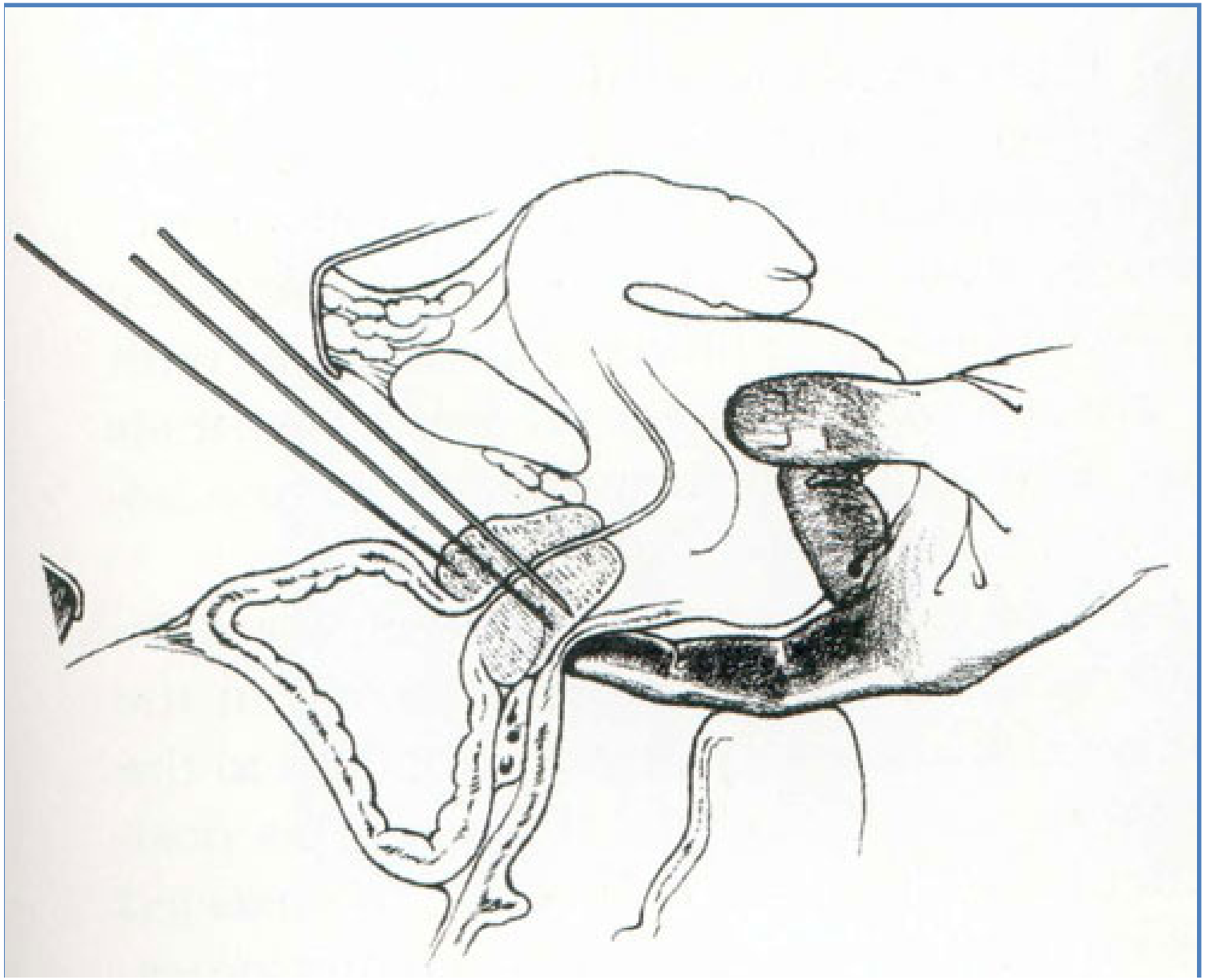
1915

Prostate brachytherapy

Radium sources

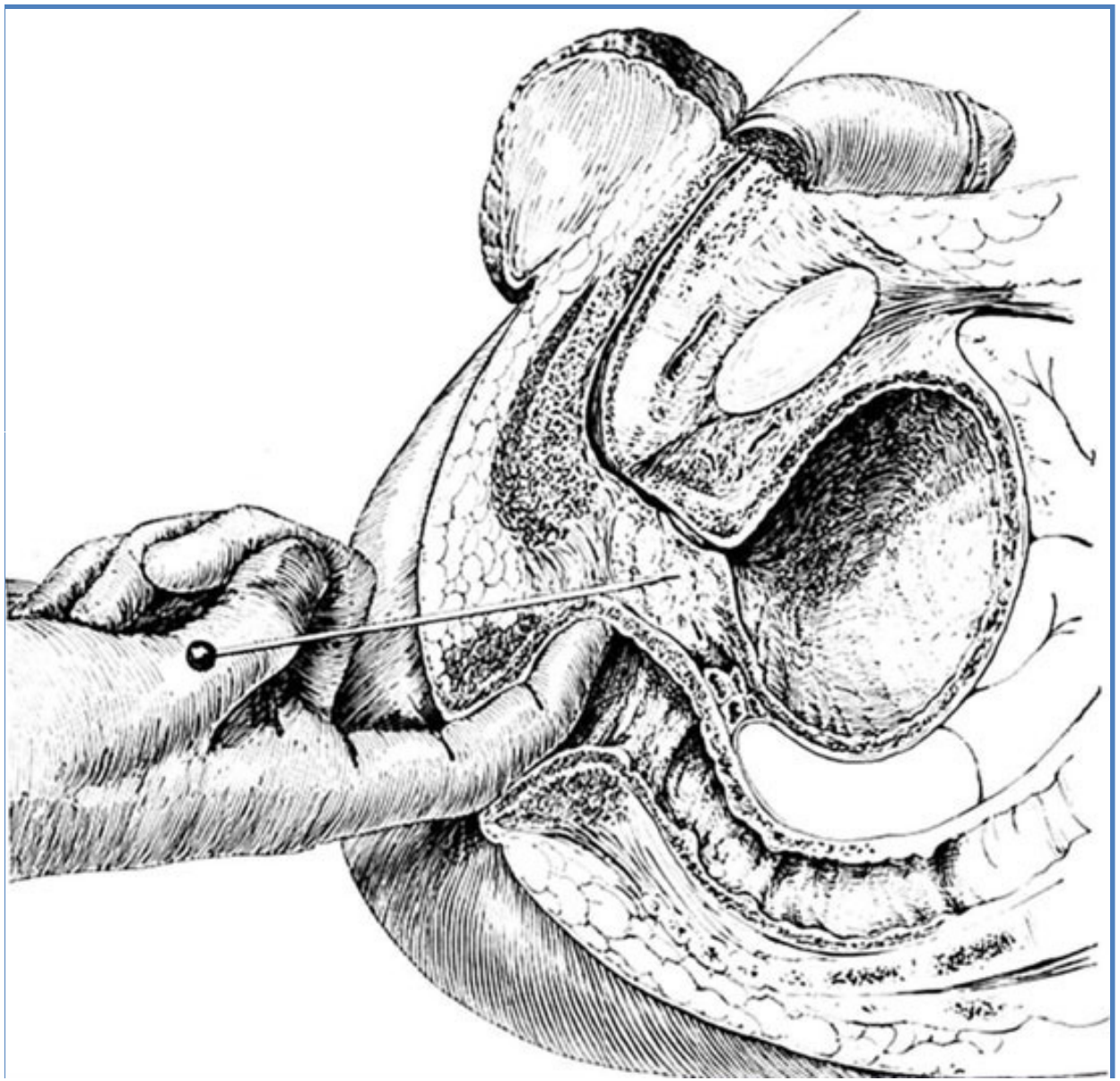
Prominent urologist., The leading innovator was Benjamin Barringer, who performed hundreds of transperineal implants beginning in 1915.

Prostate Brachytherapy



The needles inserted into the gland until the tips can be sensed

Insertion of an Emanation-Tipped Needle using a Transperineal Approach, Under Guidance of a Finger in the Rectum



Young initially reported dramatic results, with "amazing resporption of extensive carcinomatous involvement of prostate and seminal vesicles… in the majority of cases," resulting in the "disappearance of pain and obstruction.. which is indeed remarkable." [3.4]

Mick Applicator

1973

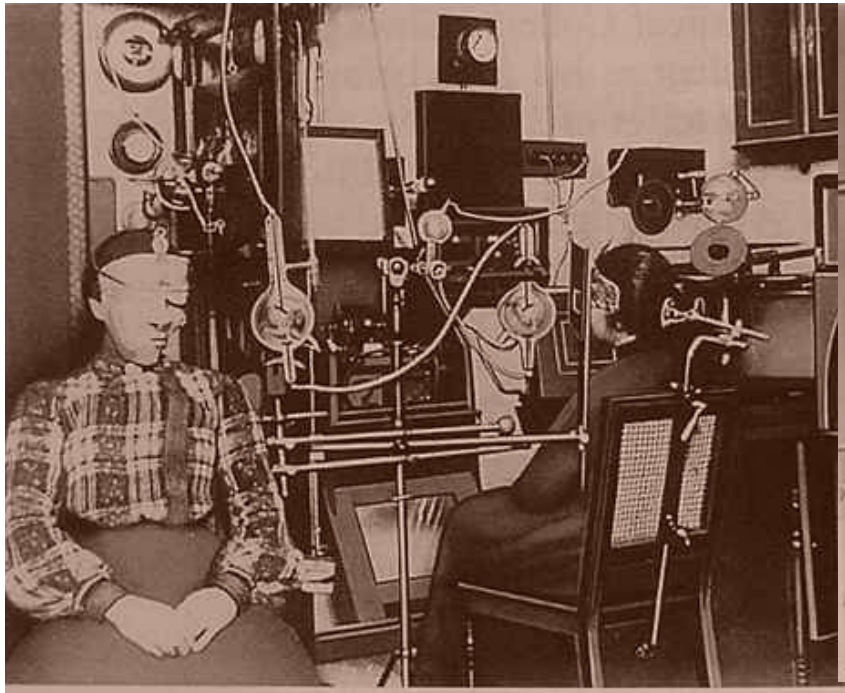
The first generation of Mick® applicators were developed in 1973

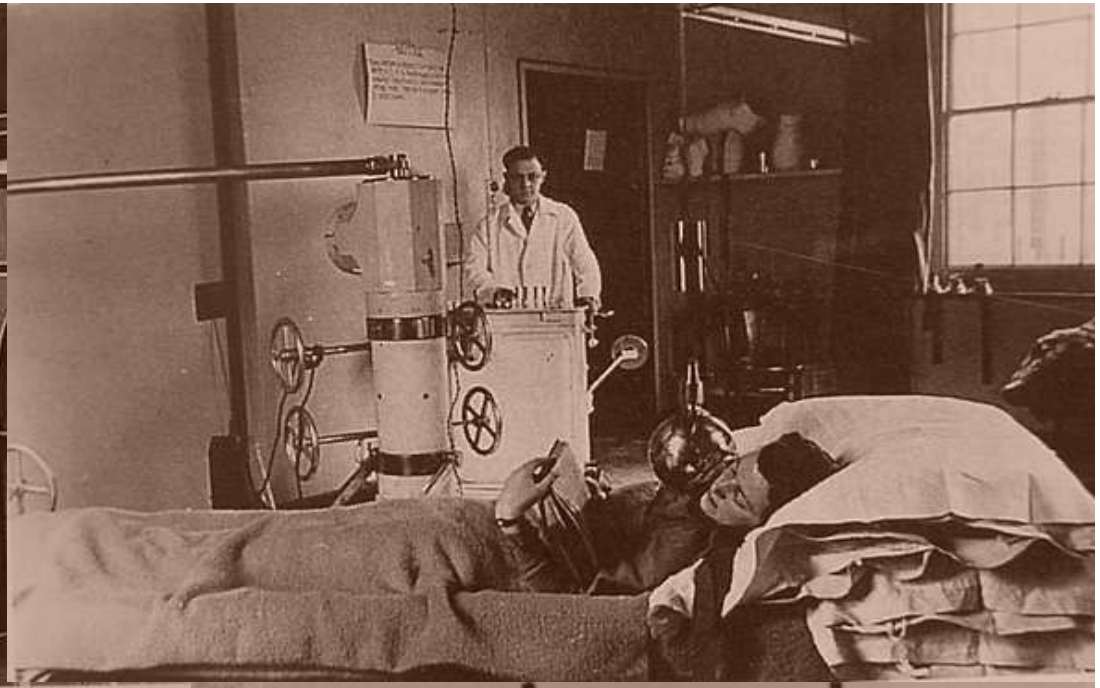
Seeds were contained in shielded cartridges

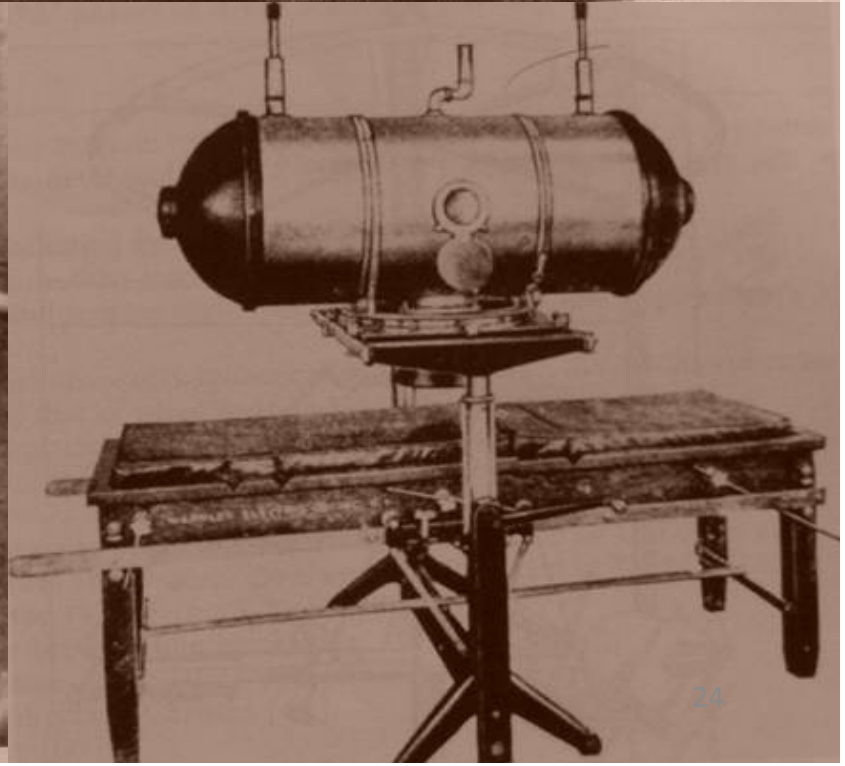
Applicator designed according to “afterloading principle” of Ulrich Henschke,

1926

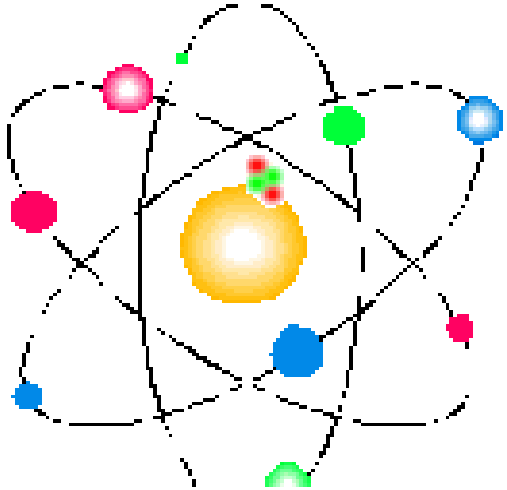
Gold Radon-Bearing Seeds







Brachytherapy



Low Dose Rate (LDR) < 2Gy/hr

Medium Dose Rate (MDR) 2-12 Gy/hr

High Dose Rate (HDR) > 12 Gy/hr

Pulse Dose Rate (PDR)

Afterloading techniques
Ulrich Henschke 1960

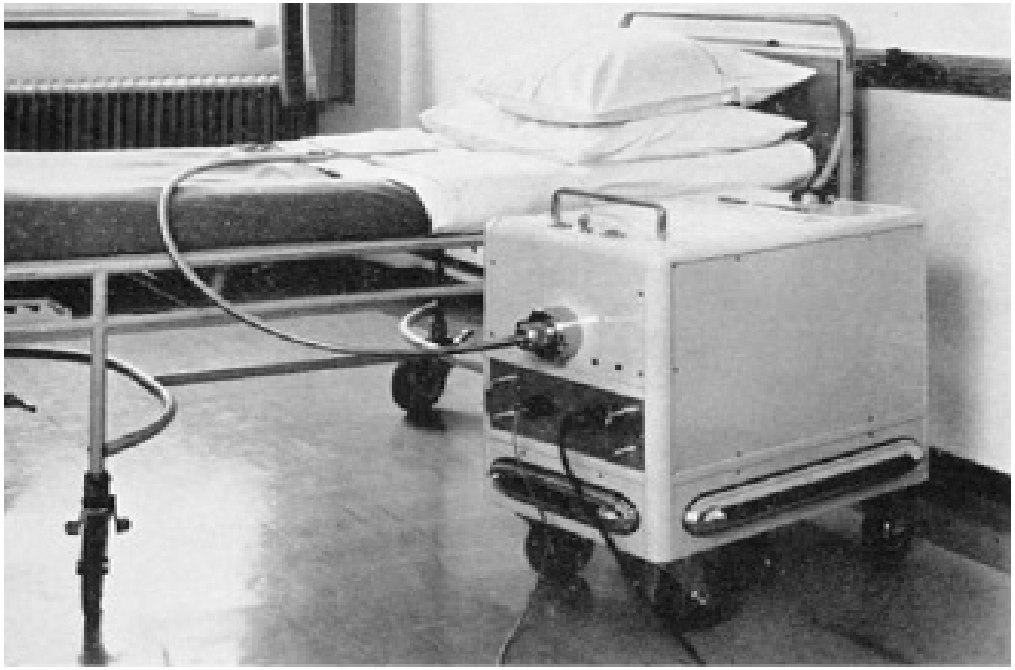


Figure 3. Illustration of early single-channel remote afterloading system (Walstam 1962). An LDR source train at the end of a flexible capable was used to move the source to and from the patient to a shielded safe under control of an automatic timer. A radiation detector was used to verify source position.

Remote After-loading

- Remote afterloading was first introduced by Walstam and Henschke et al in early 1960s for LDR and MDR Intracavitary BT.
- O'connell in 1965 introduced High dose rate Brachytherapy by using Co60 pellets in which fractionated treatment lasting only few minutes administered.
- In 1970 first SSS RAL was introduced by Gauwerky 1977 and Schulze et al 1984 by using high intensity minitiaurized Ir-192 sources welded onto the end of flexible cable drive.

It was suggested to consider treating early breast cancer with brachytherapy after removal of the visible cancer mass (lumpectomy). This technique of removing the large mass and treating the surrounding area with brachytherapy was an accepted technique for sarcomas,

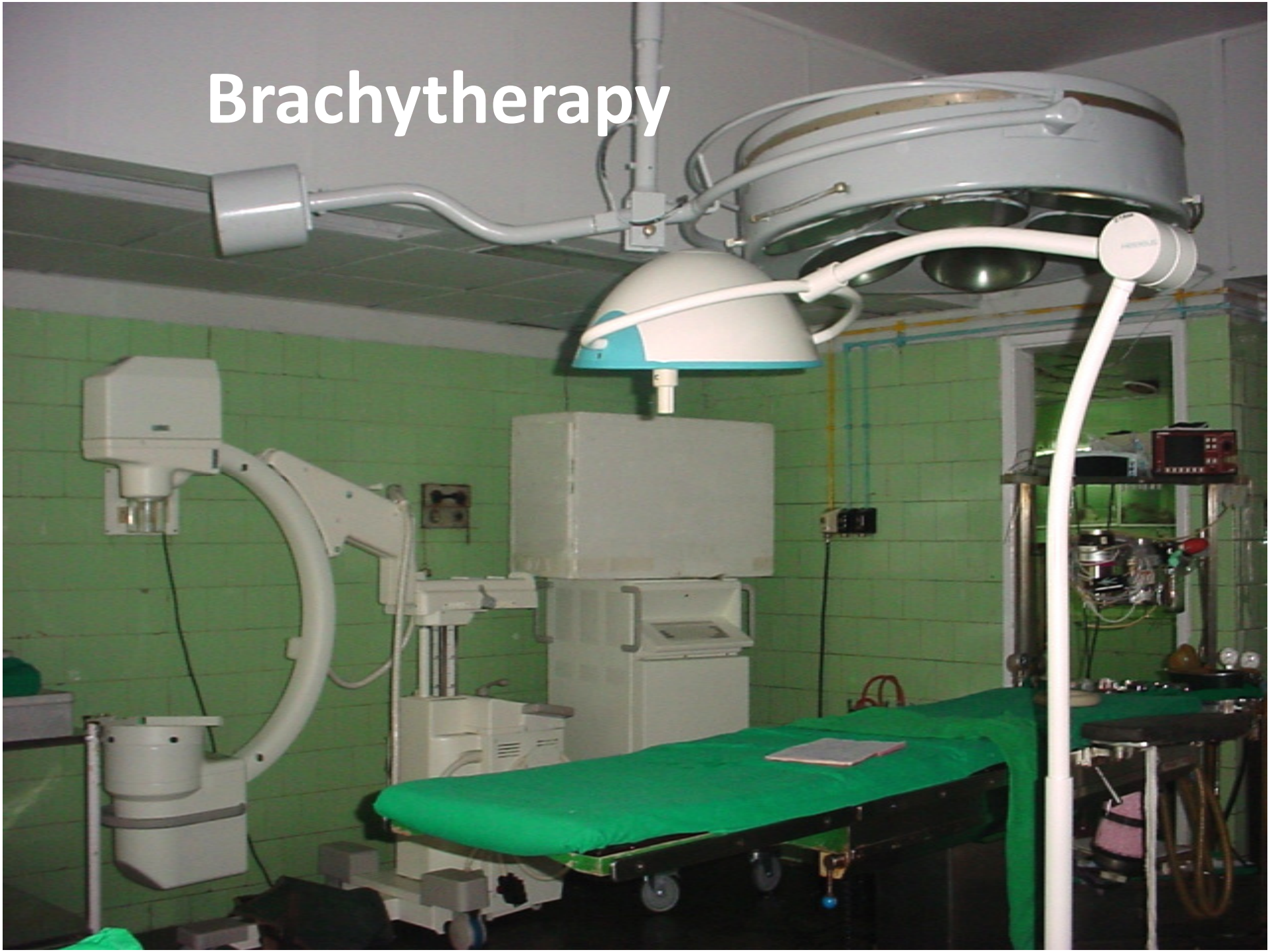
Dosimetry Planning: Major Differences

	2D planning	3D planning
Reconstruction	Orthogonal radiographs	CT/MR images
Source positions	BTB distance on radiographs	Target volume from CT/MR images
Dose prescription	point A, Basal points	target volume
Volumes	No volumes or describe only tumor volumes	• tumor and OAR volumes •CTV splits into HR CTV, IR CTV, LR CTV for ICA
Dose optimization	base on dose points, isodose shape	base on dose points, isodose shape and coverage, DVH
Dose reporting	Point A, bladder, rectum, shape ref isodose	Same as in 2D + other volumes specs

EVOLUTION OF BRACHYTHERAPY AT TATA MEMORIAL HOSPITAL

	1941	Radon Seeds
	1960	Preloaded Cesium137/Cobalt-60 capsules
	1962	Gold-192 grains
	1972	Manual after-loading Cobalt-60
	1976	Cesium-137 tubes (BARC)
	1979	Cesium137 tubes/needles (Amersham)
	1981	Selectron LDR/MDR – Cs-137 Manual after-loading Iridium-192
	1987	microSelectron LDR – Ir-192
	1994	microSelectron-HDR, TPS – PLATO
	1999	microSelectron-HDR control console & PLATO up-gradation
	2003	microSelectron console up-gradation
	2005	PLATO up-gradation. Sunrise workstation, MRI comp. applicator
	2006	Digitally networked C-Arm in OT
	2008	USG in OT, use MRI volume delineation

Brachytherapy




CARCINOMA OF CERVIX
Intracavitary Brachytherapy
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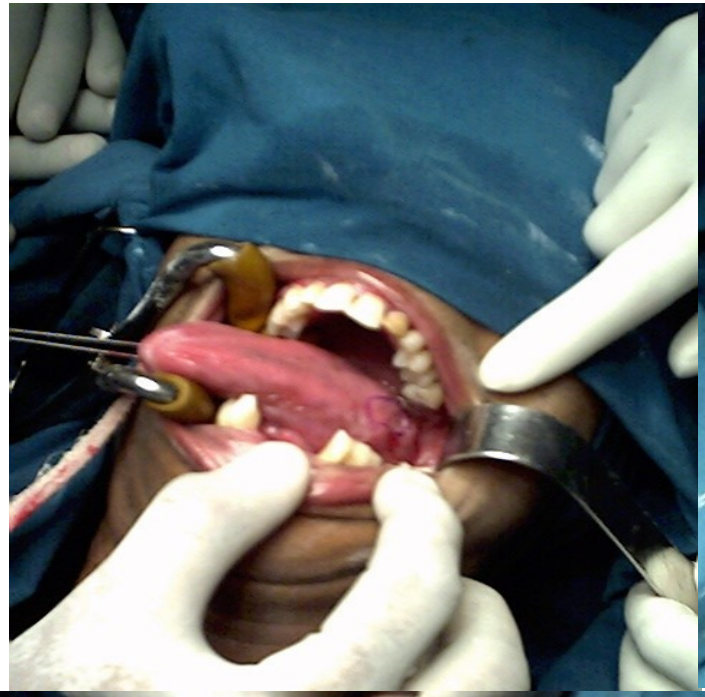
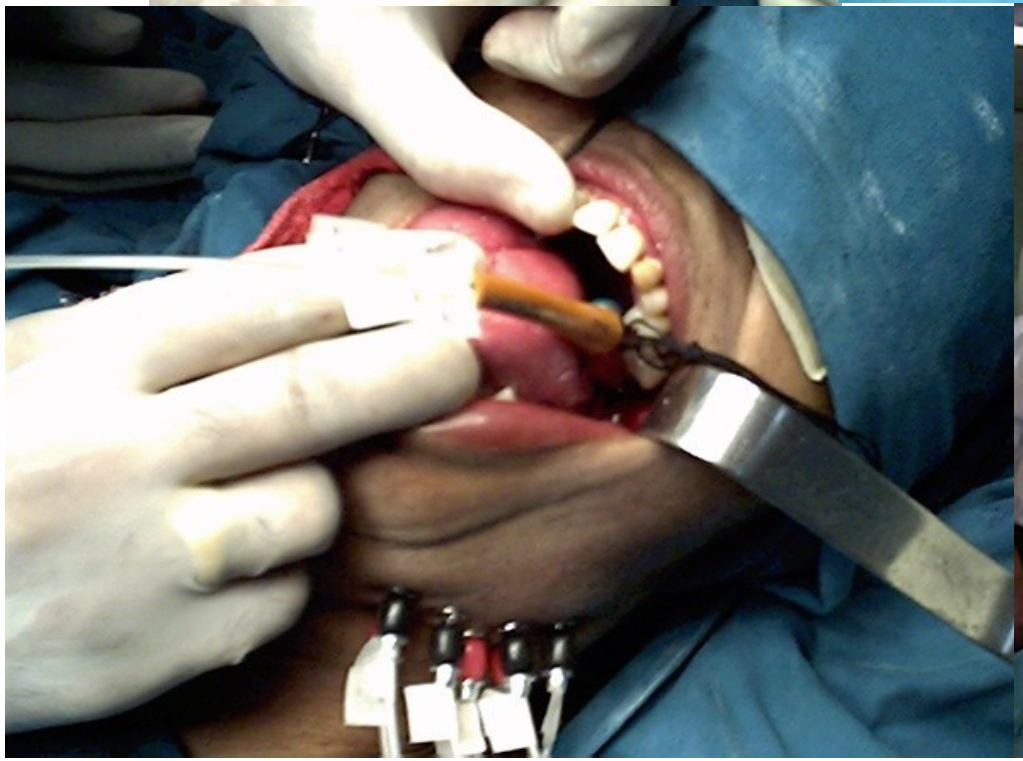
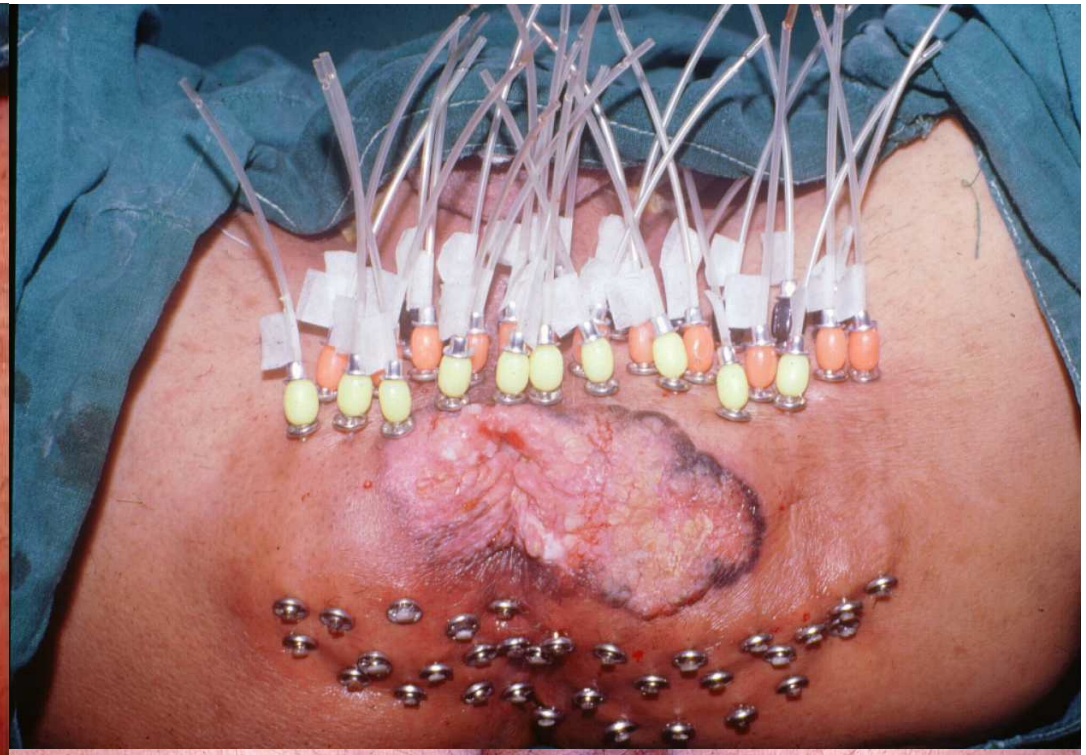
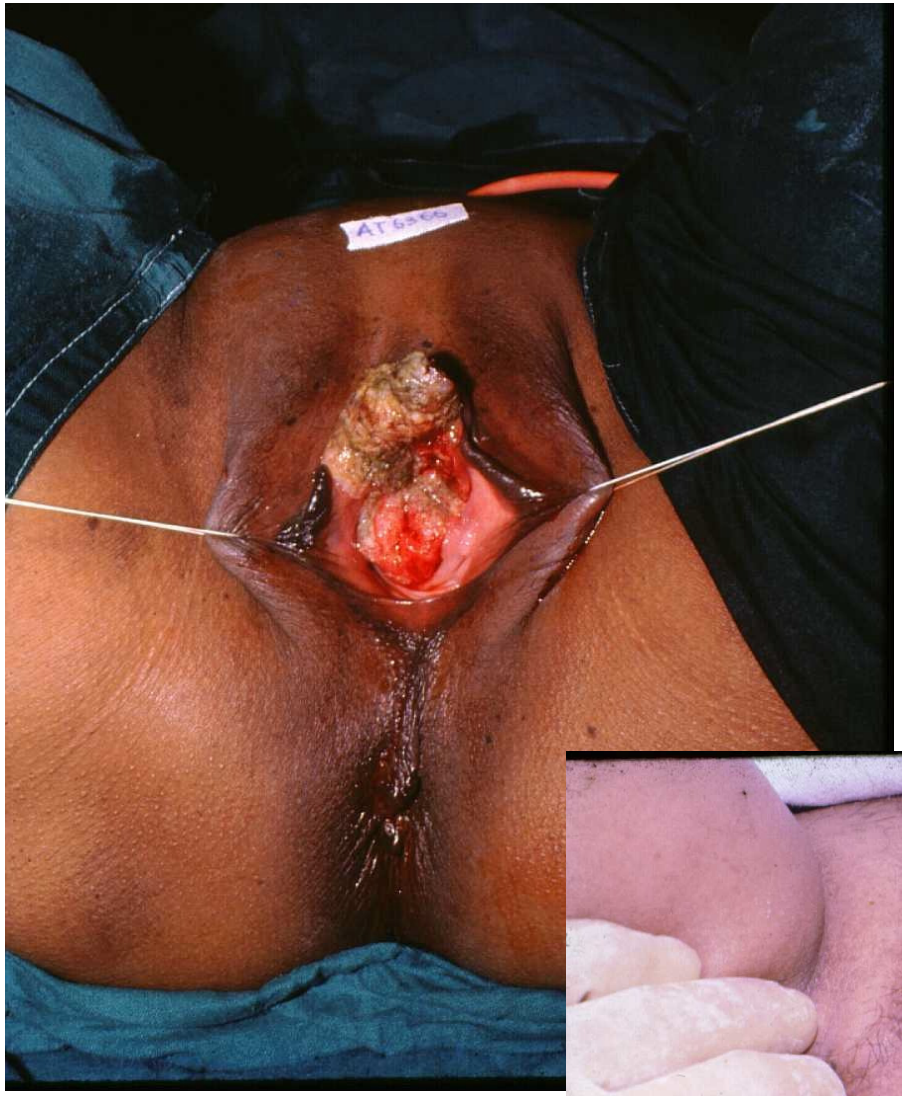
INTERSTITIAL BRACHYTHERAPY FOR

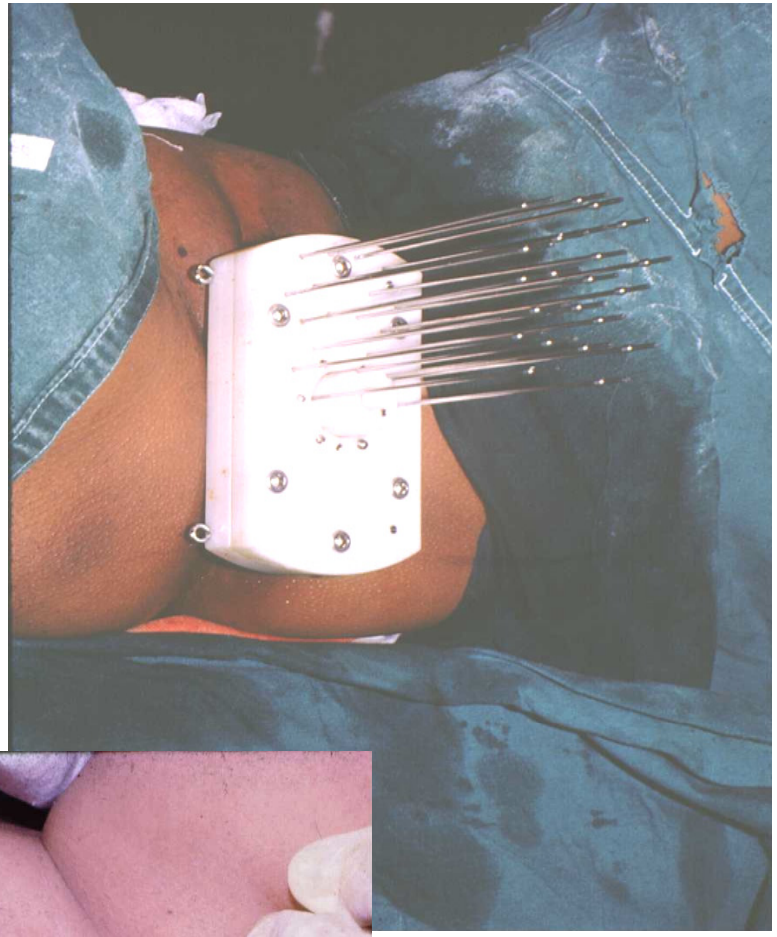
SOFT TISSUE SARCOMA












AT 6366

IORT (Intra-Operative Radiation Therapy): Brachytherapy

- Direct radiation to the target volume
- Minimizing dose to underlying normal tissues
- Local dose escalation
- Organ function preservation

Sites:

- Extremities
- Head & Neck
- Pelvis
- Gastric, Pancreatic
- Lung, Liver, Kidneys
- CNS

IORT (Intra-Operative Radiation Therapy): Brachytherapy

Advantages

- Tissue at risk is defined and visualised
- Minimize margins
- Vital adjoining structures moved out
- Useful as boost
- ? Useful for re-irradiation
- Adjuvant approaches (Hyperthermia, Chemo, radiosensitizers use)

Limitations:

- Size limited generally <5x5 cm
- Not suitable in widely un-resectable tumors
- Personal exposure (permanent implants)

XI – ICRO/AROI PG Teaching Course

TMH, Mumbai

- Physics
- Radiobiology
- GYN Cancers: Intracavitary, Image guided brachytherapy
- Soft Tissue Sarcomas
- Breast Cancer: APBI, Boost
- GI malignancy: Perineal approach, Intraluminal
- Head & Neck: Surface mould, Oral cavity

Evaluation

A Tribute to Dr. KA Dinshaw

16 November 1943 – 26 August 2011


Thank You