Challenge and Scope of Radiation Oncology in Cancer Care

Tata Memorial Center, INDIA

Cancer in India
Current scenario (2000-05)

800,000 new cases; 2,500,000 prevalent cases; 550,000 cancer deaths in a year

- ✓ Relatively young cancer population as per the existent age pyramid
- ✓ Tobacco-related cancers-important concern (40% in men & 25% in women)
- ✓ Cervix still the leading cancer in women across the country
- ✓ Breast cancer has overtaken cervix in urban metropolitan registries
- ✓ Only 337 teletherapy units in the entire country presently
- ✓ 2/3 rd of cancer patients need RT i.e. 5,00,000 patients / year
- ✓ Only 1/3 rd of these estimated patients actually receive RT (major shortfall)

Modalities of cancer therapy

Radiation Therapy needed in > 60 % of patients as part of

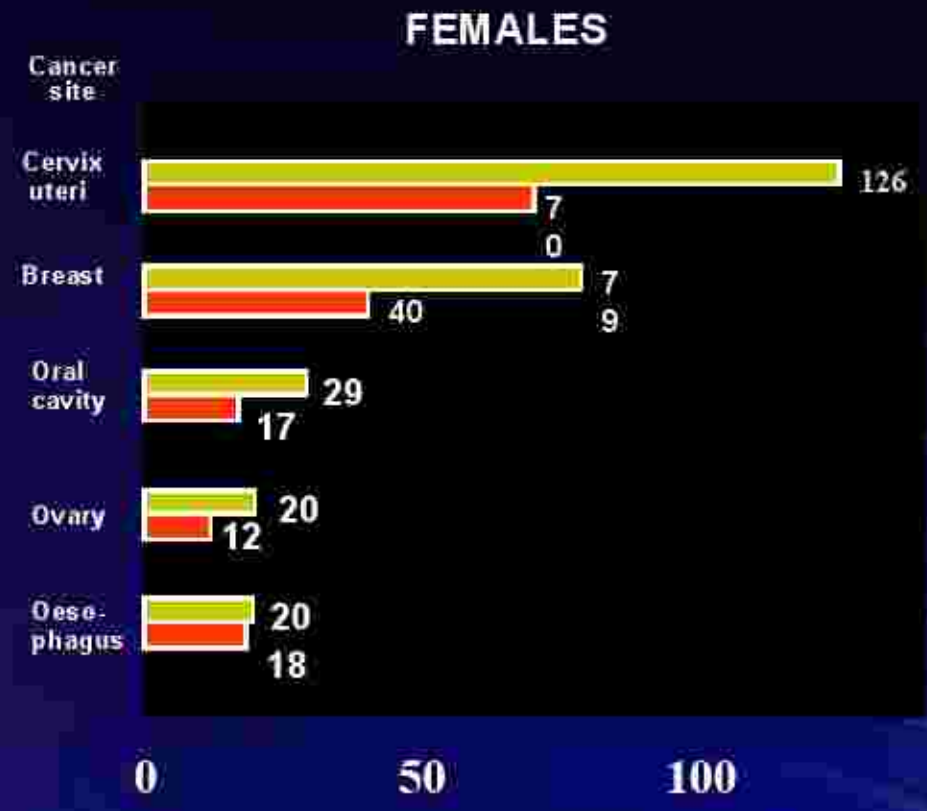
Radical or Definitive radiotherapy

Post-op adjuvant radiotherapy

Consolidation radiotherapy

Palliative radiotherapy

FIVE MOST COMMON CANCERS : INDIA
ESTIMATED NUMBER OF NEW CASES AND DEATHS (IN THOUSANDS) : 2000



Five most common cancers account for almost half the total cases and deaths due to cancer in Indian men

Five most common cancers account for almost two-thirds of the total cases) and deaths due to cancer in Indian women

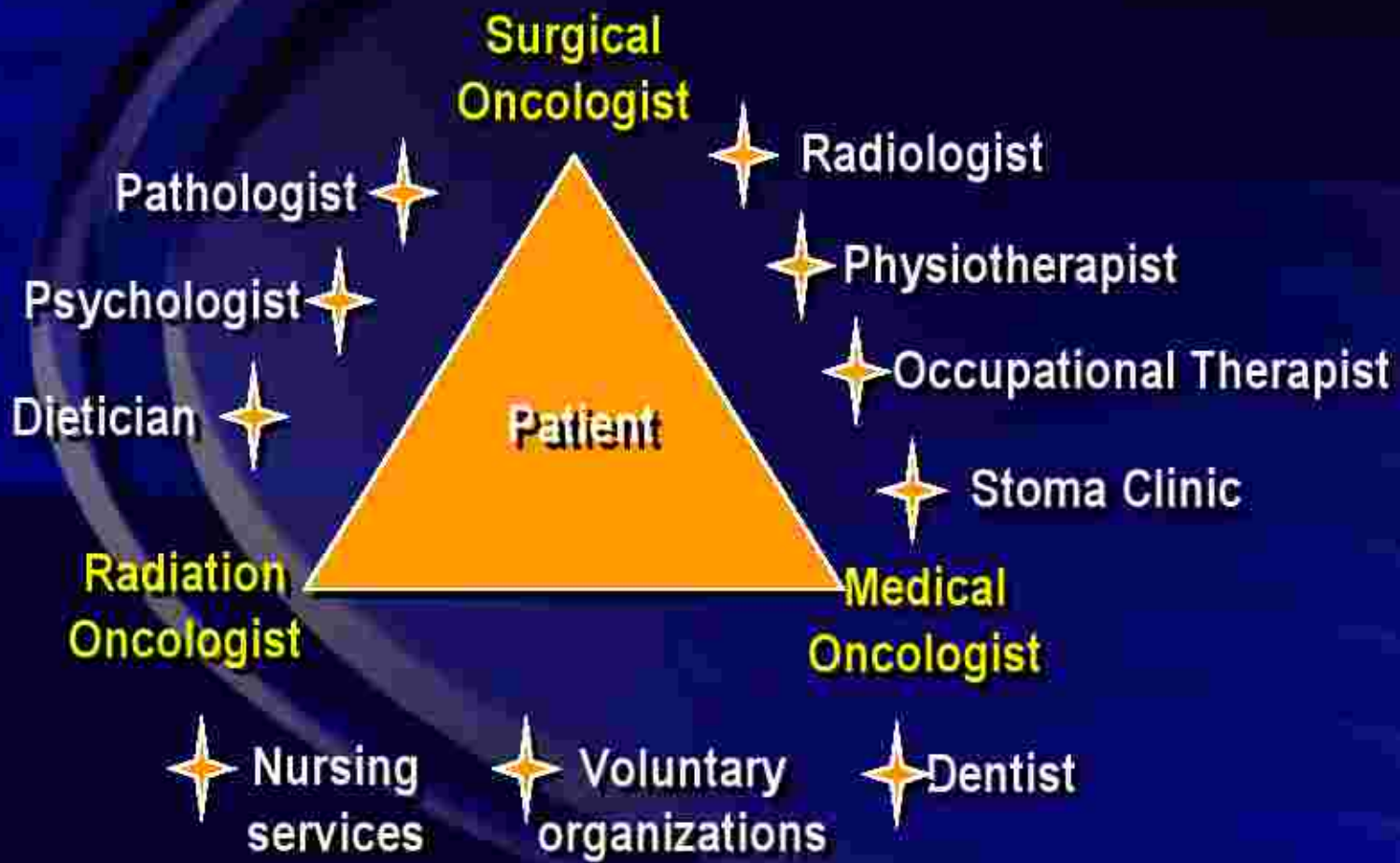
Source: IARC website www-dep.iarc.fr (updated 19.04. 2001)

Cancer in India

Projections for future (2015-2020)

- ✓ Doubling of the cancer incidence in next 15 years
- ✓ Ageing population with consequent increase in cancer incidence & prevalence
- ✓ Huge shortage of RT infrastructure (equipment and human resource) to meet recommended norms

Multidisciplinary Team



Advances in RT

- Technological advances in treatment planning in external beam radiotherapy **(teletherapy)**
- Use of modern imaging (CT, MRI, USG, PET) crucial for modern day practice
- Computerization in computation and treatment delivery
- Better understanding of cancer biology, radiobiology and interaction with other modalities such as surgery, chemotherapy, immunotherapy
- Greater use of remote controlled **brachytherapy**, using radioisotopes directly around the tumour without any risk to personnel
- Generating quality clinical data as per appropriate scientific rigour

Conventional Radiotherapy

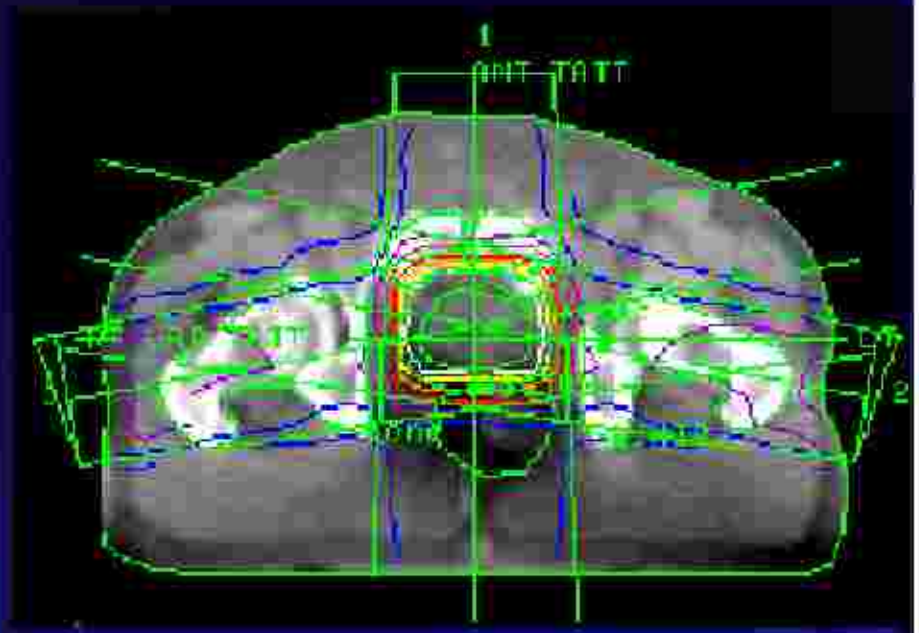
Conformal Radiotherapy

Excellent conformation

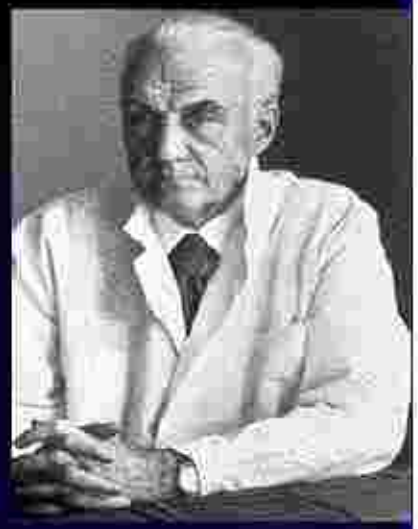
Multileaf collimators (MLC)

3D Conformal Radiotherapy (3D CRT)

- ✓ Large body of evidence including prospective and randomised data
- ✓ Prostate, head and neck cancers, GI cancers, paediatric malignancies
- ✓ reduction of side effects
- ✓ dose escalation and improved local control
- ✓ Chemotherapy can be combined concurrently
- ✓ has already become the standard treatment in majority of the centres



Stereotactic radiosurgery

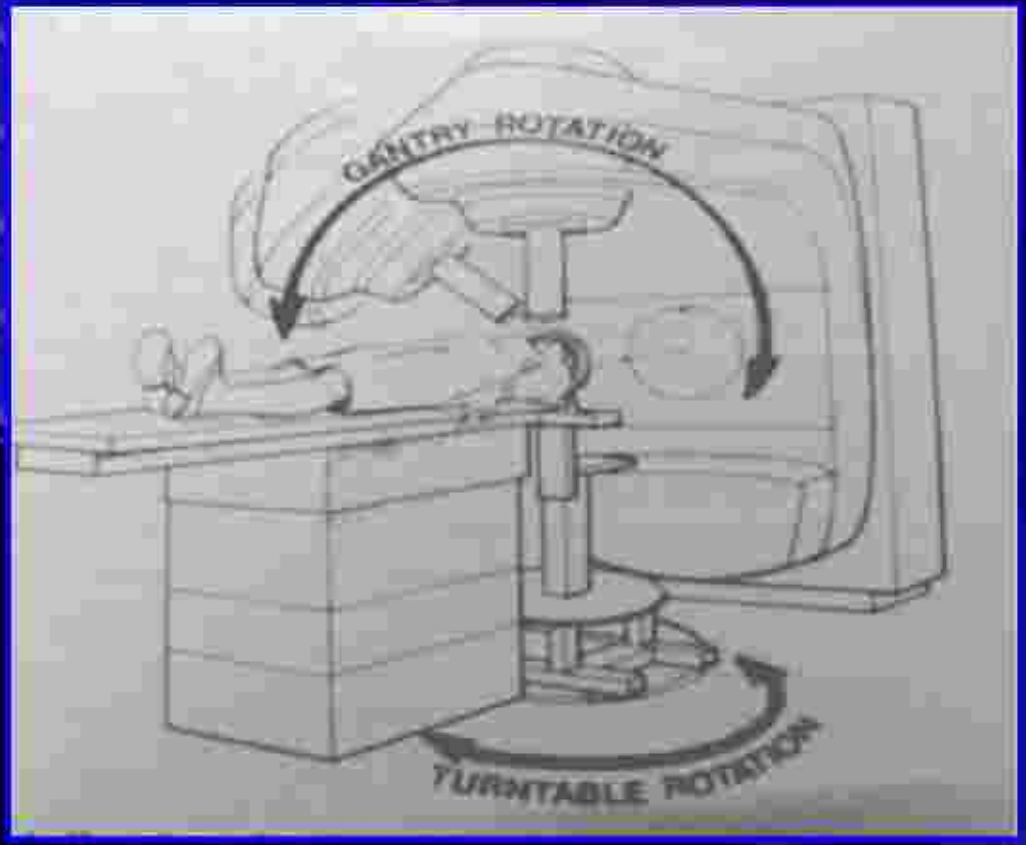


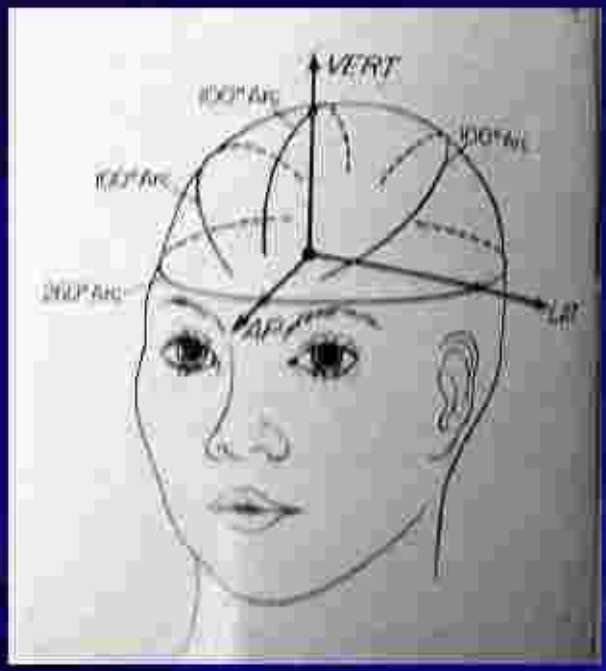
Stereos - solid

- Gamma knife
- **Modified Linacs**
- Proton beam

Firm immobilisation (stereotactic frames)
Treatment planning (dedicated workstations)
precise treatment delivery (high QA)

LA based Radiosurgery





Lutz IJROBP 1988; 14: 373-81

Stereotactic Conformal Radiotherapy (SCRT)

Stereotactic frame

Tight Conformation

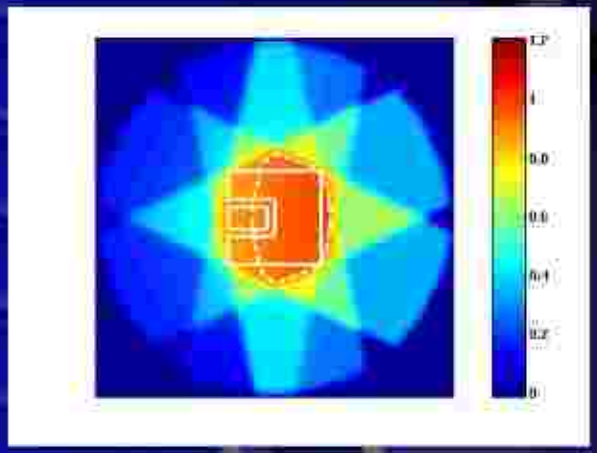
Computer planning

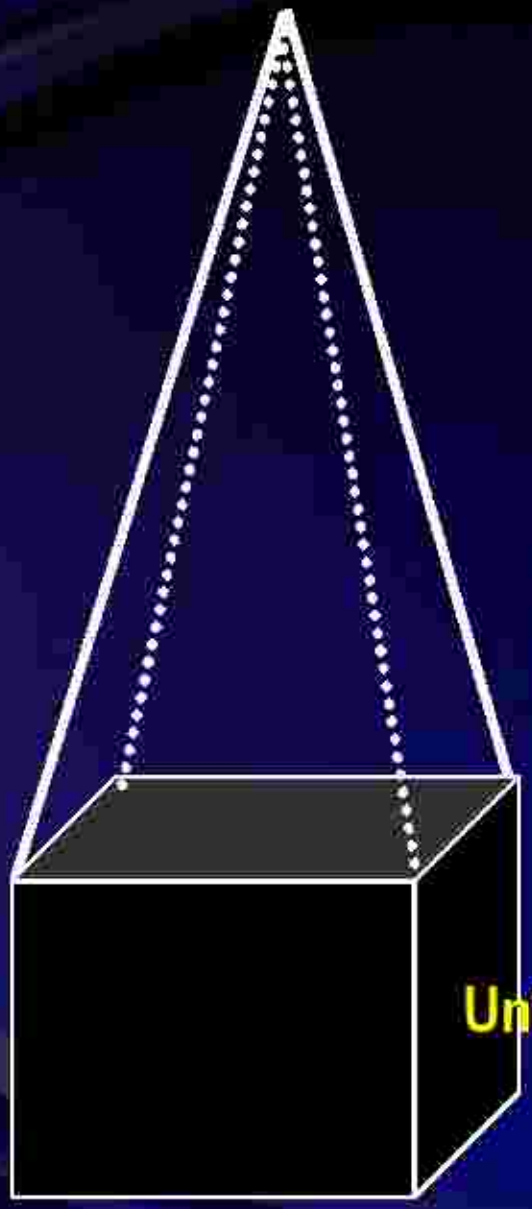
Precise treatment delivery

IMRT
Intensity Modulated Radiotherapy

- ✓ Advanced form of conformal radiotherapy, exciting
- ✓ Vary the intensity of beams in a non-uniform manner to achieve higher conformality
- ✓ Sophisticated computer algorithms required
- ✓ Wrought with complexities, stringent QA

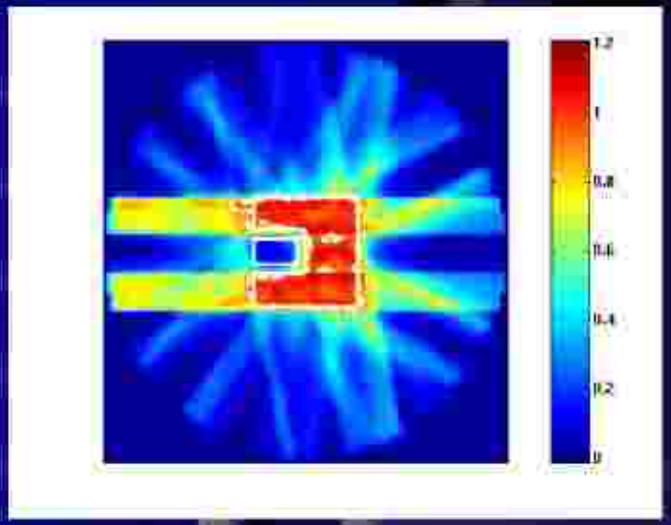
CRT

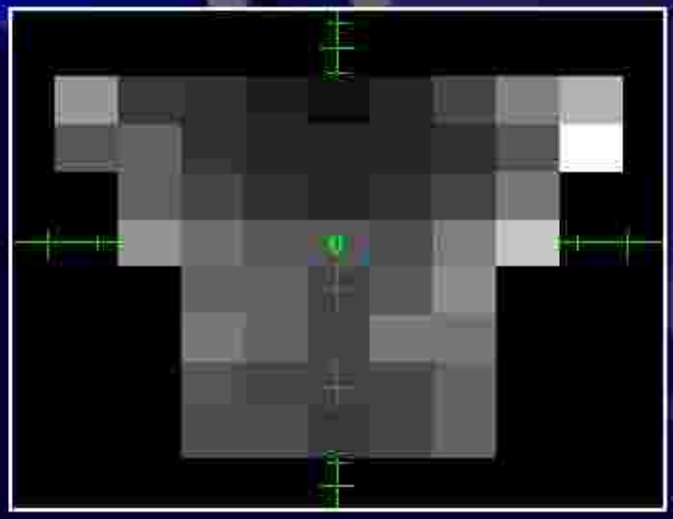


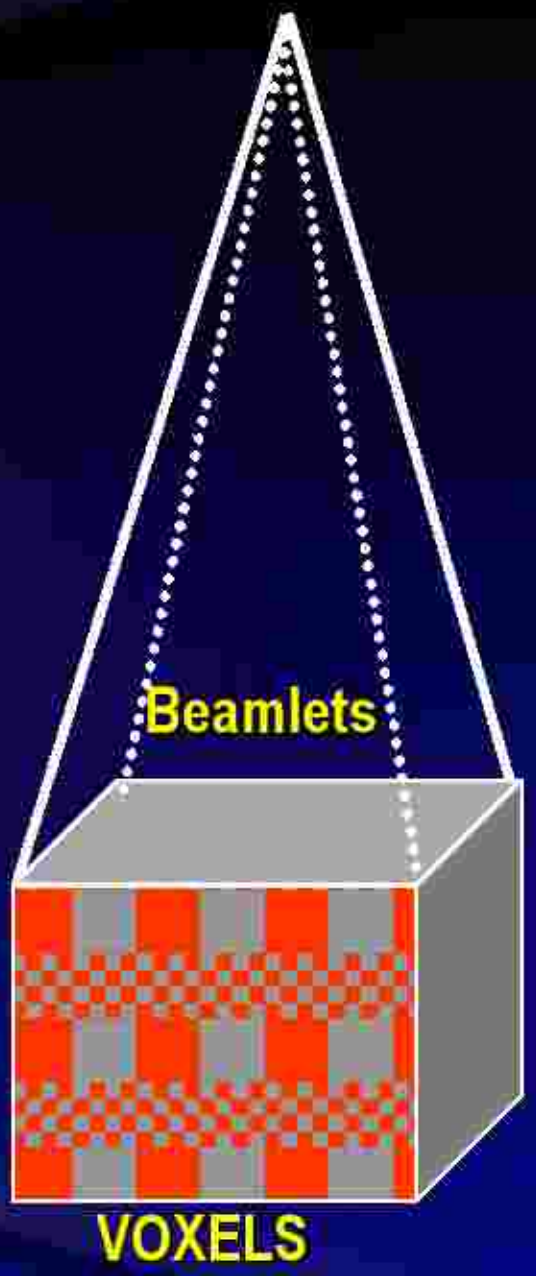


Uniform intensity

IMRT

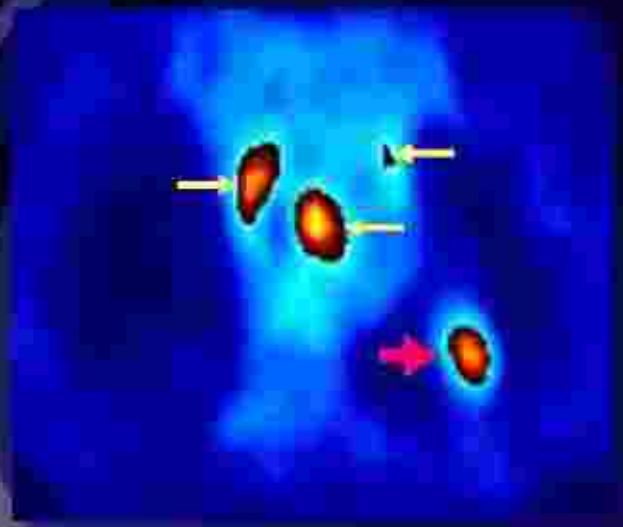


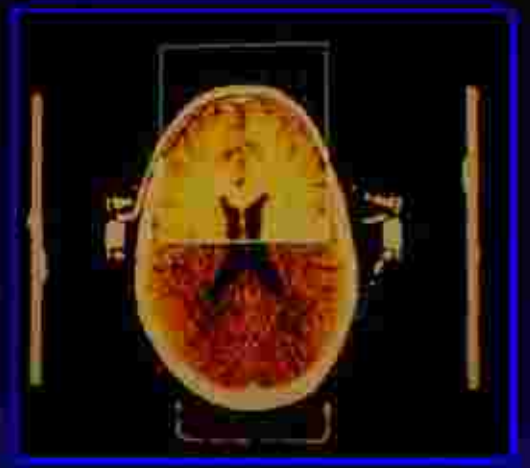




Metabolic image-based Planning

Tremendous enthusiasm



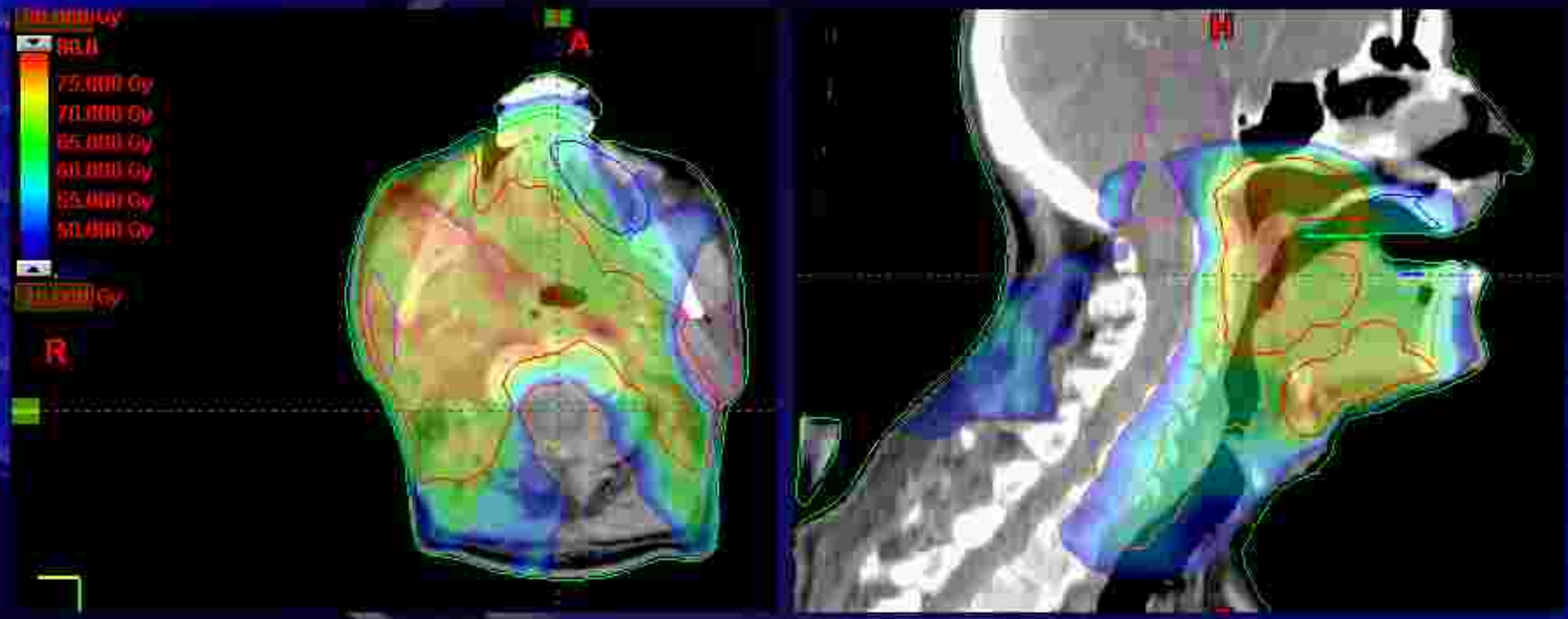


PET used in cancers of lung, head & neck, cervix, brain

Biological target Volume (BTV)

IMRT for Head and neck cancers

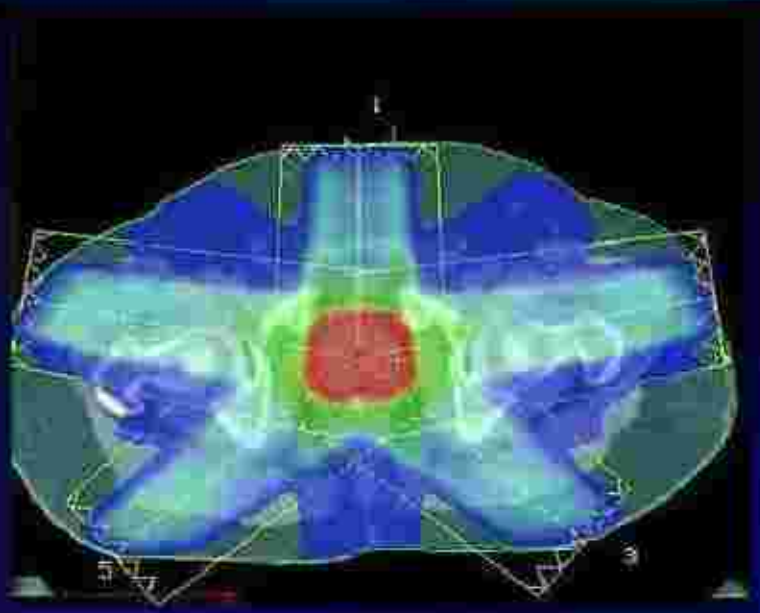
a lot of potential; very exciting



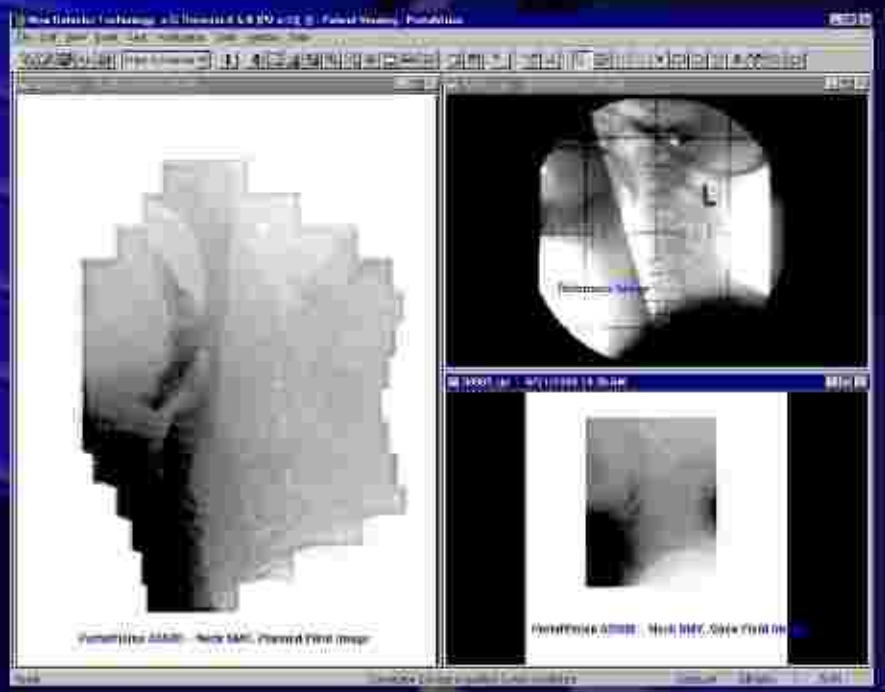
Characteristics

- Sparing of spinal cord
- Sparing of parotid gland
- Dose escalation possible

Treatment Planning and delivery



Daily verification

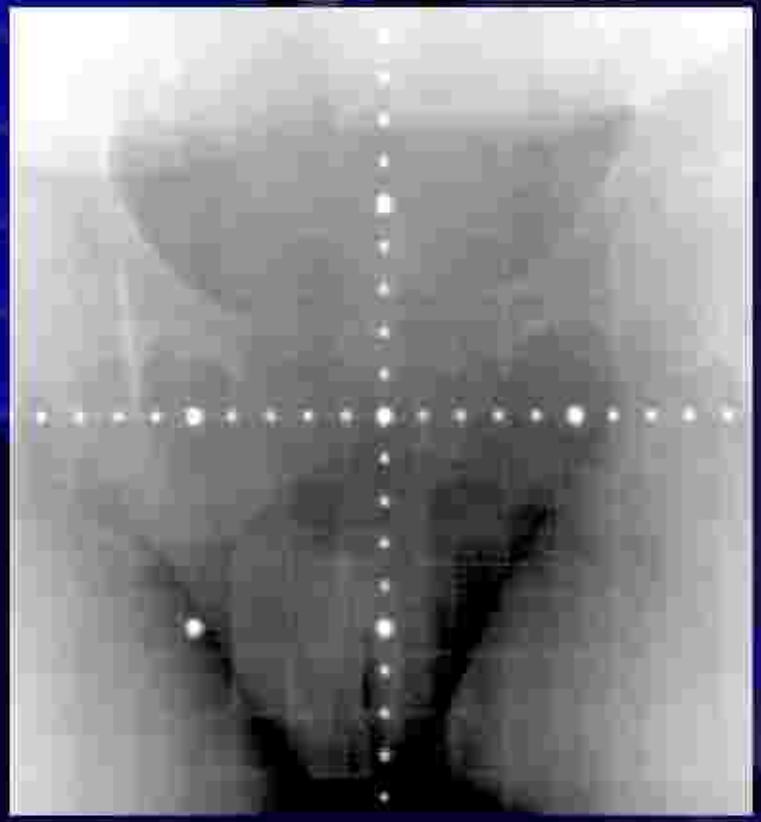


Electronic Portal Imaging Device (EPID)

Cone CT

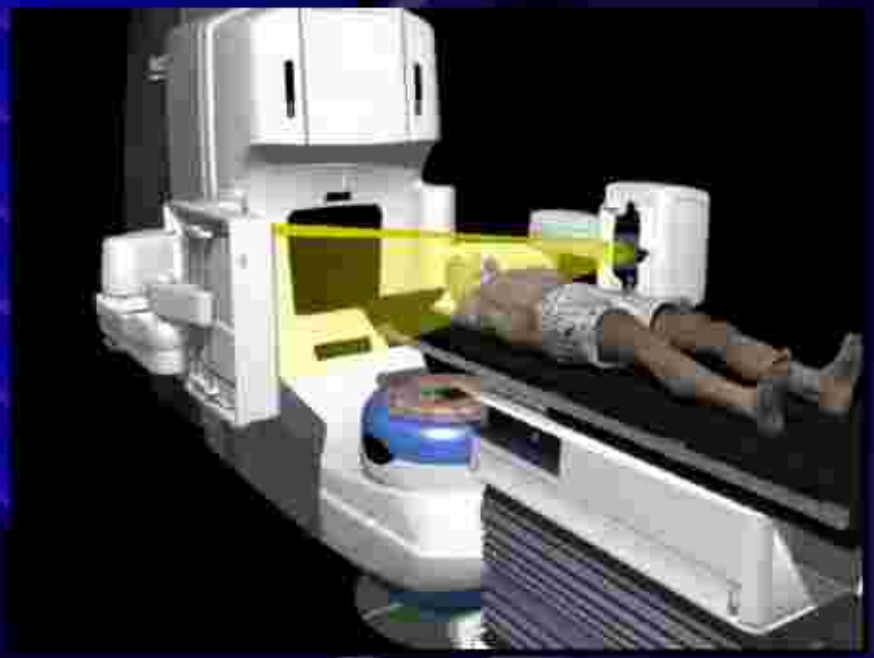
Image guided Radiotherapy (IGRT)

Cone Beam CT Imaging



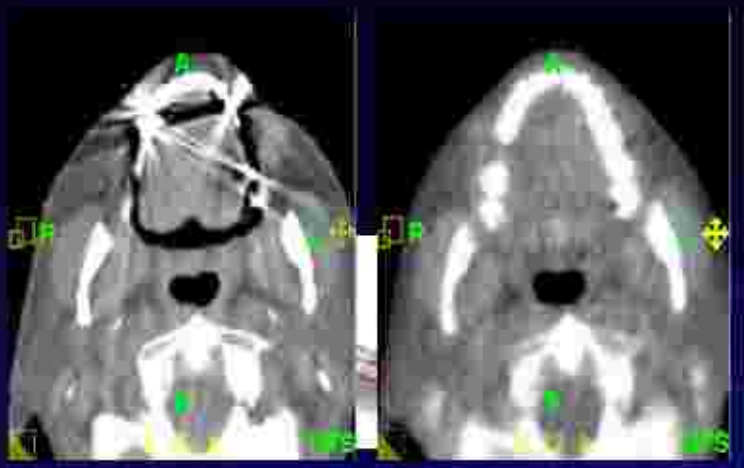
EPID

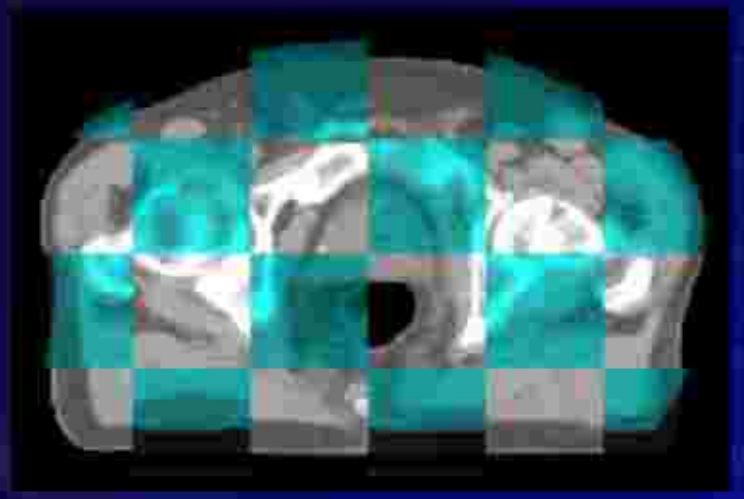
Cone Beam CT



3D Volume acquisition to construct 3D images

Tomotherapy





TomoImage alignment

Role of Radiotherapy

5 common cancers in India

- ✓ Head & Neck squamous cell cancers (HNSCC)
- ✓ Carcinoma breast
- ✓ Carcinoma of uterine cervix
- ✓ Carcinoma esophagus
- ✓ Non small cell lung cancer

Constitute almost 80-85 % of cancer burden

HEAD & NECK CANCER

Radical Radiotherapy

Indications

- ✓ Early stage disease
- ✓ Inoperable (medical contra indications)
- ✓ Surgery is morbid
- ✓ As Organ preservation Protocol

- ✓ Combination of EBRT+Brachy
- ✓ _____ EBRT alone
- ✓ Radical Brachy

HEAD & NECK CANCER

BRACHYTHERAPY

RADICAL

BOOST TO EBRT

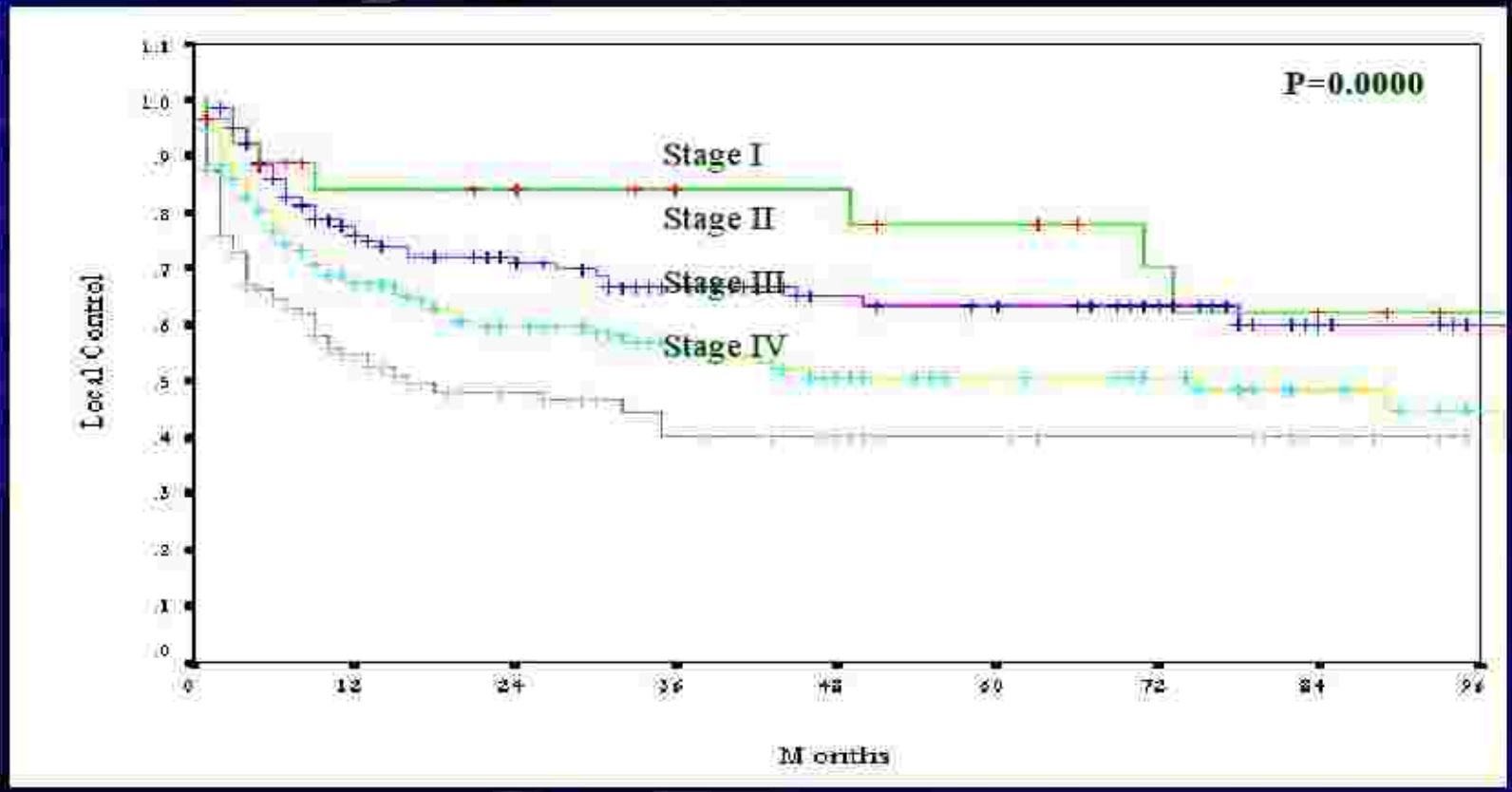
} Primary treatment

PALLIATIVE/ SALVAGE - Recurrent disease

RETREATMENT IN IRRADIATED AREAS - Second primary

FACTORS: Location of lesion
Size < 4 cm
Accessibility
Proximity to cartilage or bones

Head & Neck Cancer: TMH Experience
RADICAL EXT. RADIOTHERAPY (n=568)
1990-1996



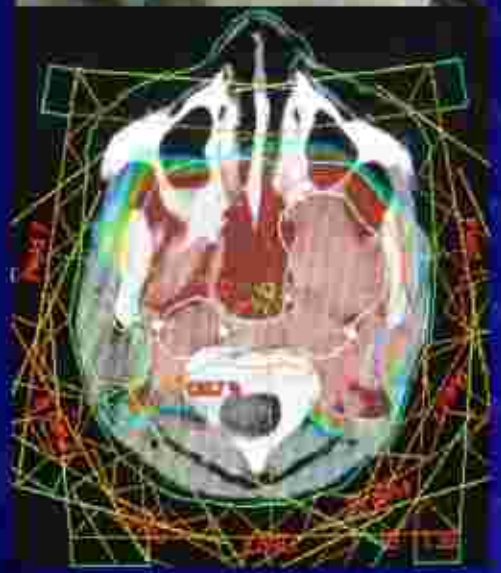
Local Control vs AJCC stage

DINSHAW ET AL 2000

LOCO-REGIONALLY ADVANCED HNSCC

Strategies to improve outcome

- ✓ Chemoradiation
- ✓ Altered fractionation
- ✓ Radiation sensitizers
- ✓ Dose escalation using 3D-CRT or IMRT



TMH Protocol HNSCC: Postoperative radiotherapy (PORT)

Primary site

- Large tumor-T3, T4
- Close or positive margins
- Deeply infiltrative tumor
- High grade histology
- LVE & PNI

Regional nodes

- Bulky nodes N2, N3
- Extranodal extension
- Multiple lymph nodes
- Multiple level nodes

Doses of PORT

Primary & Nodal sites: 50-60 Gy/25-30#/5-6 wks (reducing fields)

R1 or R2 resection: 4-10 Gy boost to residual disease

ROLE OF RADIATION IN BREAST CANCERS

Radiotherapy in Locoregional Disease

- ✓ All women who undergo Breast Conserving Surgery
- ✓ Women undergoing MRM with tumour > 5 cm and/or > 3 axillary nodes +ve
- ✓ Supraclavicular fossa RT if > 3 axill. nodes +ve
- ✓ Axilla only for known residual disease or sometimes incomplete axill. Surgery & +ve nodes (not recommended)

Radiation Therapy after BCT

External Radiation

- ✓ Entire breast with adequate margin
- ✓ 6MV LA- 45 Gy/25#/5 wks
- ✓ Computerized treatment planning to ensure optimal dose homogeneity

TUMOR BED BOOST

- ✓ Interstitial Brachytherapy (implant):

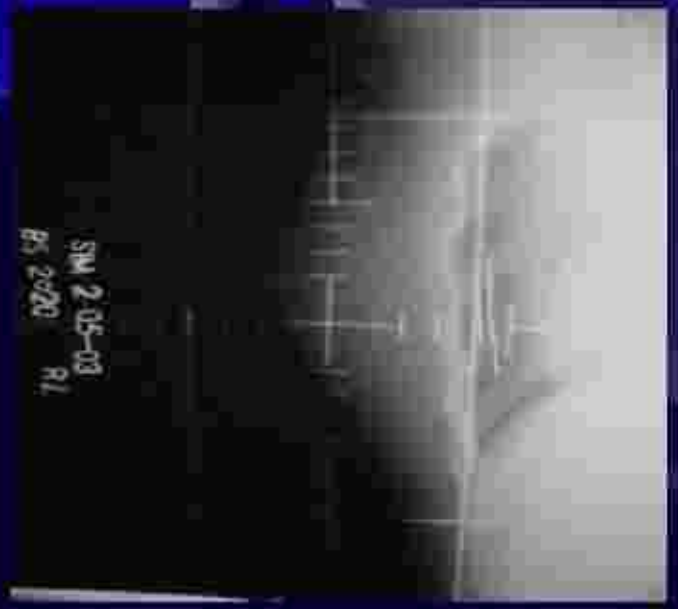
  LDR Ir-192 : 15-20Gy

  HDR Ir-192 : 10 Gy/1 #

- ✓ Electron:

  Appropriate energy (9 to 16 MeV) according to tumour bed depth (clinical data, mammo, CT) to a dose of 15 Gy/6 #

Tangential portals



Tumor Bed Boost

- **Interstitial Brachytherapy (implant):**

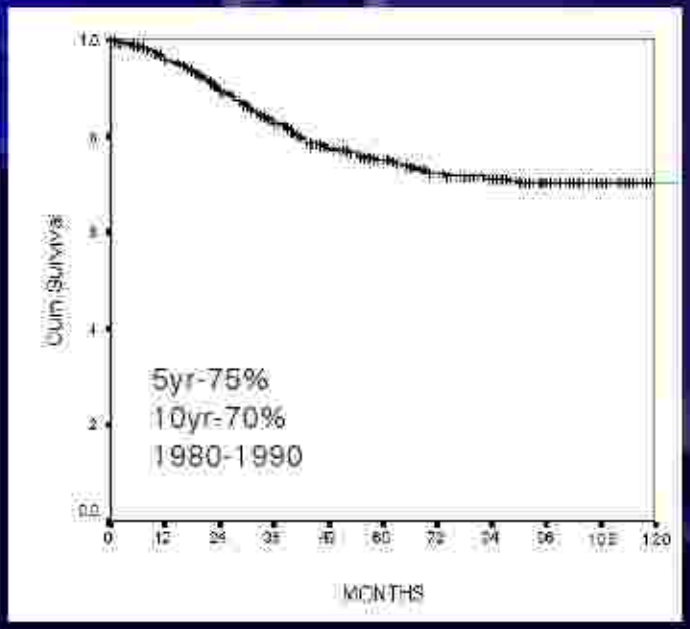
  Low Dose Rate(LDR) Ir-192 : 15-20Gy

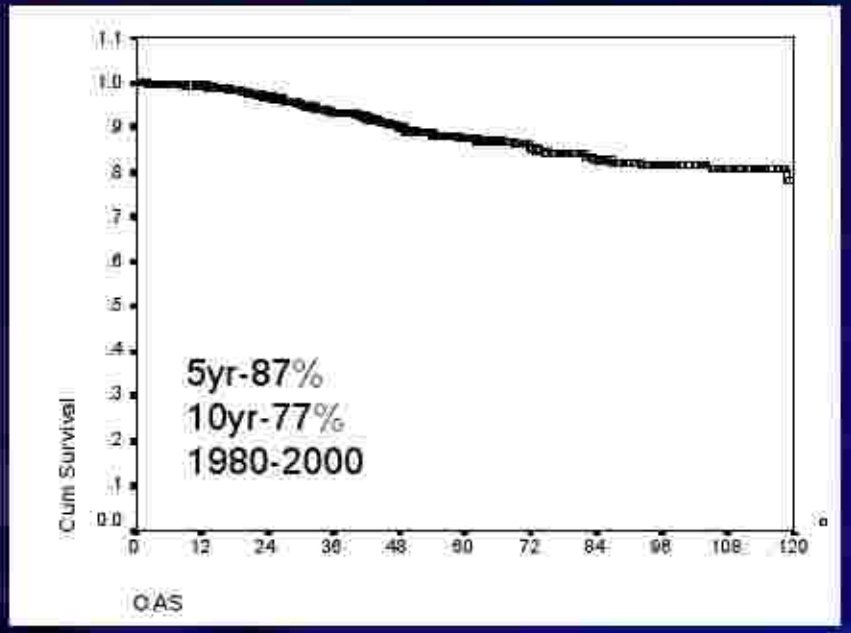
  High Dose Rate (HDR) Ir-192 : 10 Gy/1 #

- **Electron:**

  Appropriate energy (9 to 16 MeV) according to tumour bed depth (clinical data, mammo, CT) to a dose of 15 Gy/6 #

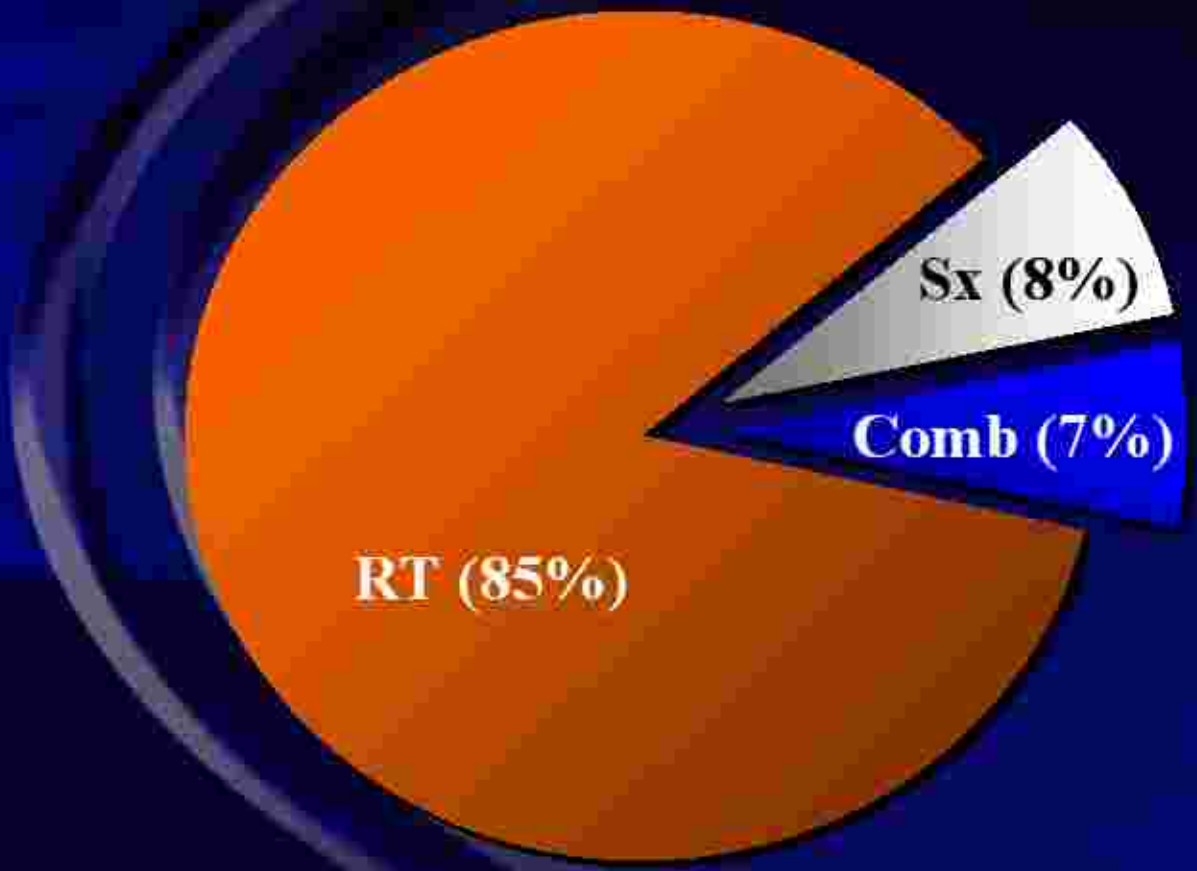
Comparison of MRM vs BCT





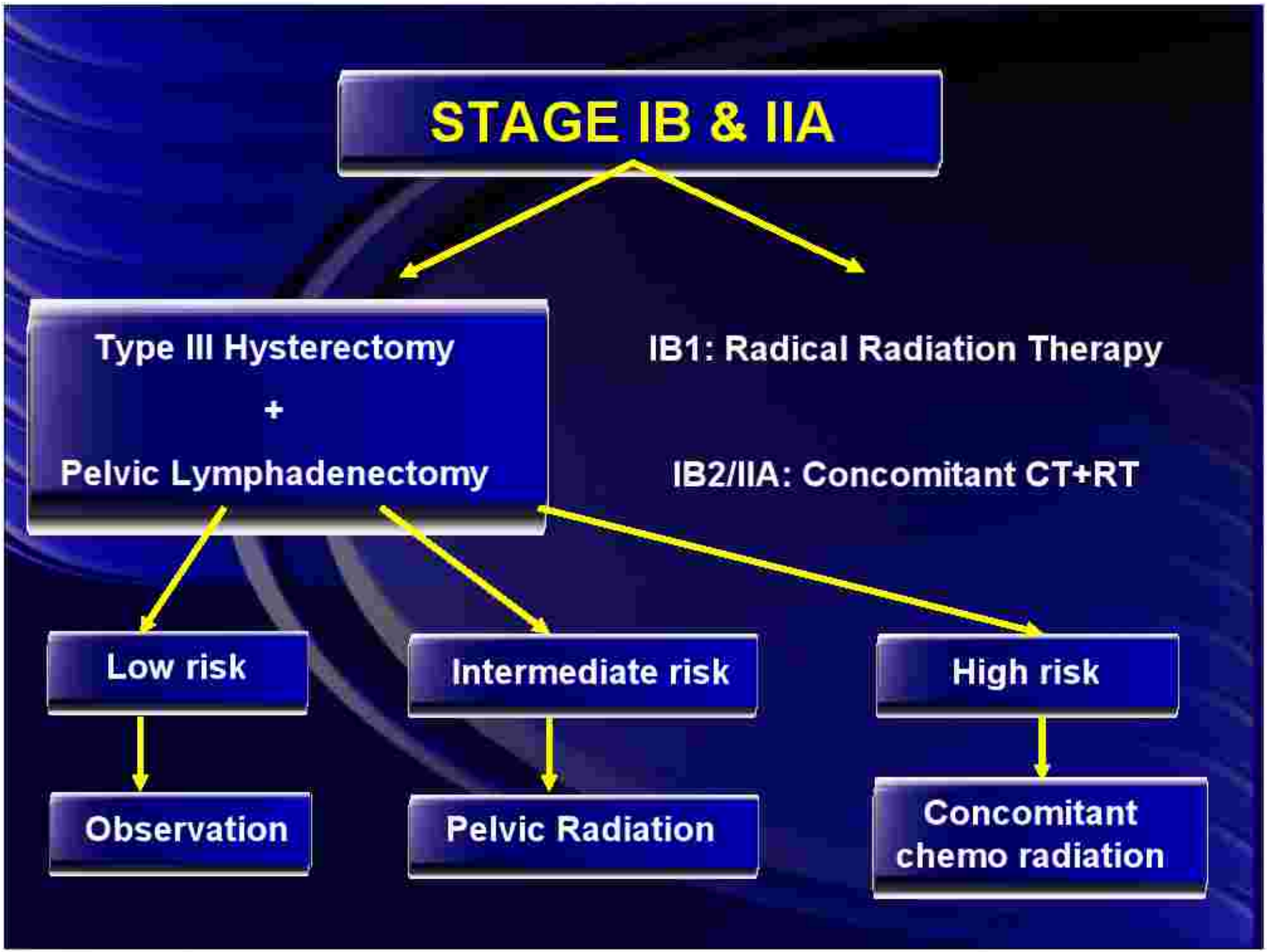
OVERALL SURVIVAL

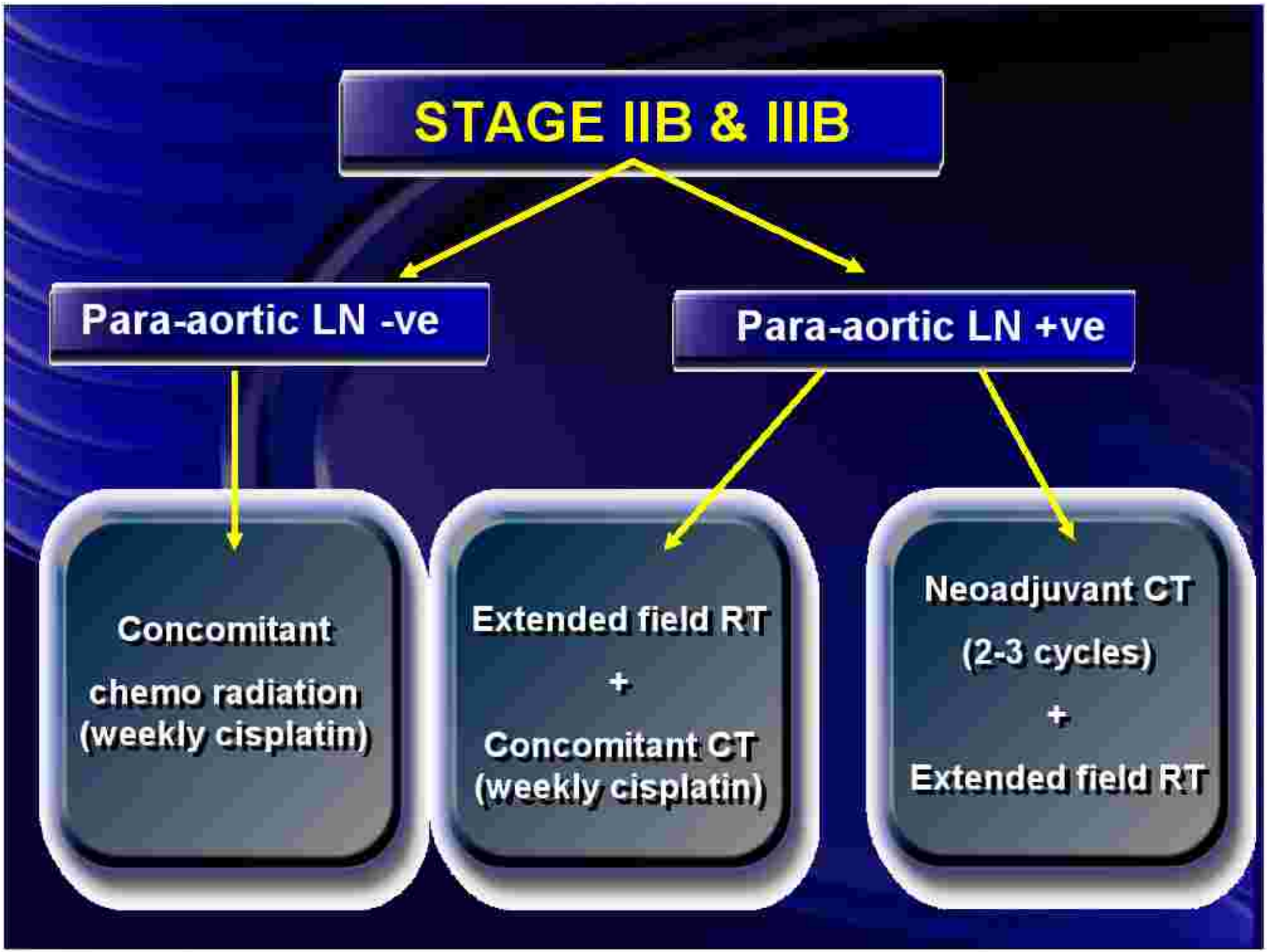
The role of Radiotherapy in carcinoma of uterine cervix



TREATMENT PATTERNS IN CARCINOMA CERVIX

TMH Cancer Registry 1997


STAGE IB & IIA
Type III Hysterectomy
+
Pelvic Lymphadenectomy
IB1: Radical Radiation Therapy
IB2/IIA: Concomitant CT+RT
Low risk
Intermediate risk
High risk
Observation
Pelvic Radiation
Concomitant chemo radiation


STAGE IIB & IIIB
Para-aortic LN -ve
Para-aortic LN +ve
Concomitant
chemo radiation
(weekly cisplatin)
Extended field RT
+
Concomitant CT
(weekly cisplatin)
Neoadjuvant CT
(2-3 cycles)
+
Extended field RT

CA. CERVIX 1979-1994

STAGE IB & IIA (952 pts)

Disease free survival

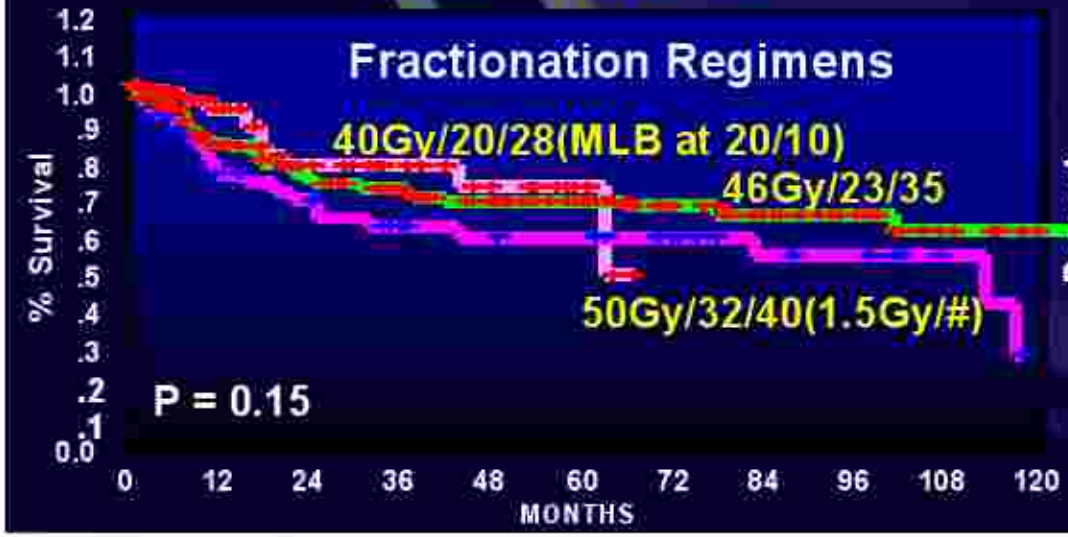
TREATMENT MODALITY

- **Sx ALONE (303 PTS)**
- **PREOP RT + Sx (293 PTS)**
- **RT ALONE (356 PTS)**

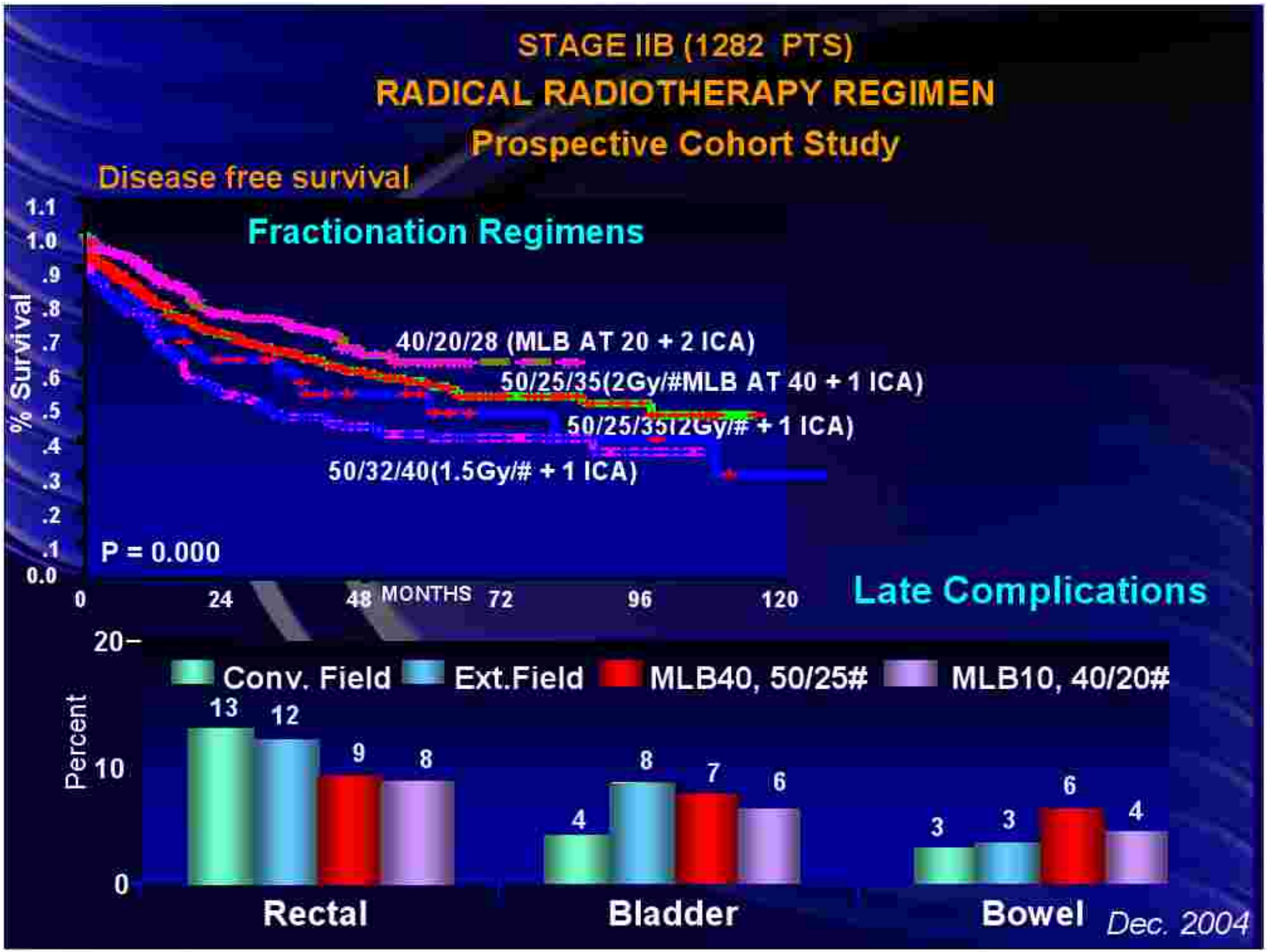
STAGES IB & IIA (356 pts)

RADICAL RADIOTHERAPY REGIMEN

Disease free survival



Dec. 2004


STAGE IIB (1282 PTS)
RADICAL RADIOTHERAPY REGIMEN
Prospective Cohort Study
Disease free survival
Fractionation Regimens
% Survival
1.1
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0.0
40/20/28 (MLB AT 20 + 2 ICA)
50/25/35(2Gy/#MLB AT 40 + 1 ICA)
50/25/35(2Gy/# + 1 ICA)
50/32/40(1.5Gy/# + 1 ICA)
P = 0.000
0
24
48
MONTHS
72
96
120
Late Complications
20
10
0
Percent
Conv. Field
Ext.Field
MLB40, 50/25#
MLB10, 40/20#
13
12
9
8
4
8
7
6
3
3
6
4
Rectal
Bladder
Bowel
Dec. 2004

Other sites where RT is used commonly

- Esophagus
- Lung
- Prostate
- Brain tumors
- Anal canal/ Rectum
- Soft Tissue Sarcomas
- Lymphomas (HD & NHL)
- Penile cancers
- Pediatric solid tumors
- Urinary Bladder

Oncological Emergencies

- ✓ Cord compression
- ✓ SVC compression
- ✓ Brain Metastasis
- ✓ Impending fracture
- ✓ Tumor bleed
- ✓ Nerve root compression
- ✓ Hypercalcemia
- ✓ Tumor lysis syndrome

Preventive Oncology

- ✓ Early detection of cervical and breast cancer
- ✓ Down staging of common cancers
- ✓ Prevention of tobacco related cancers.

Palliative Care

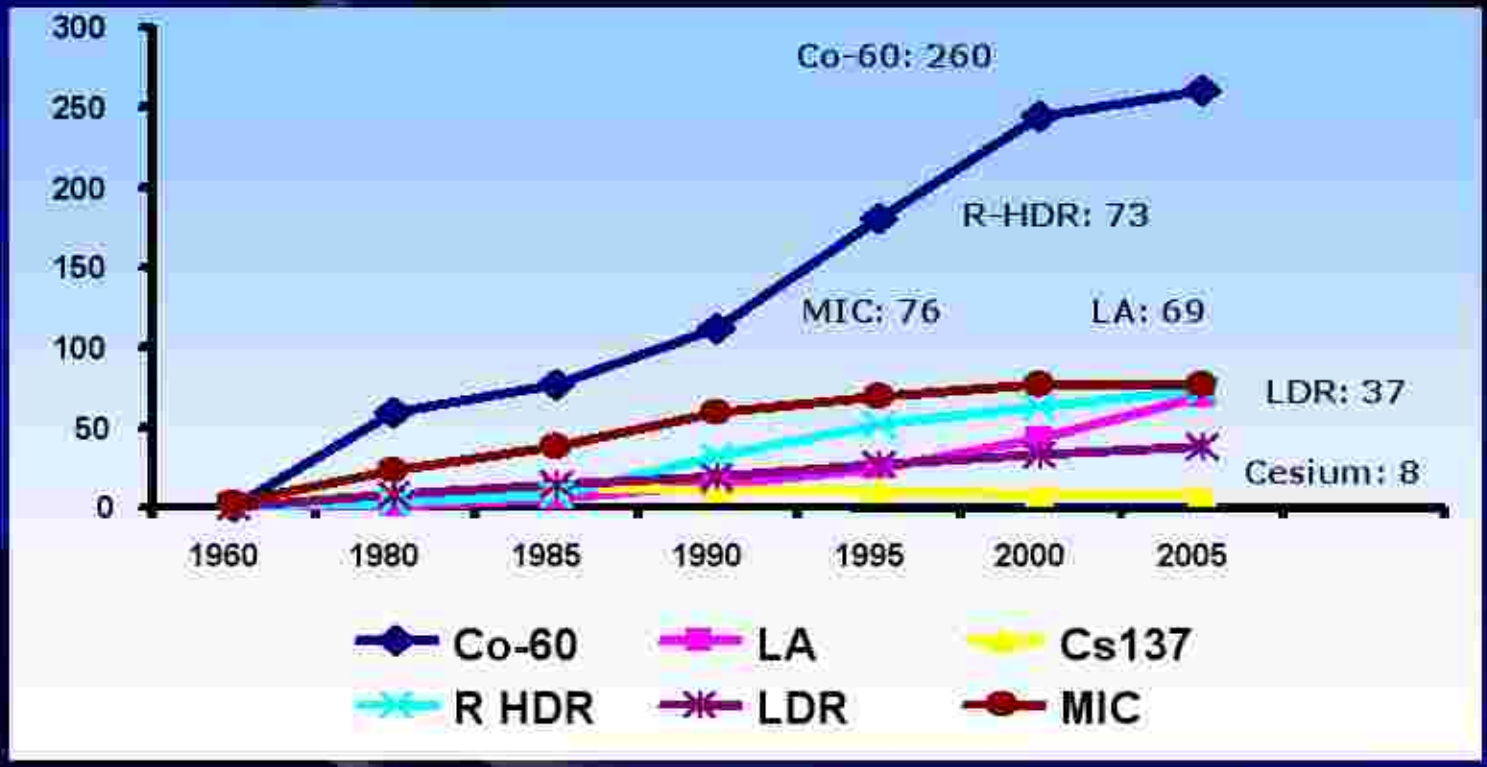
Symptom relief

Psychosocial support

Teamwork and partnership

Growth of RT infrastructure in India over the years

	Population	Tele-den /million	Tele-units	Co-60	LA	Cs-137	Brach units	LDR	HDR	MIC
India	1027000000	0.33	337	260	69	8	186	37	73	76

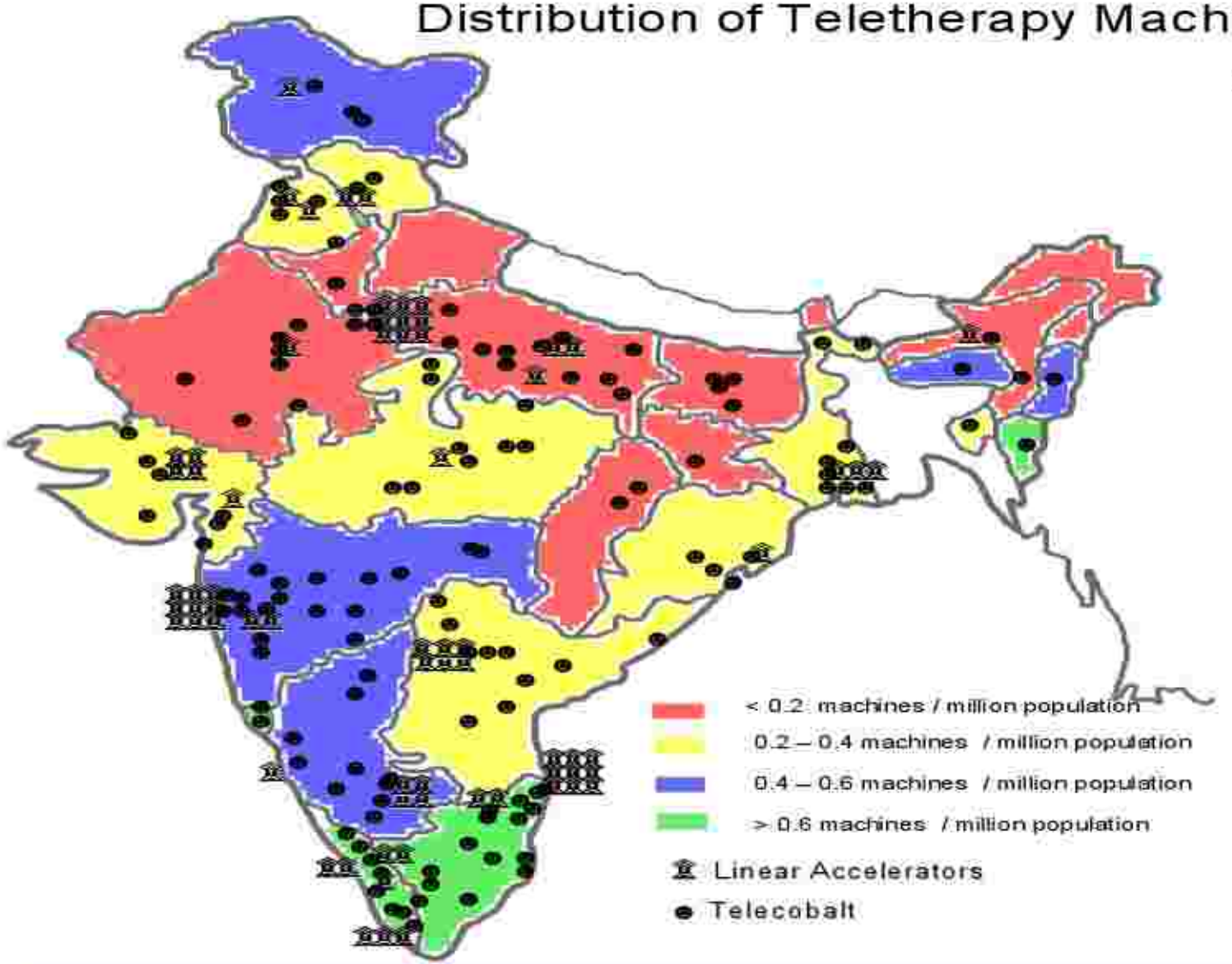


1962-1986 -- 76 Co-60 & Cs-137 units (> 20 years old): Definitely need replacement
1987-1991 -- 35 Co-60 units (> 15 years old): Should be considered for replacement
Pre 1991 LA -- 12 units (>15 years old): Could be considered for replacement

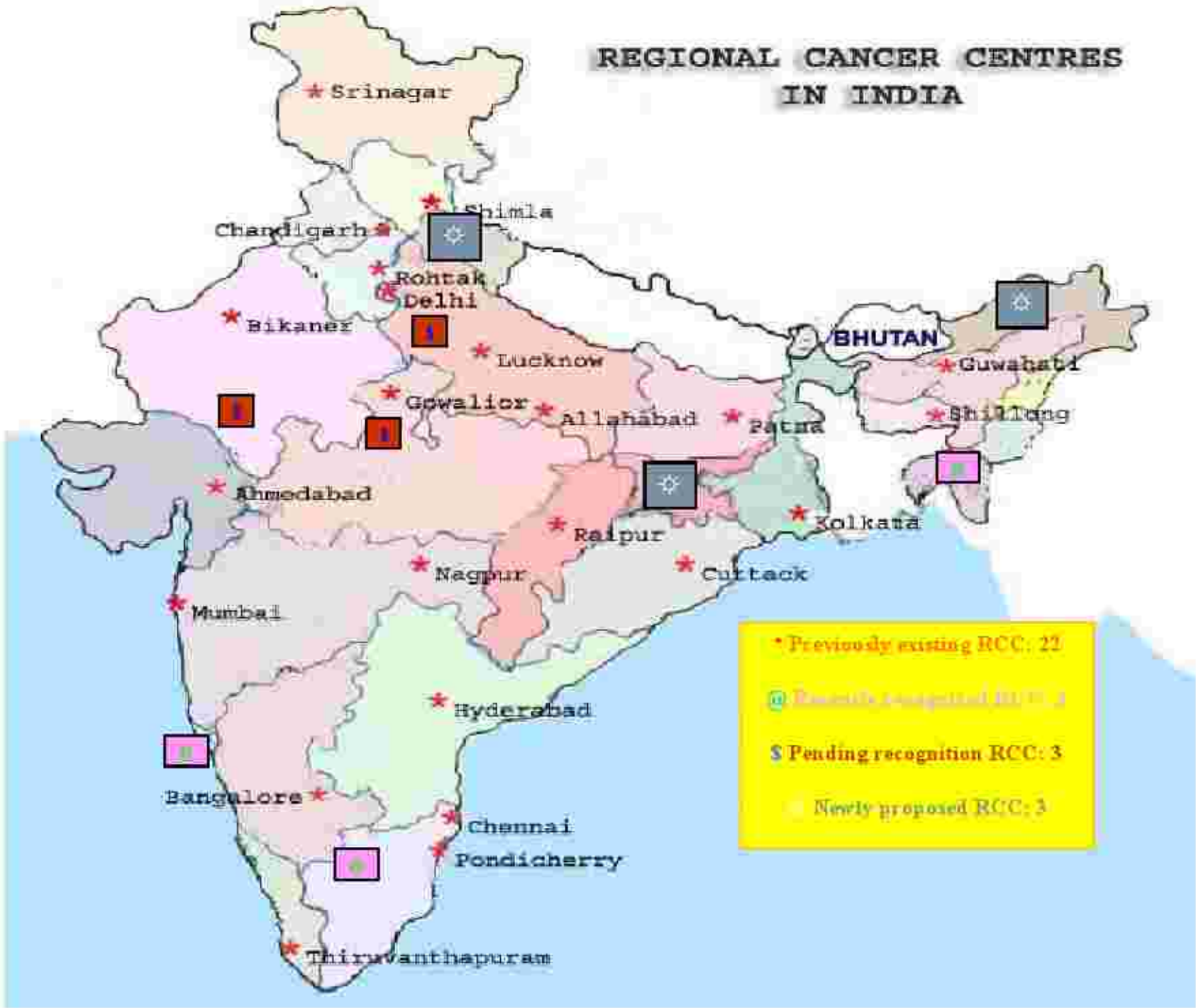
123/337 teletherapy units need replacement

Distribution of Teletherapy Machines: India

December 2(



International norm: 2 machines/million population


REGIONAL CANCER CENTRES IN INDIA
Srinagar
Shimla
Chandigarh
Rohtak
Delhi
Bikaner
Lucknow
Gwalior
Allahabad
Patna
BHUTAN
Guwahati
Shillong
Ahmedabad
Raipur
Kolkata
Nagpur
Cuttack
Mumbai
Hyderabad
Bangalore
Chennai
Pondicherry
Thiruvanthapuram
* Previously existing RCC: 22
@ Recently recognized RCC: 3
$ Pending recognition RCC: 3
Newly proposed RCC: 3

Radiation Oncology Infrastructure
Gap between demand and supply

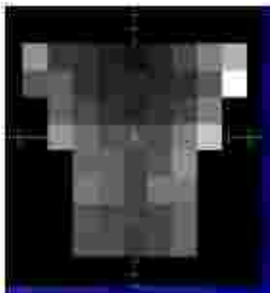
Equipment

Parameter	*Current Existing*	*Ideal Scenario* (international norms)*
Tele-density	0.33 per million population	2 per million population
Tele-units	337 (includes 76 units >20 years old)	2000
Brachytherapy	186 (0.19 per million)	330 (0.33 per million population)
Simulator	41	1 per RT centre
3-D TPS	48	1 per RT centre

Radiation Oncology Infrastructure
Gap between demand and supply

Personnel

Parameter	*Current Existing*	*Ideal Scenario** *(international norms)*
Radiation Oncologist	700 (1 per 715 patients annually)	2000 (1 per 250 patients annually)
Medical Physicist	500 (1 per 1000 patients annually)	1250 (1 per 400 patients annually)
Dosimetrist	Nil	500 (1 per 1000 patients annually)
RT Technologist	700 (2 per MV unit)	8000 (4 per MV units)



Summary

- ✓ Radiotherapy plays a very important role in the treatment of cancer
- ✓ Organ preservation protocols have made the role of Radiation Oncologist extremely important and central in the cancer care
- ✓ Radiation Oncologist are also important link in early detection, oncological emergencies and palliative care
- ✓ With advances in technology Radiation Oncology is becoming a very exciting branch
- ✓ With the increasing cancer burden there is need for more trained Radiation Oncologist in the country