Head and Neck Radiotherapy Transition from 2D to Adaptive Radiotherapy

Dr R K Vyas

MD Radiotherapy

Director, GCRI, Ahmedabad

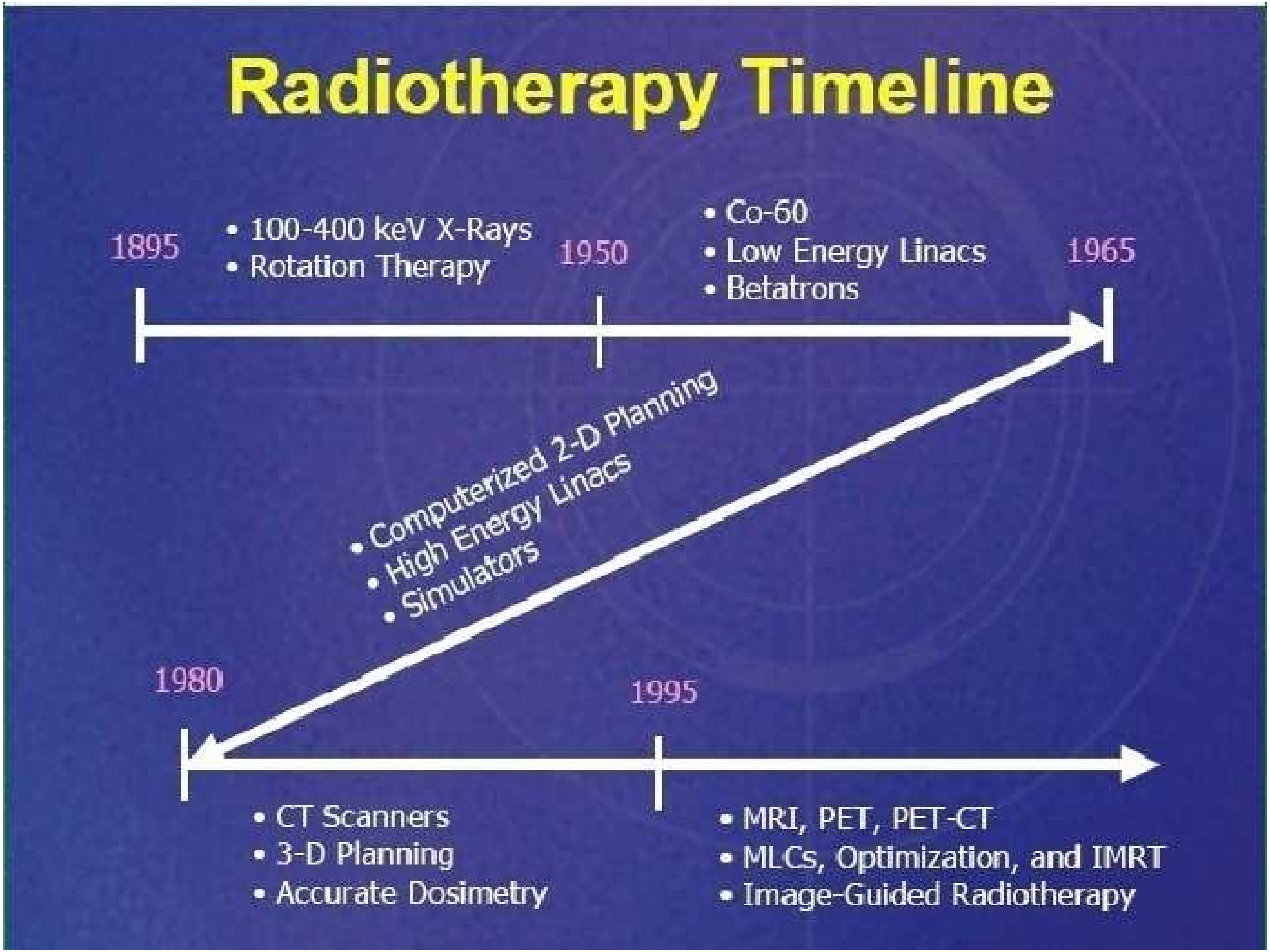
AIM OF RADIOTHERAPY IN HEAD AND NECK

- Radiotherapy remains integral part of treatment of Head and neck malignancies, in curative, post operative and palliative set ups.

- **Aim:**
- Highest possible locoregional control
- Preservation of function
- Good Cosmetic results
- Good quality of life

SPECIFIC OBJECTIVES

- *To identify*
  1) Differences between 2D-RT and 3D-CRT
  2) Chain of processes in 3D-CRT
  3) Transiting from 2D-RT to 3D-CRT
  4) Impact of IMRT
  5) Ultimate goal – Adaptive RT


Radiotherapy Timeline
1895
• 100-400 keV X-Rays
• Rotation Therapy
1950
• Co-60
• Low Energy Linacs
• Betatrons
1965
• Computerized 2-D Planning
• High Energy Linacs
• Simulators
1980
1995
• CT Scanners
• 3-D Planning
• Accurate Dosimetry
• MRI, PET, PET-CT
• MLCs, Optimization, and IMRT
• Image-Guided Radiotherapy

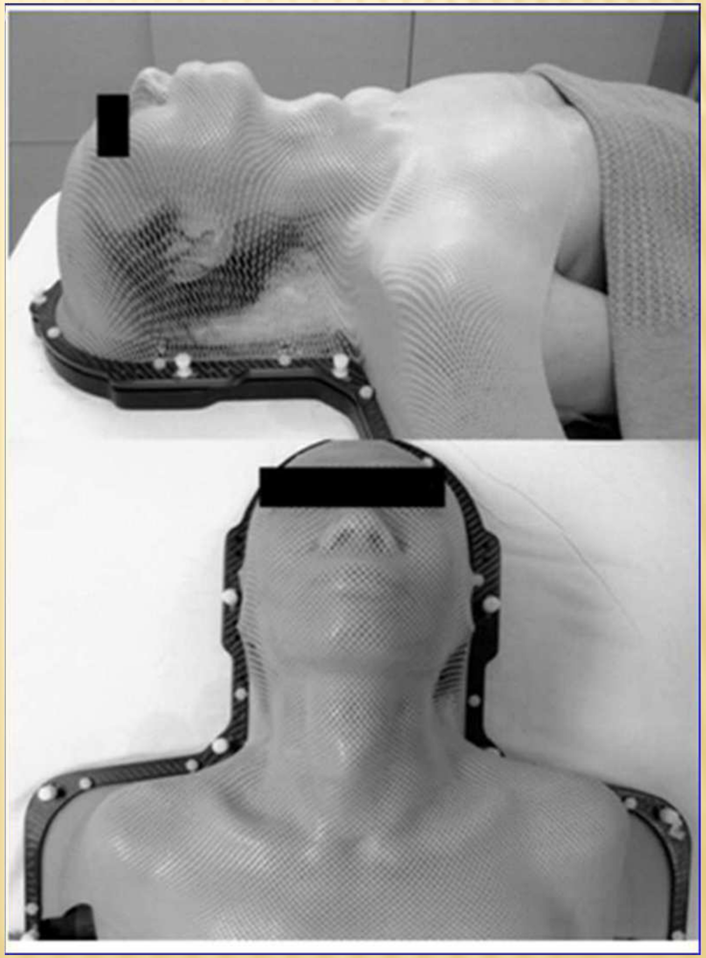
CONVENTIONAL 2D-RT - 1960S

- Simple treatment delivers uniform doses from 2-4 beam angles.
- Beam shape is either rectangular or square.
- Beam hits healthy tissue as well as tumor tissues
- Doses have to be kept low to minimize harm to normal tissue

STEPS FOR 2D PLANNING

Positioning

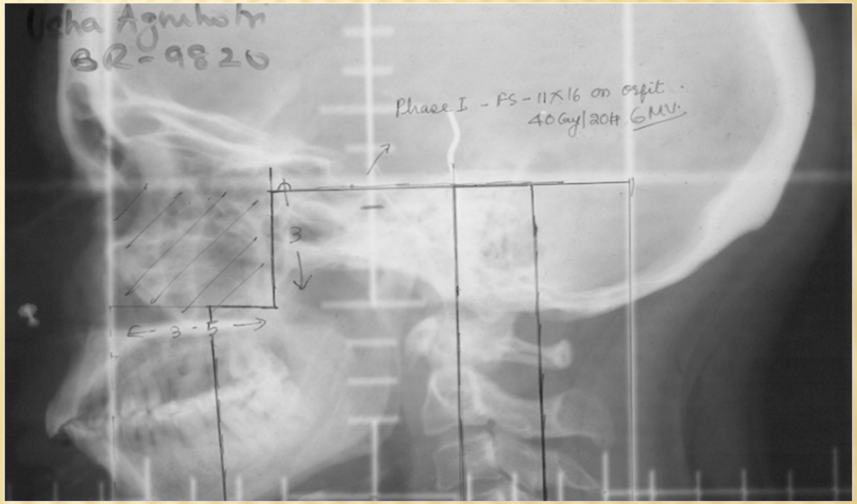
- Supine position (usual)
- Head - extended
- Immobilization- custom-made thermoplastic cast



TWO-DIMENSIONAL (2D) RT FOR HEAD-NECK CANCERS

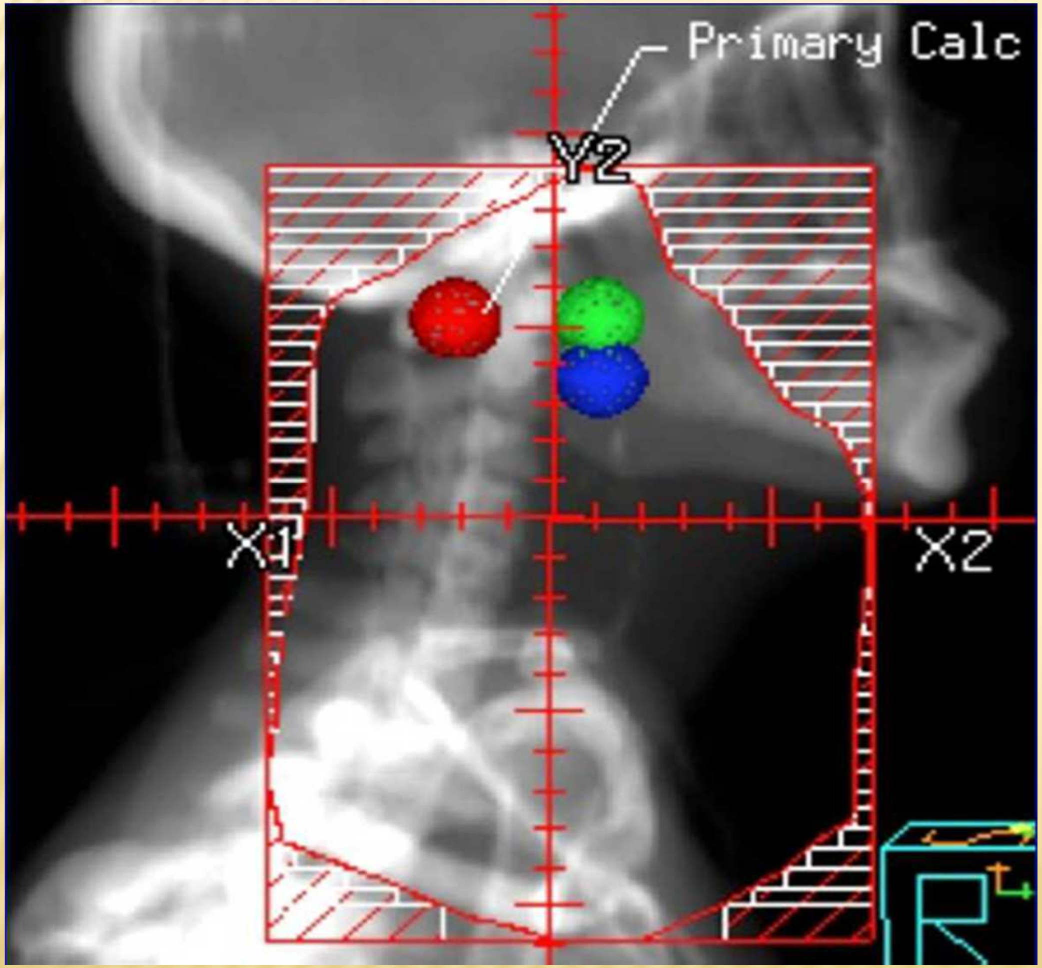
Treatment area - drawn on orthogonal simulator films.

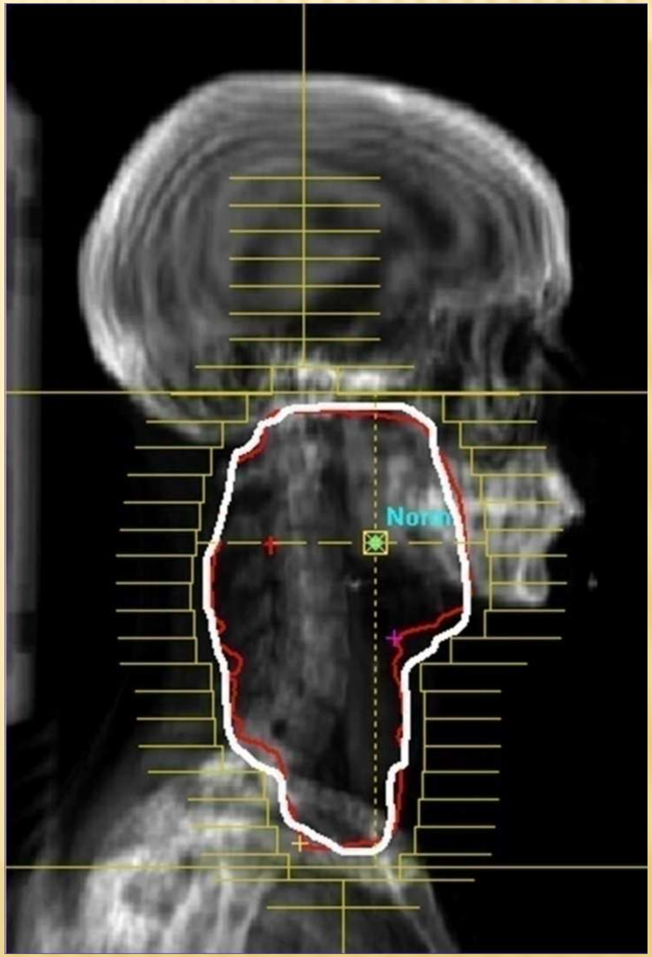
Field- Bilaleral or antero lateral Wedge pair portals



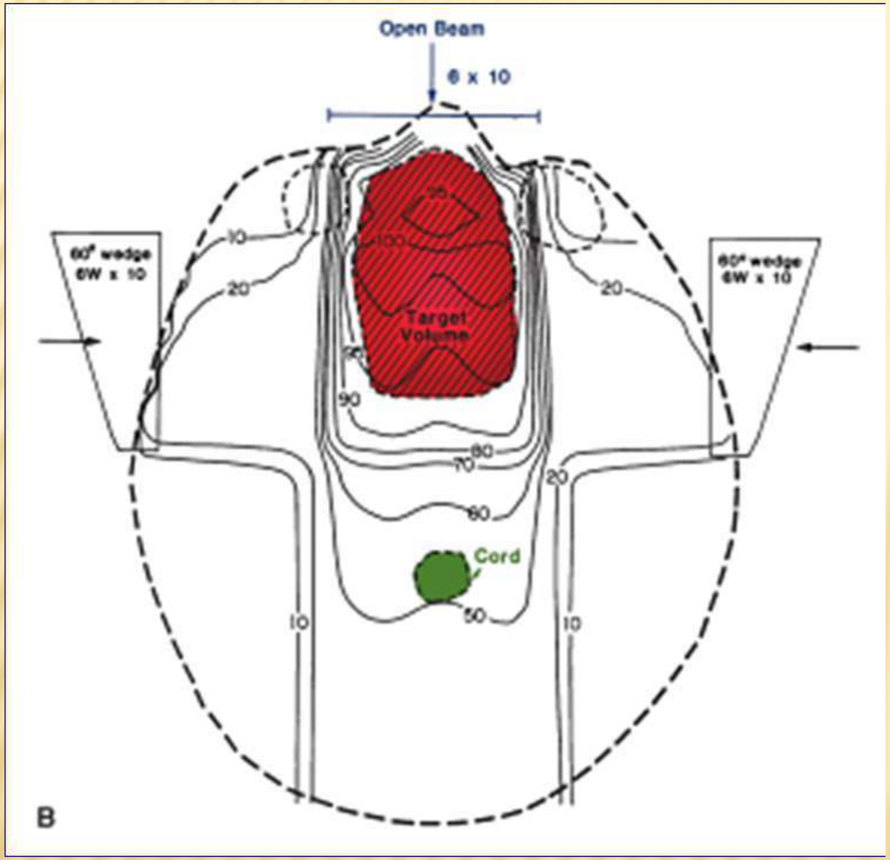
- Matching third low anterior neck field-added sometimes
- Treatment planning with isodose plans on 1-3 planes

2D-RT (CONVENTIONAL OPEN FIELDS)
2.5D-RT (CONVENTIONAL SHAPED FIELDS)

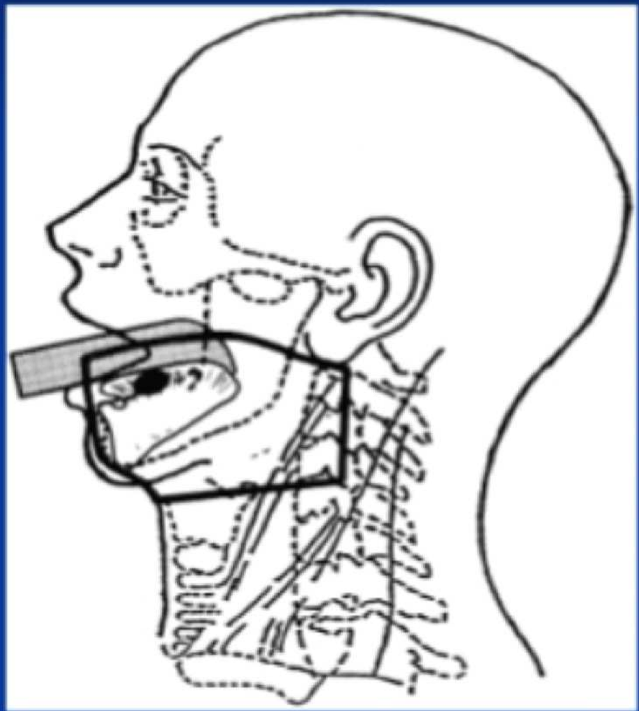


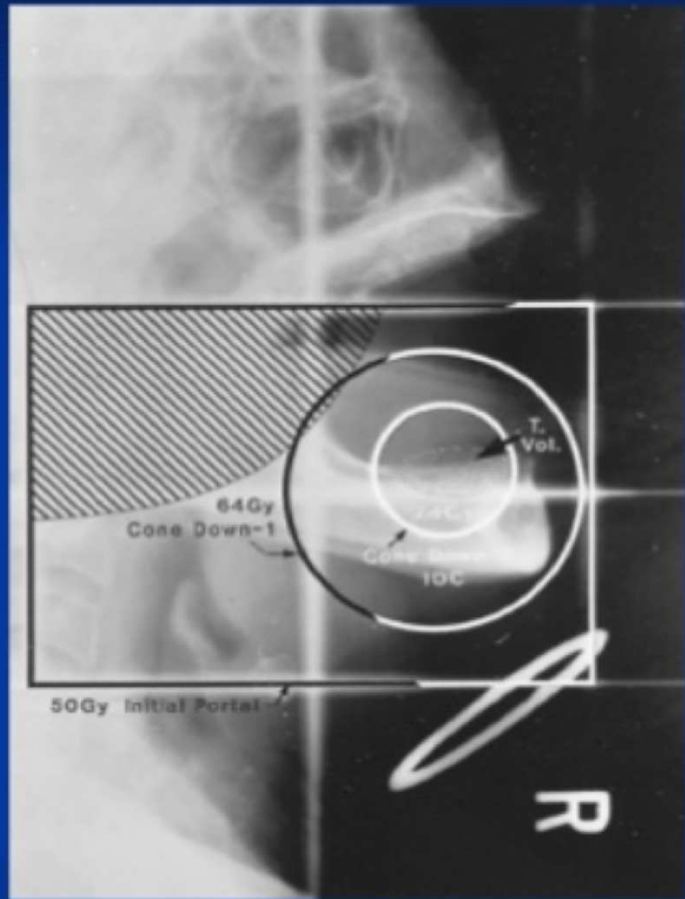


2D RADIATION TREATMENT PLANNING



Conventional 2D Planning





BENEFITS OF 2D PLAN

- Optimal field margins
- Large enough to prevent regrowth of the tumour
- Limited enough to prevent excessive irradiation to normal tissue
- Optimal dose distribution

CHALLENGES IN OPTIMAL DELIVERY OF CONVENTIONAL RADIOTHERAPY FOR HEAD-NECK CANCERS

- Close proximity of tumour to organs at risk.
- Tolerance of normal tissues limits the delivery of optimum high dose.
- Contour variation and tissue inhomogenity.
- Set up uncertainties.

3D-CRT
(CONFORMAL RADIOTHERAPY)

- Tumour volume and critical structures are drawn slice by slice on CT/MR Images
- BEV (Beam's eye view) are created
- Complex set of 4-6 beams with precise immobilization
- Tight margins are used

RATIONALE OF CONFORMAL RADIOTHERAPY

- Achievement of Dose Escalation

  -To Improve Loco-regional control

  -To improve disease free and overall survival

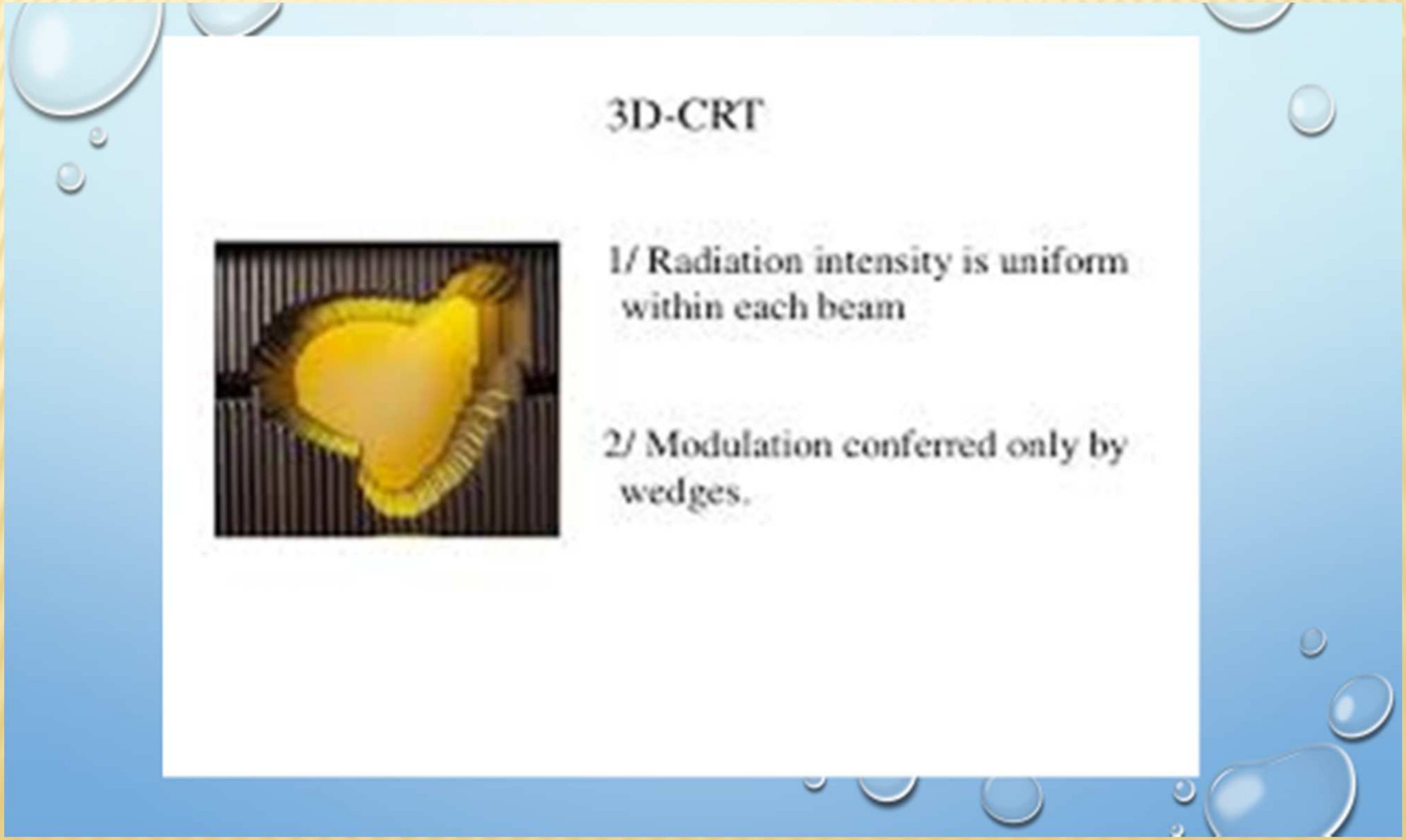
- Reduction in normal tissue complications

  -To improve quality of life

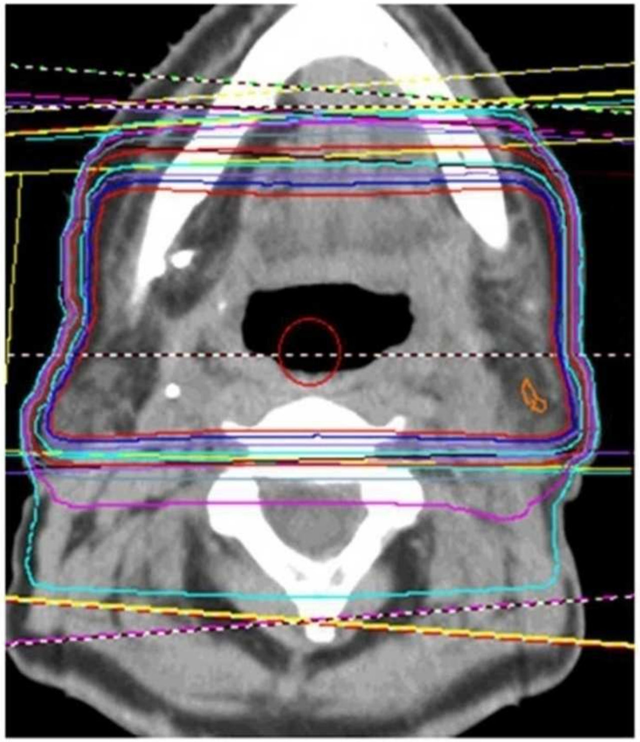
BEAM MODIFICATION IN CONFORMAL RT

- Multiple fields including oblique and non co-planar beams.
- Varying weightage and wedges.
- Multi-leaf collimators
- Shaped blocks- Cerrobend blocks or MLC

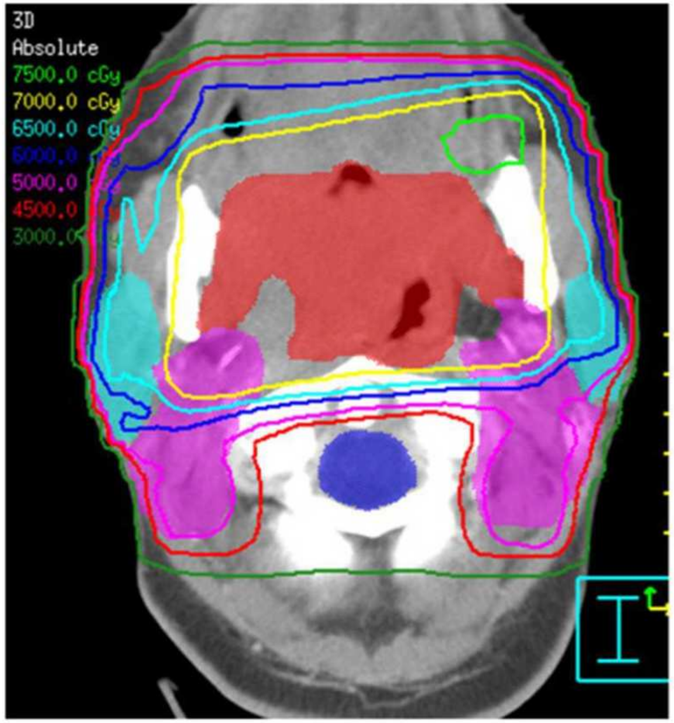
MULTI-LEAF COLLIMATOR (MLC):
TRUE ENABLER OF CONFORMAL RADIOTHERAPY



2-DIMENSIONAL CONFORMAL RADIOTHERAPY TO 3 - DIMENSIONAL CONFORMAL RADIOTHERAPY



2D RT



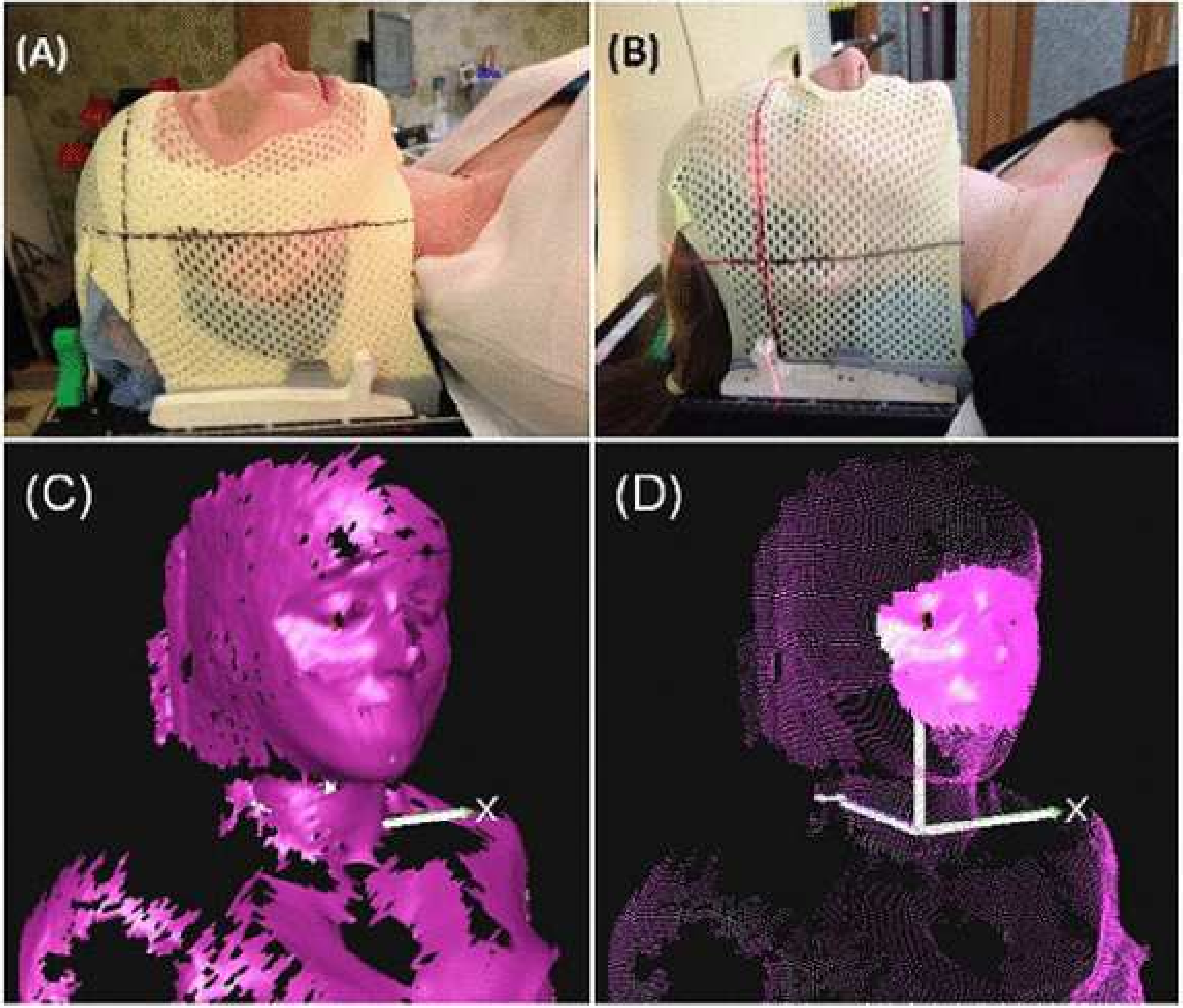
3D CRT

TYPES OF ERRORS

- Discrepancy in intended and actual treatment position
- Systemic positioning errors
- Target delineation errors
- Recurring errors
- Treatment plan transcription errors

IMMOBILIZATION

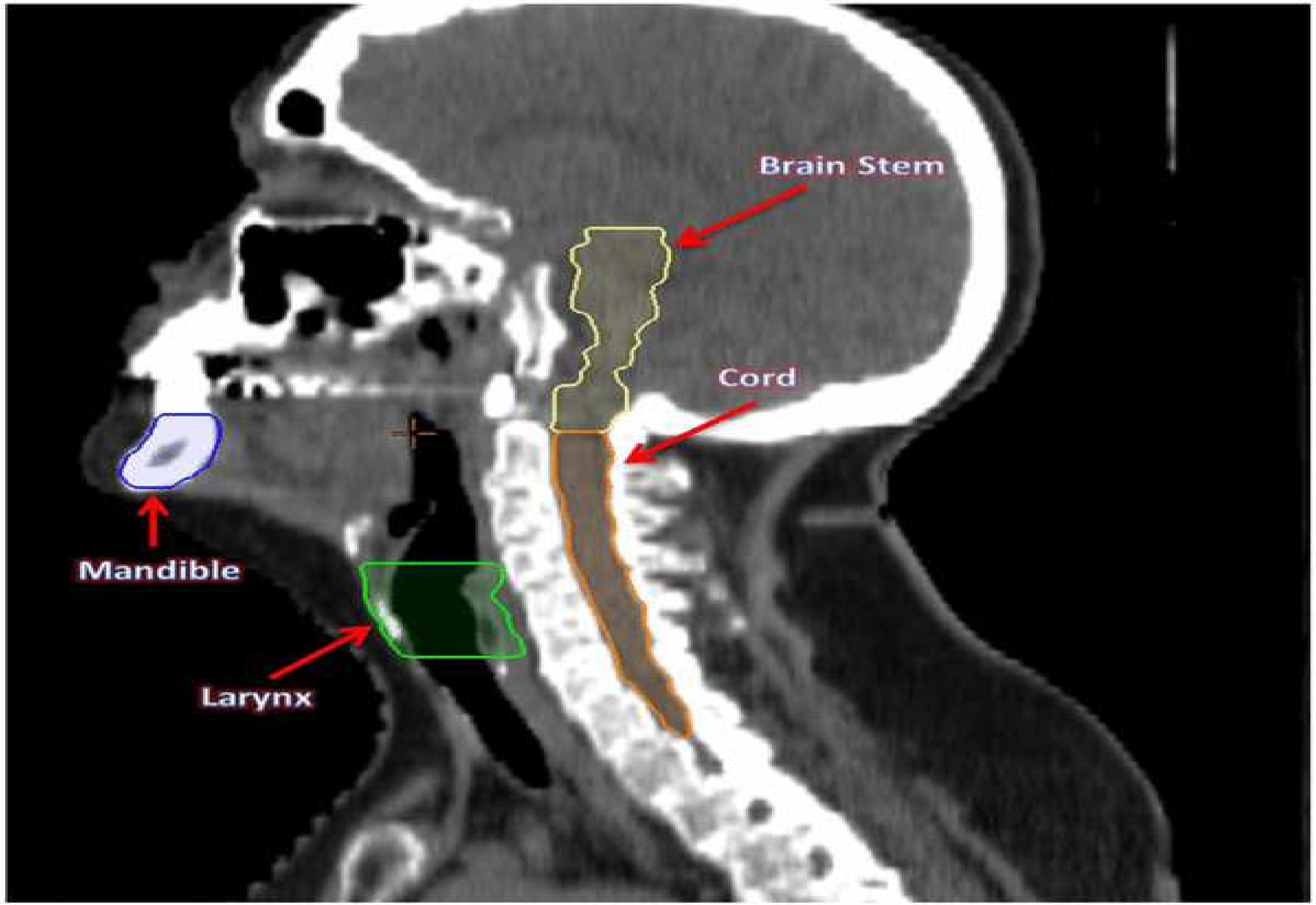
- Patient immobilization is the most important step for all types of conformal therapy.


(A)
(B)
(C)
(D)
X
X

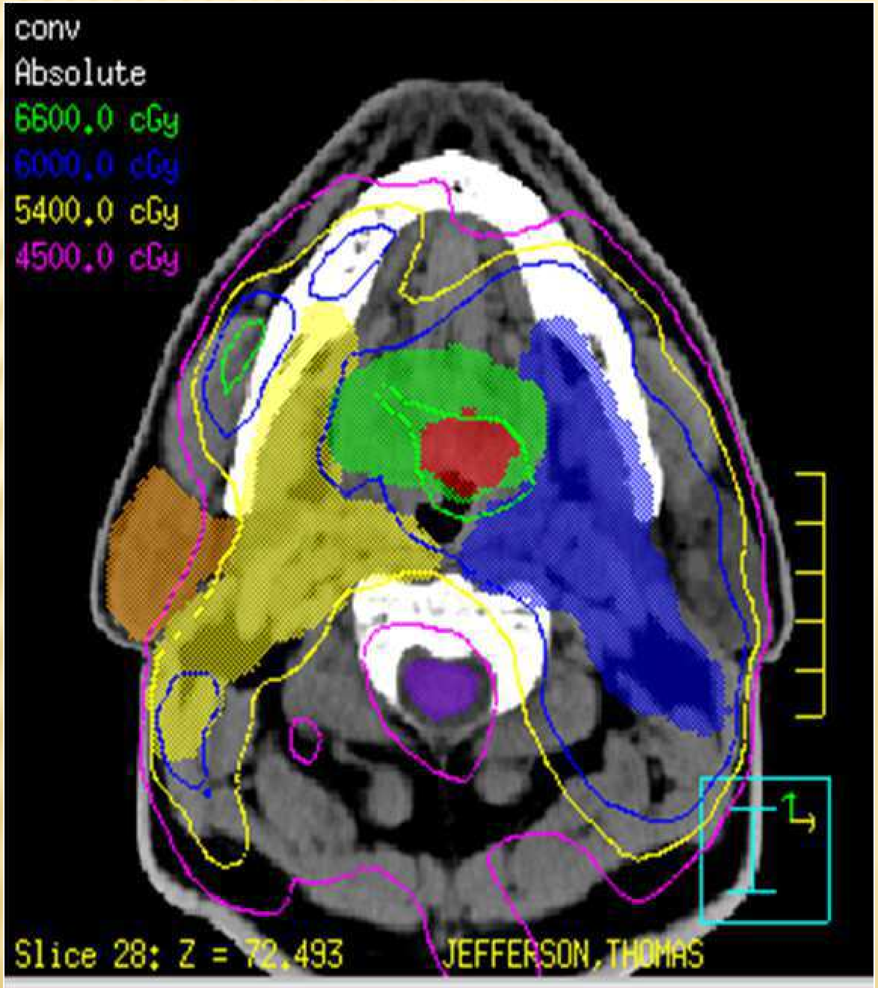
CT-SIMULATION:
IMAGING FOR CONFORMAL PLANNING

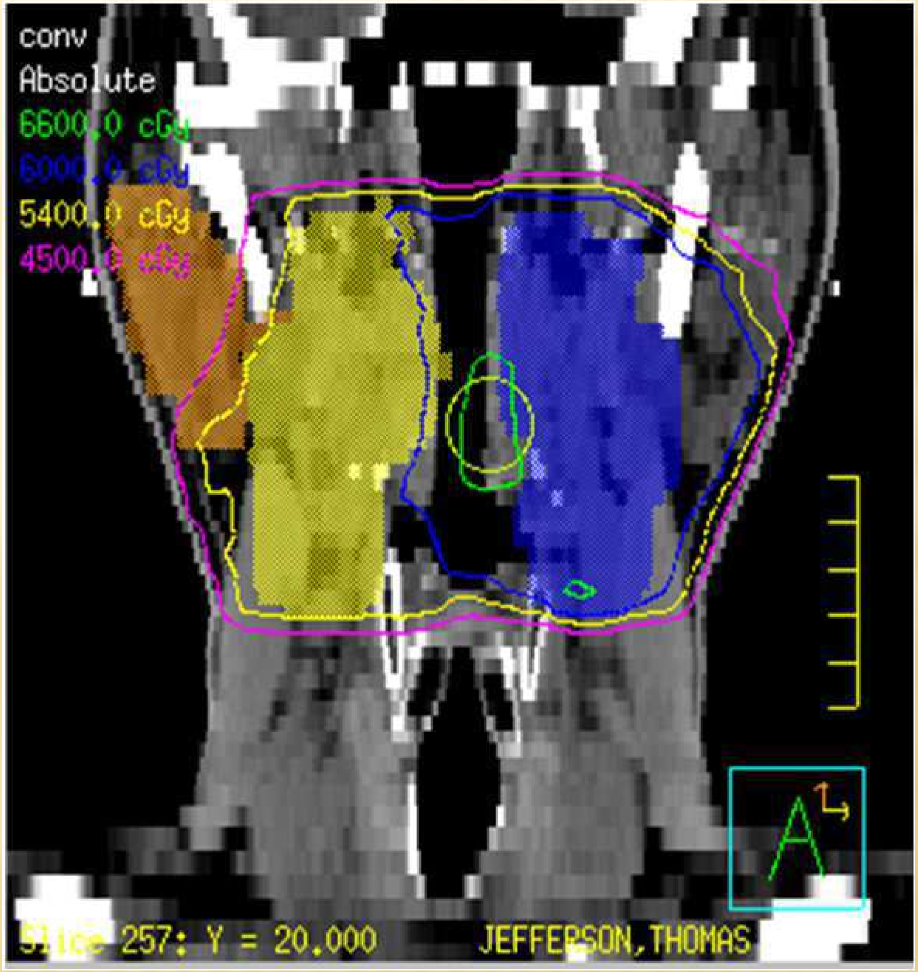
- High Resolution Diagnostic images
- 3-D Reconstruction capabilities
- 3-D Tumour / OAR localisation
- Networked to Treatment Planning

OAR DELINEATION



NORMAL STRUCTURE DELINEATION

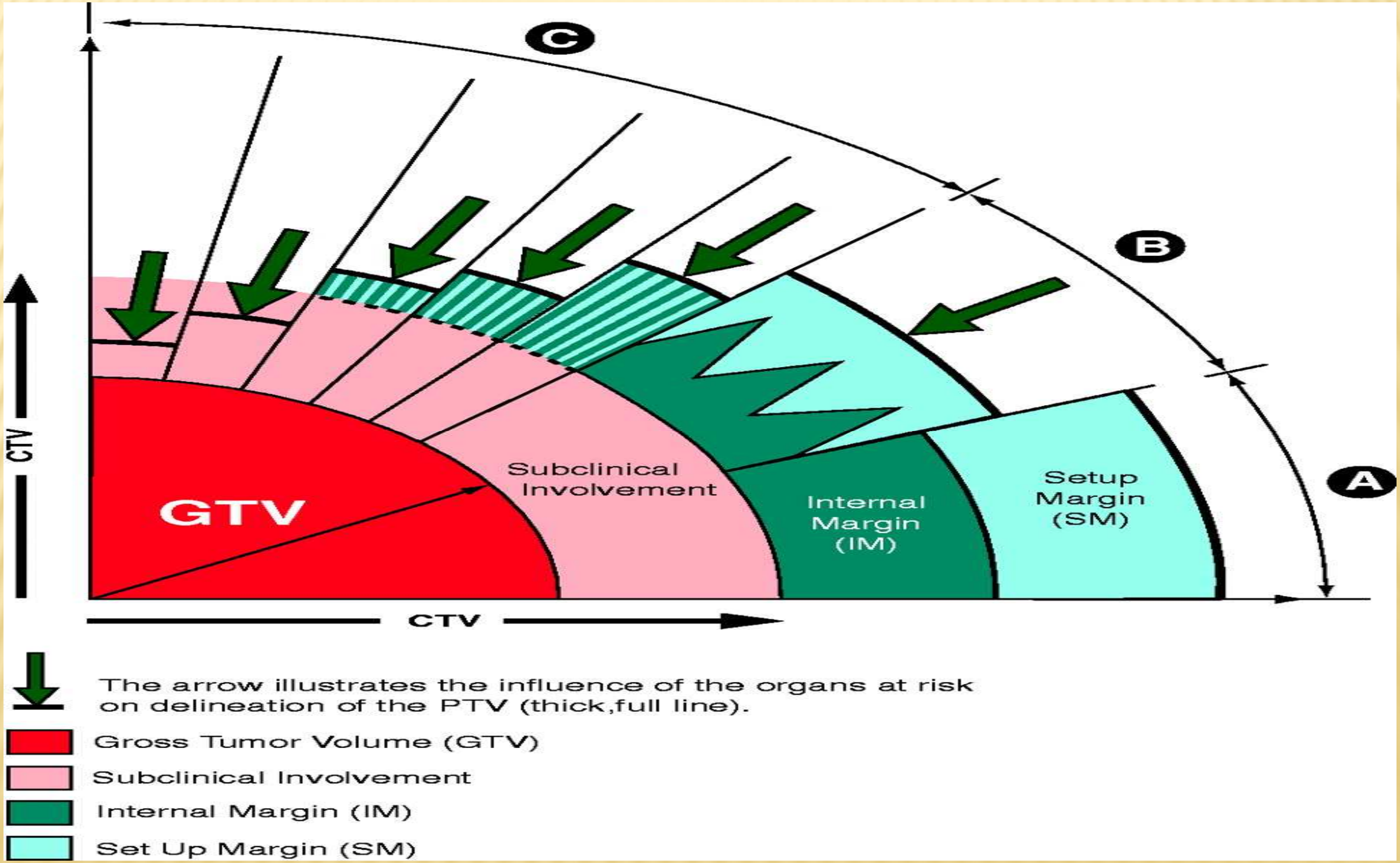




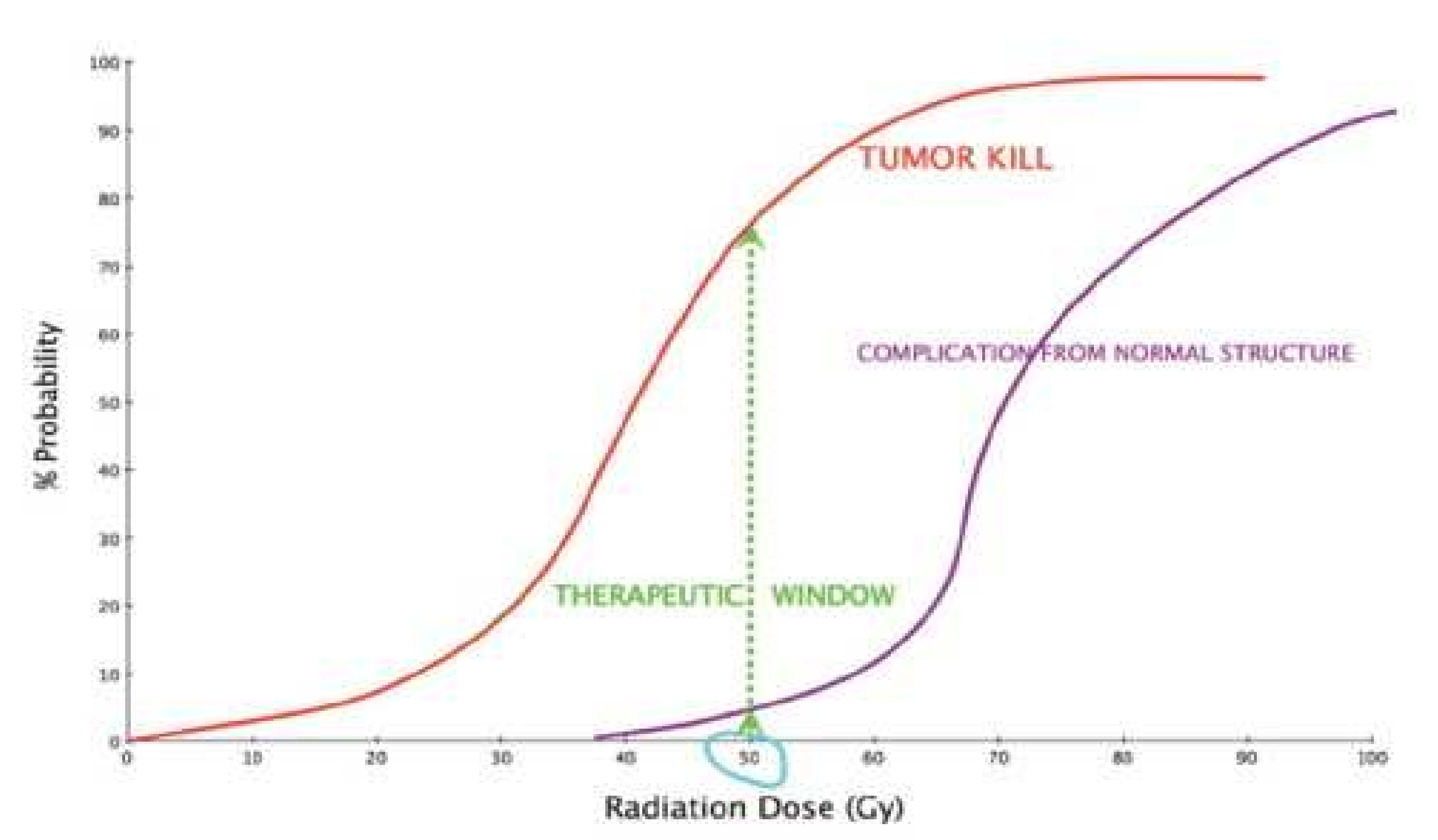
TARGET VOLUME DELINEATION ICRU 50/62/83 GUIDELINES

- GTV = Visible/palpable tumor
- CTV = microscopic extension
- ITV = CTV + Internal margin (IM)
- PTV = ITV + Set up margin (SM)

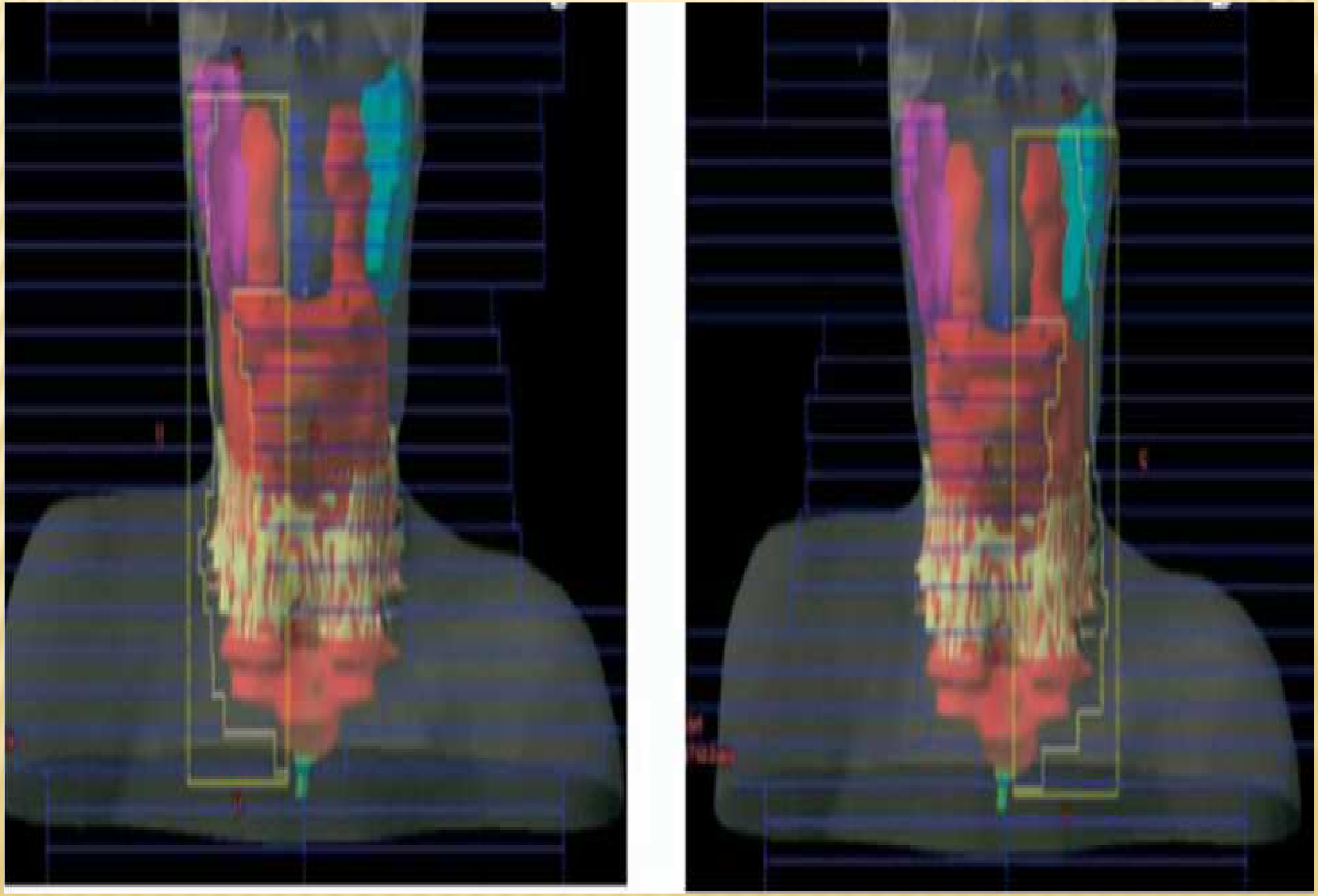
TUMOUR VOLUMES



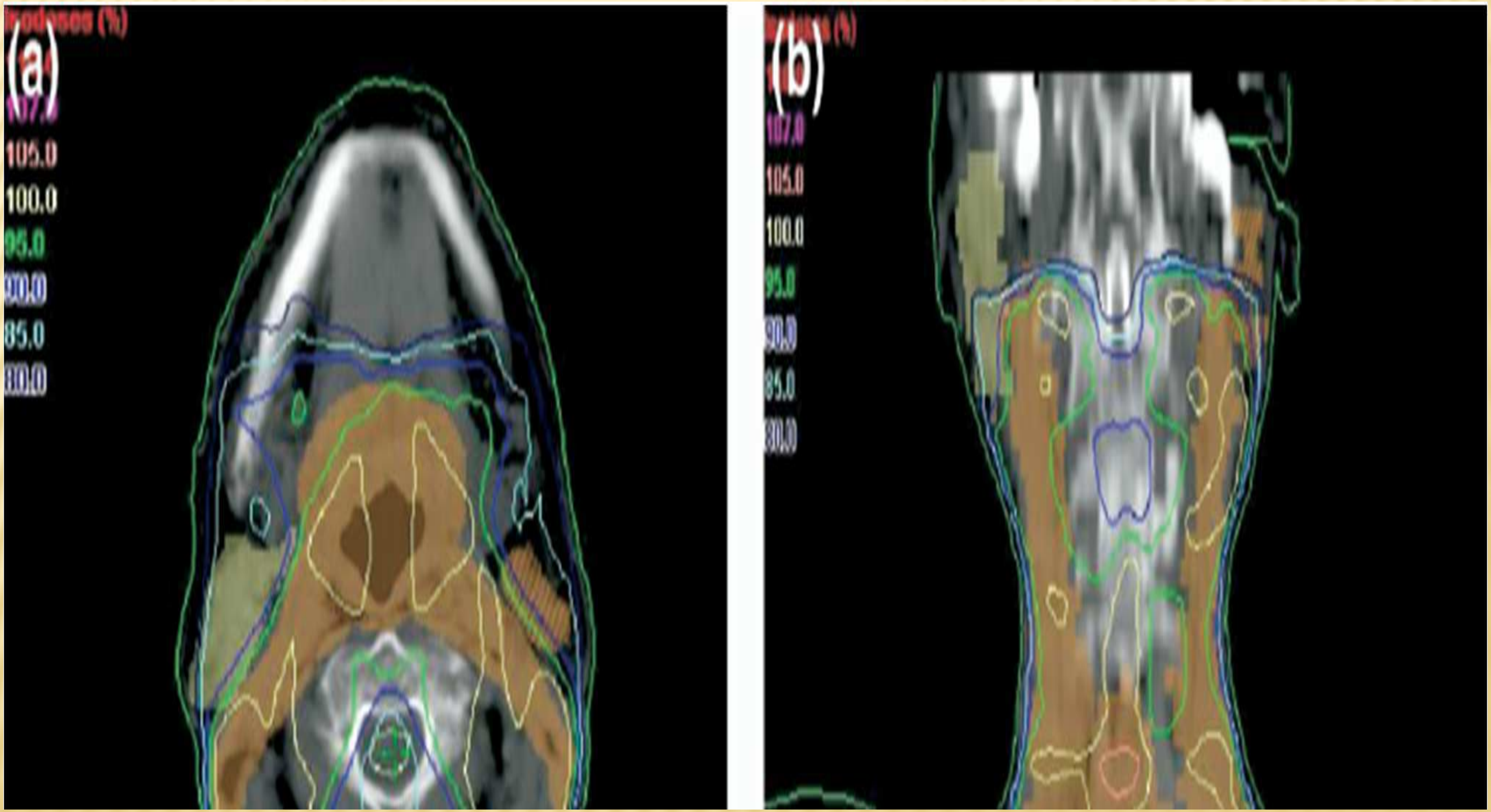
DOSE RESPONSE CURVE



BEV PROJECTION FROM DIFFERENT ANGLES



TYPICAL 3D-CRT DOSE DISTRIBUTION



PLAN APPROVAL & TRANSFER

- Final plan
- MU setting
- Final MU calculations

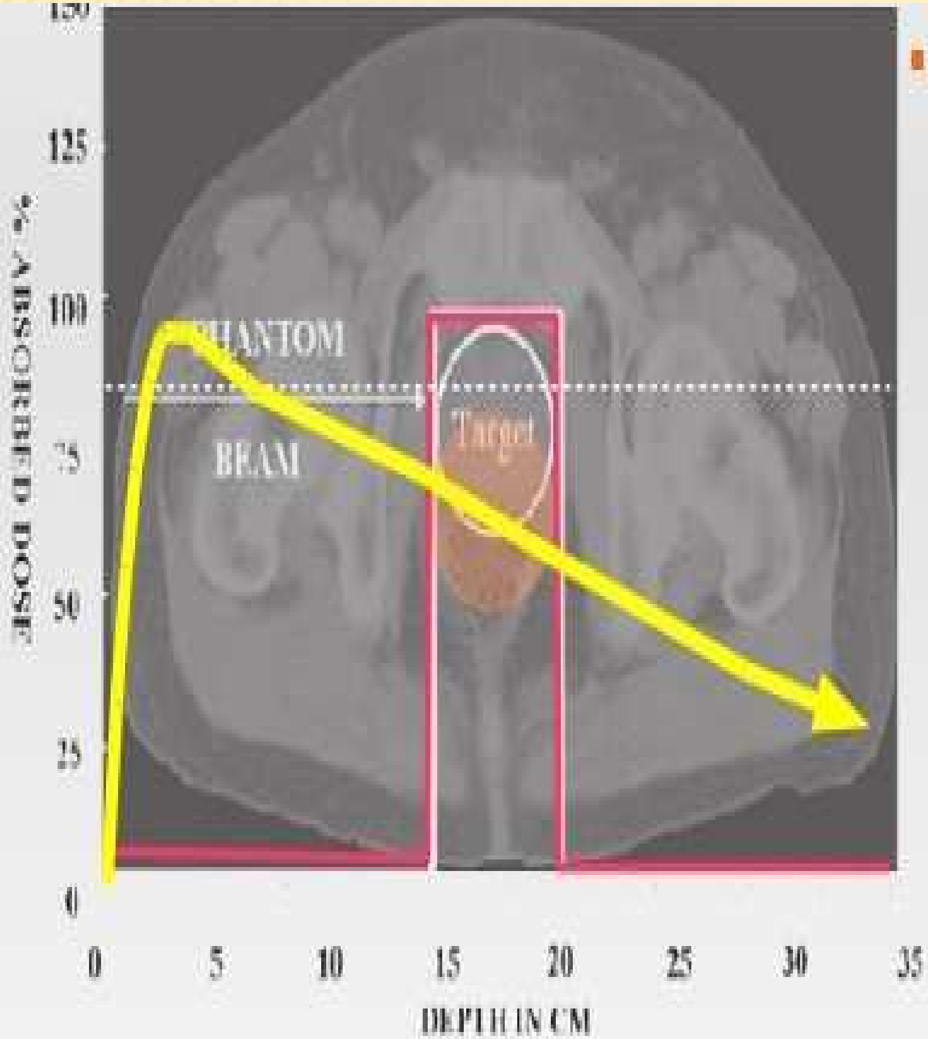
PLAN EVALUATION

- Dose Uniformity
- DVH
- Beam Weights

DELIVERY VERIFICATION

- Port film or EPID to verify Isocentre placement as well as beam shape determination, prior to start of treatment.

DISADVANTAGE OF CONFORMALITY



- Nature of the photon beam is the biggest impediment
  - Has an entrance dose.
  - Has an exit dose.
  - Follows the inverse square law.

LIMITATIONS OF CONFORMAL RADIOTHERAPY

- Sophisticated Treatment and set up.
- Good understanding of cross sectional anatomy
- Stringent QA procedures
- High integral dose

Highly susceptible to motion and treatment related errors– Achilles heel of Conformal RT.

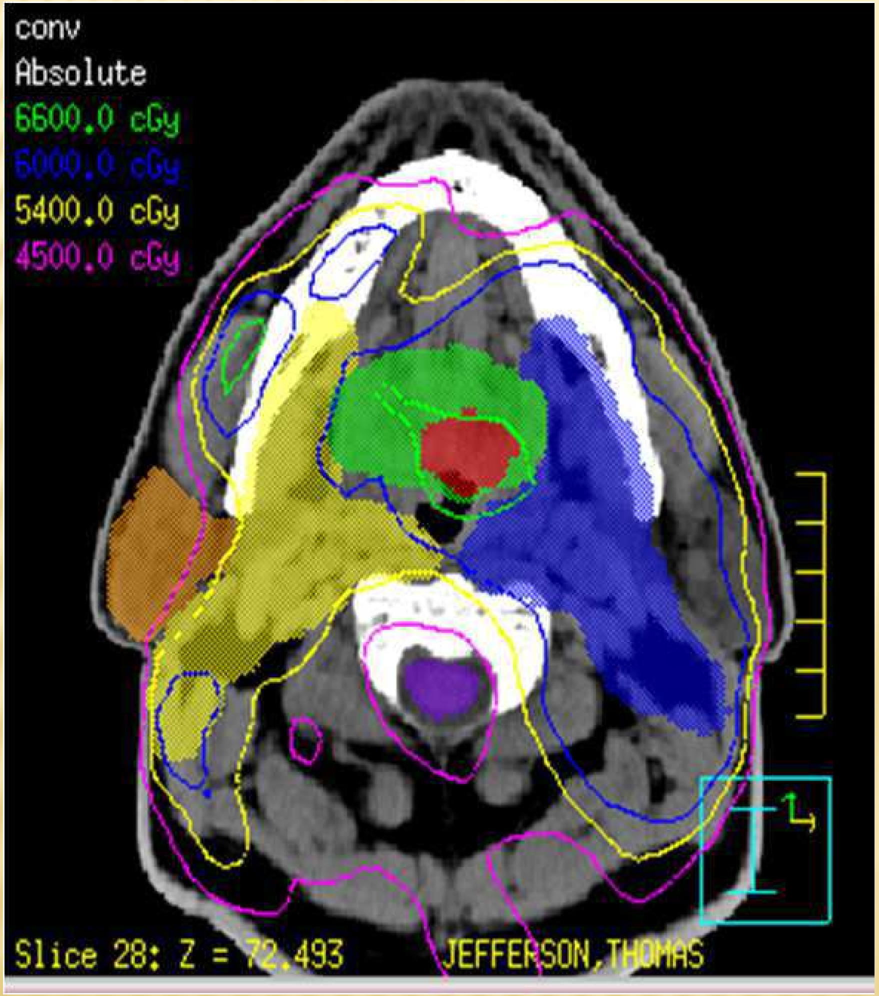
DIFFERENCES BETWEEN 2D AND 3DCRT

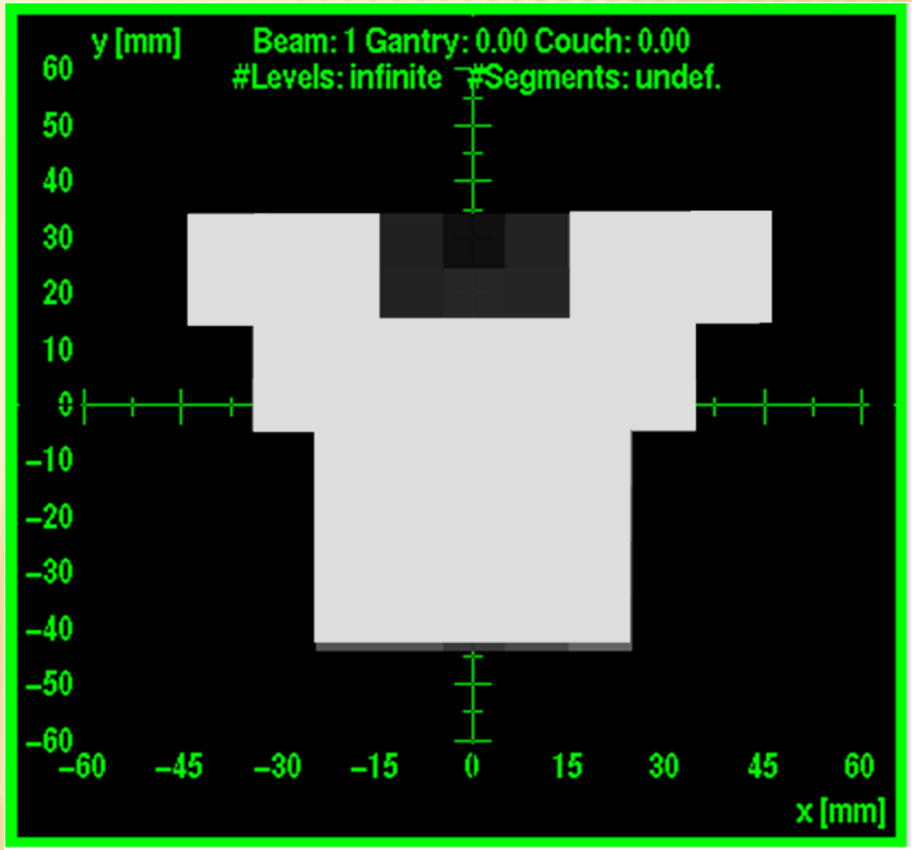
Key Steps	Typical Procedures	
	2DRT	3DRT
Patient assessment & decision to treat with curative radiation therapy	• Clinical procedures	• Clinical procedures
Patient positioning & Immobilization	• Establish treatment position • Construct patient immobilization device	• Establish treatment position • Construct patient immobilization device • Mark reference marks/coordinate system patient or immobilization cast
Image acquisition	• Fluoroscopy • Single CT slice in treatment position	• CT, MR, PET and input into TPS system
Target & organ contouring	• Concept non-existant	• Image registration • Contour target volumes on CT slices • Contour OARs on CT slices
Dose prescription	• Prescription in midplane or at isocentre	• Specify dose prescription for PTV • Specify dose tolerances for OARs

3D-CRT PROCESS & WORKFLOW SUMMARY

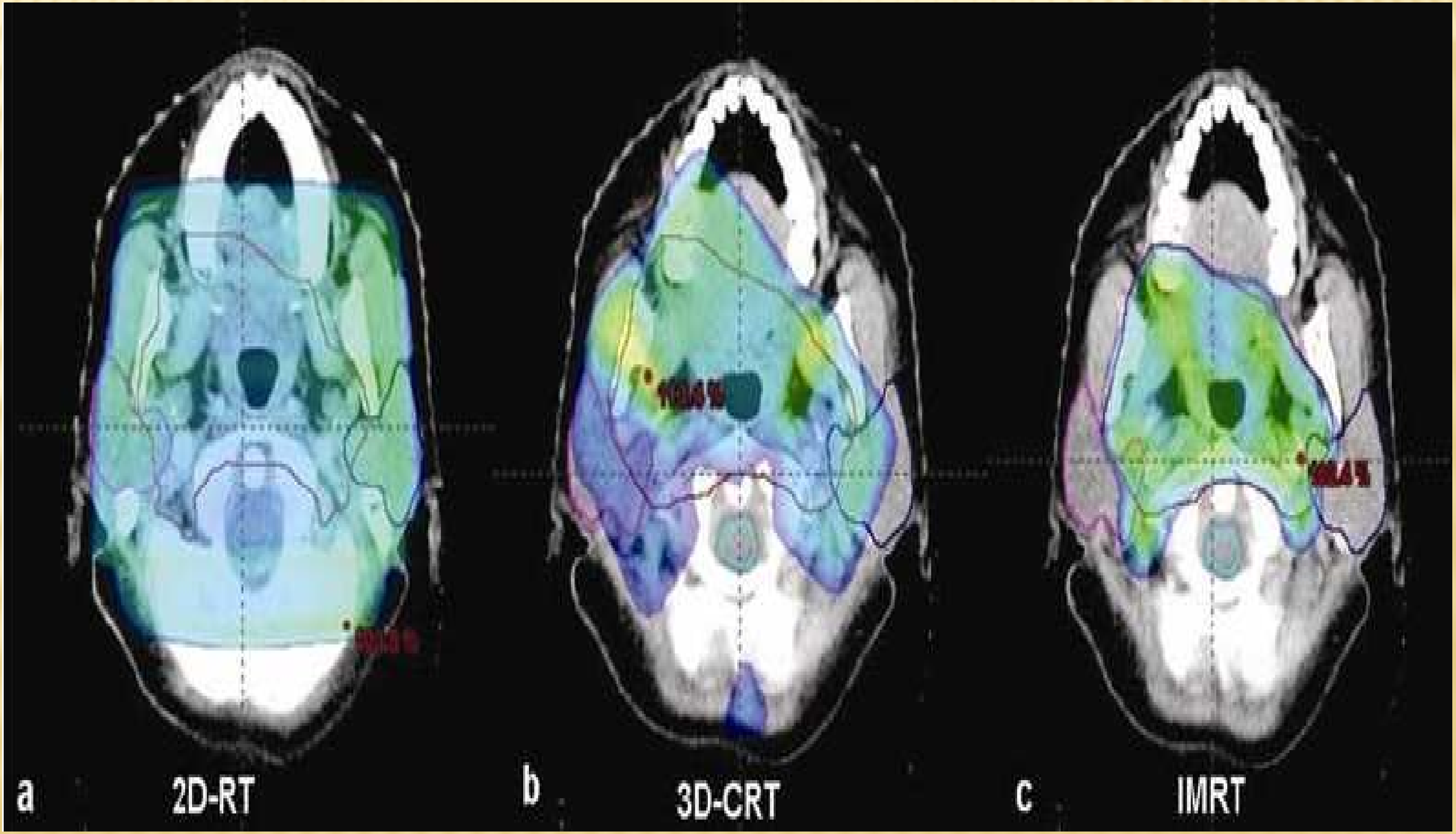
- Immobilization
- Planning Imaging
- CT/MR/PET
- Contour Target Volume and Normal Structure
- Select Beam Geometry and Energy
- Forward Planning & Optimization
- Plan Evaluation & Approval
- Patient set up varification & Treatment
- Machine QA

3D-CRT PROCESS & WORKFLOW SUMMARY



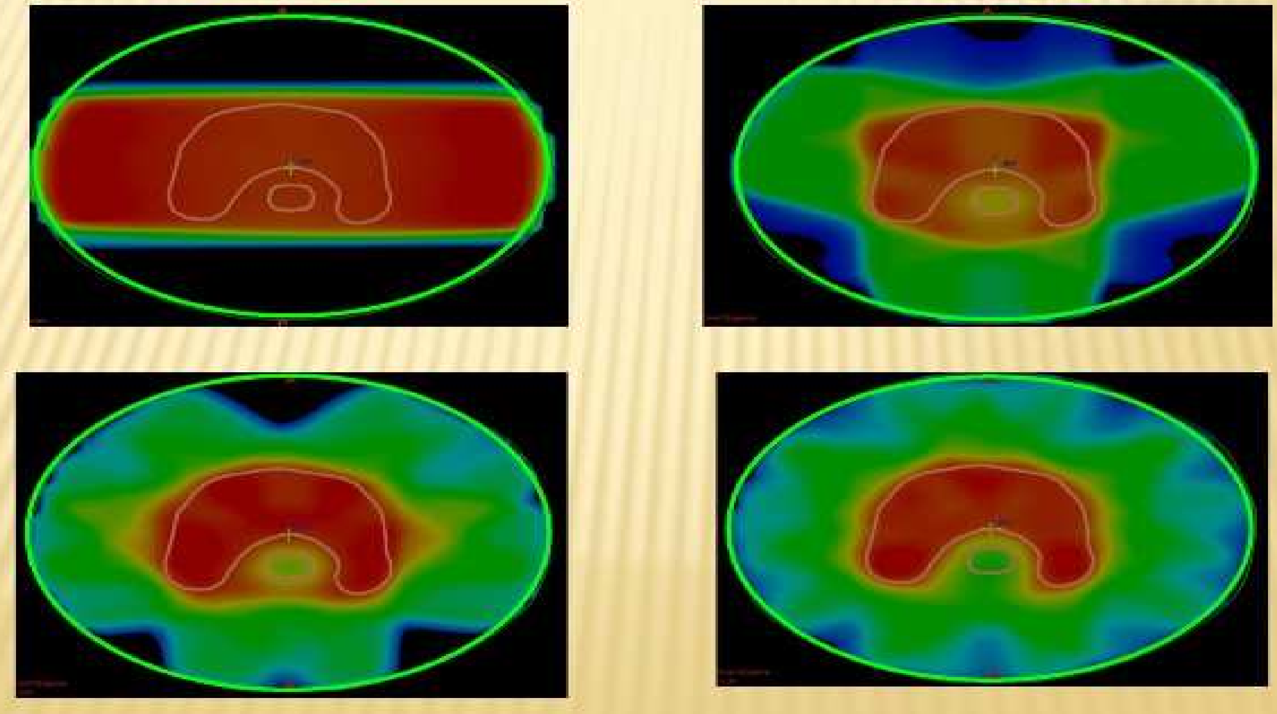


EVOLUTION FROM 2D TO IMRT



IMRT

THE SEARCH FOR CONFORMALITY



IMRT (INTENSITY MODULATED RADIOTHERAPY)

- An advanced form of 3DCRT.
- It is a radiation therapy technique where non-uniform fluence is delivered, using computer aided optimization.
- Types: Forward

  Inverse

RATIONALE OF IMRT

- More conformal than 3DCRT
- Dose more homogenous within PTV
- Sharp fall off beyond PTV boundary
- Less dose to OAR- lesser complications

IMRT

Forward Planning

Beam parameters (beam orientation, shape, modifier, beam weights, etc.)

3D dose distribution.

If not satisfactory, then modify the beam parameters

Inverse Planning

3D dose distribution

Beams Fluence Profile

If objective criteria is not satisfied, Then, changes the beam parameters and/ or objective criteria

INVERSE PLANNING

- The user specifies the dose and dose-volume constraints for the PTV and OARs, using a system of **priorities** and **weights**.
- Normally the beam arrangement is predefined also.
- The system performs **iterative calculations** with a quadratic function, to achieve the best possible dose distribution based on the given dose constraints.
- After this, the accurate dose distribution is **recalculated** after considering the **machine (jaw & MLC) parameters.**

DOSE CONSTRAINTS

1.Based on physical parameters.

Dose based

Dose volume based

2.Biological model

Tumor control probability.

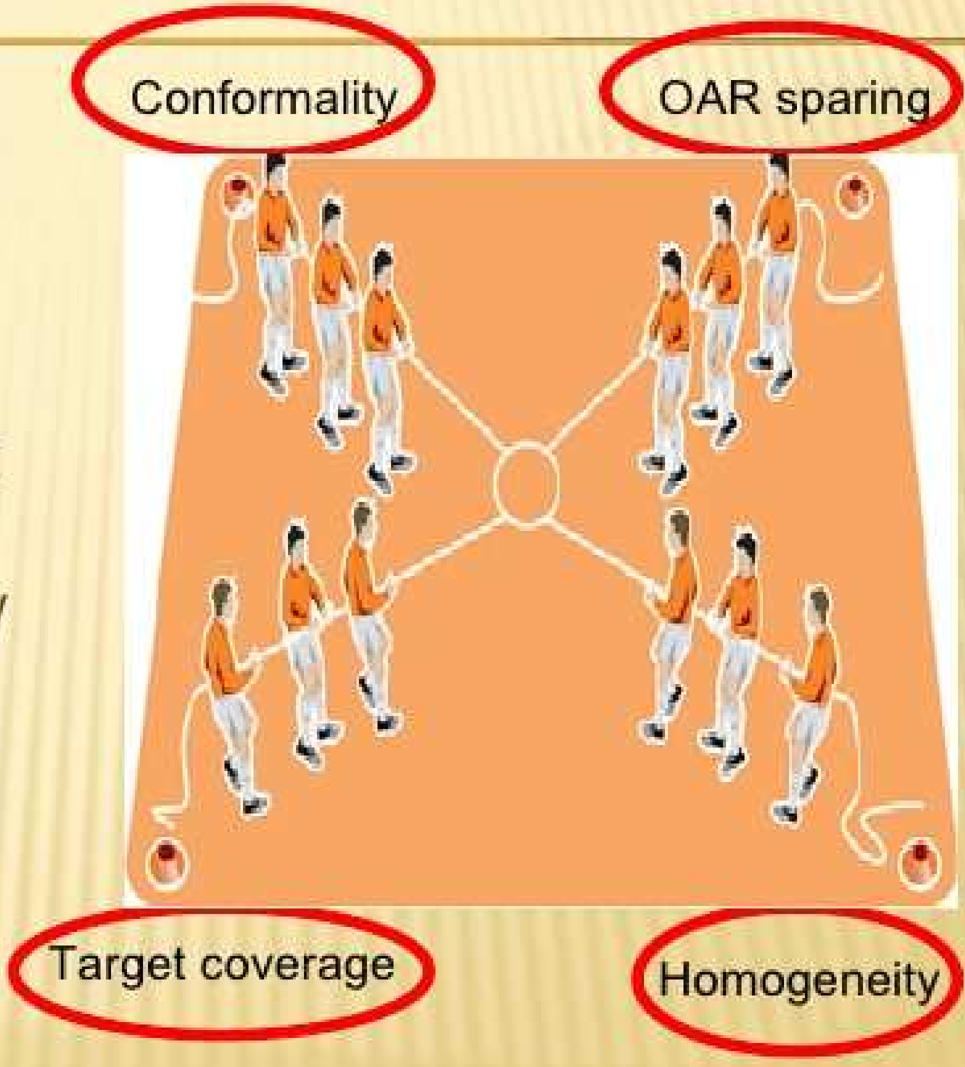
Normal tissue complication probability.

EUD.

Effective volume.

OPTIMISATION

- The process by which the optimum beam weight or intensity distribution is determined that can best satisfy the **objective function/ cost function/ score** as specified by planner.



STEP & SHOOT VS SLIDING WINDOW IMRT

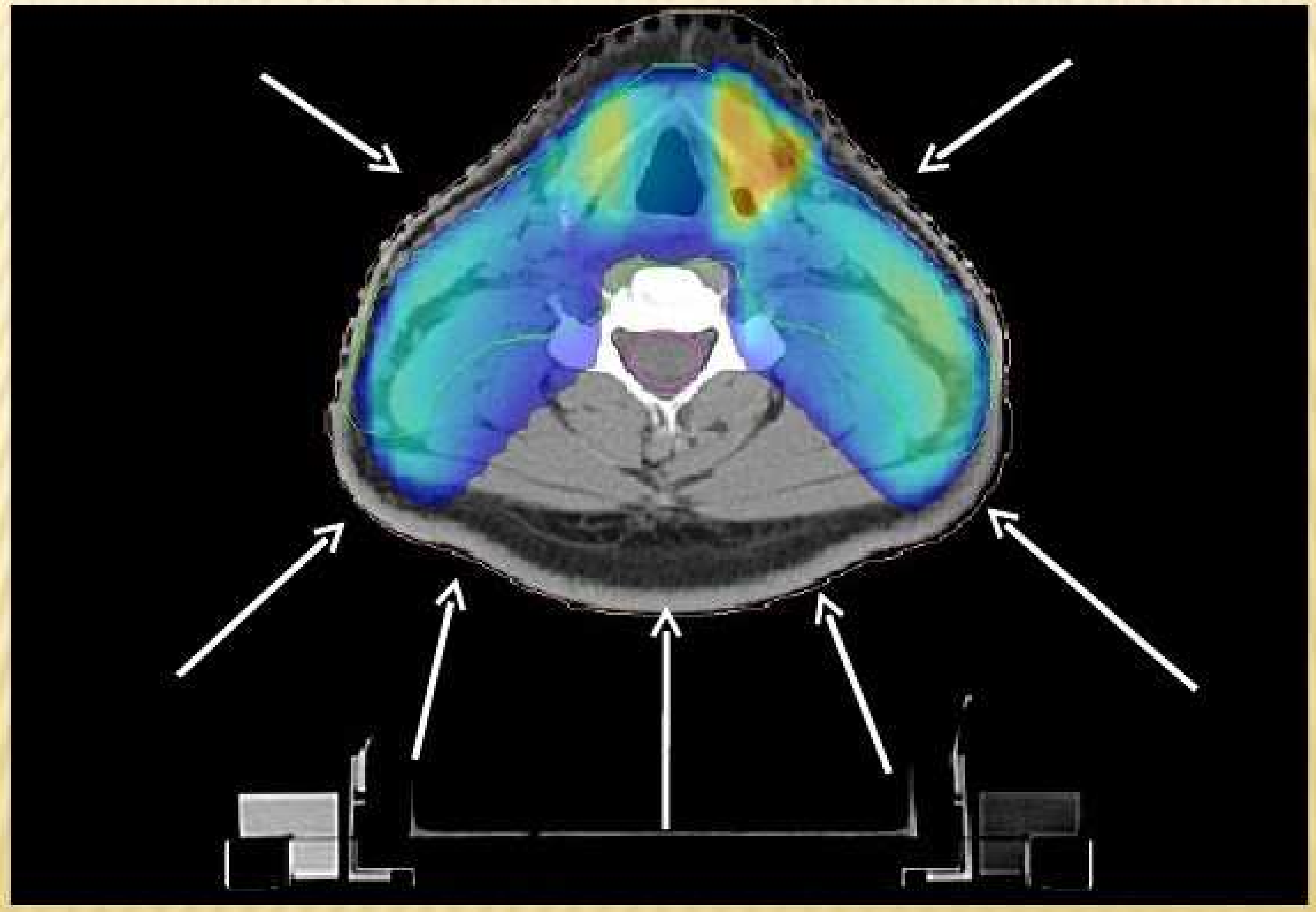
Comparing 3DCRT and inversely optimized IMRT planning for head and neck cancer: Equivalence between step-and-shoot and sliding window techniques

Barbara Longobardi[a], Elena De Martin[a], Claudio Fiorino[a,*], Italo Dell'oca[b], Sara Broggi[a], Giovanni Mauro Cattaneo[a], Riccardo Calandrino[a]

Conclusions: With the Varian planning and delivery system, Step-and-shoot approximations of inversely optimised fluences in head-neck IMRT compare well with SW delivery, even with only five intensity levels. With a number of intensity level of 10 or more, no differences can be appreciated in PTV coverage/OAR sparing with respect to SW.

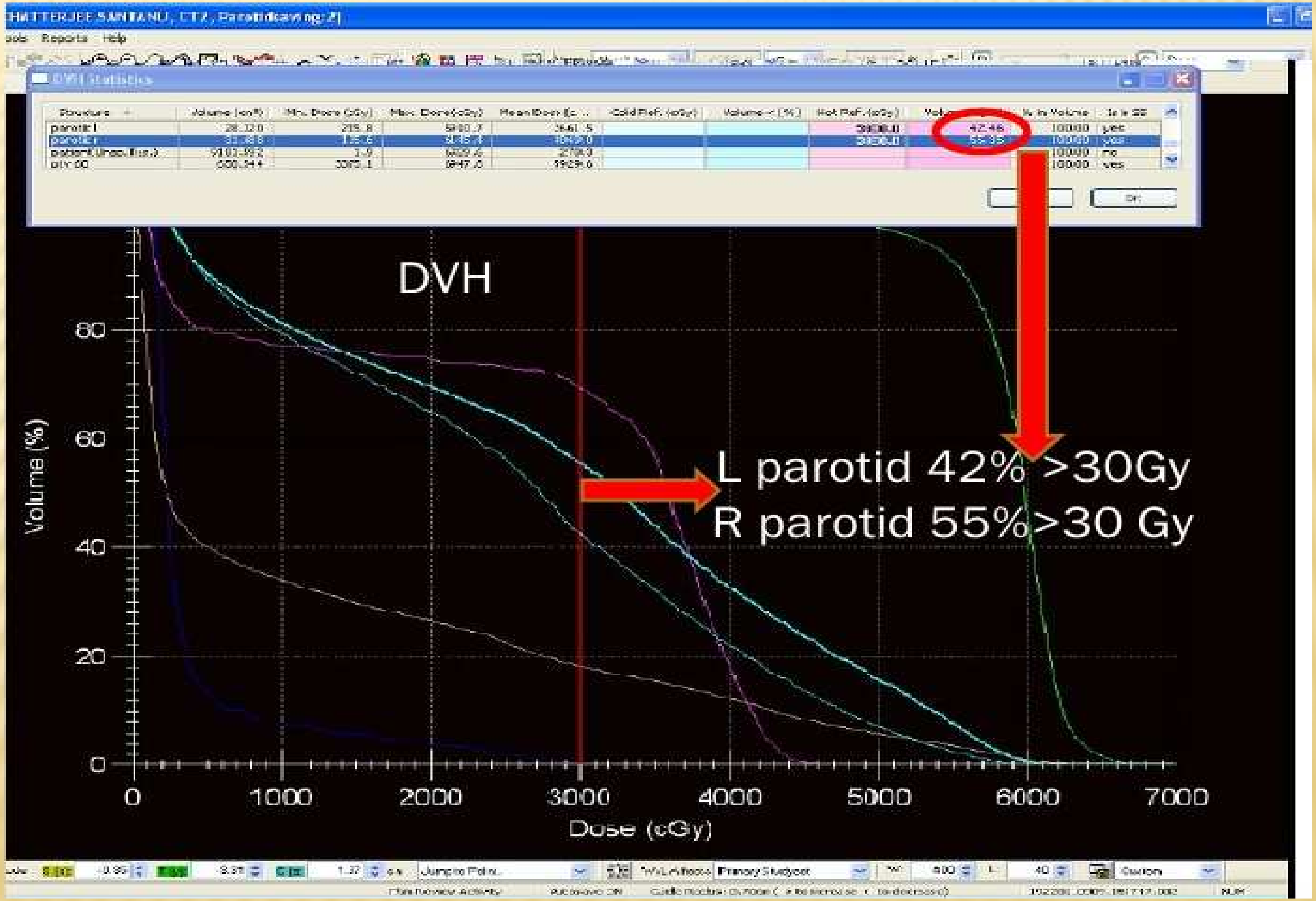
Radiotherapy and Oncology 77 (2005) 148-156

95% DOSE COLOUR WASH



7 Beam arrangement

IMRT



DVH
L parotid 42% >30Gy
R parotid 55%>30 Gy
Volume (%)
Dose (cGy)
0
20
40
60
80
1000
2000
3000
4000
5000
6000
7000

3D CRT V/S IMRT

THREE-DIMENSIONAL CONFORMAL VS. INTENSITY-MODULATED RADIOTHERAPY IN HEAD-AND-NECK CANCER PATIENTS: COMPARATIVE ANALYSIS OF DOSIMETRIC AND TECHNICAL PARAMETERS

LUCA COZZI, PH.D.,* ANTONELLA FOGLIATA, DR.,* ALESSANDRA BOLSI, DR.,*†
GIORGIA NICOLINI, DR.,* AND JACQUES BERNIER, PH.D., M.D.‡

Materials and Methods: Twenty-six head-and-neck cancer patients were irradiated following a feasibility internal protocol with IMRT. Treatments were performed with either the static step-and-shoot (20) or the dynamic sliding window (6) techniques on a 6 MV Varian Clinac equipped with a multileaf collimator with 80 leaves. Dose plans were computed using commercial treatment planning systems: MDS-Nordion Helax-TMS for static cases and Varian Eclipse for dynamic cases. Dose plans were evaluated in terms of physical quantities based on dose–volume histograms and isodose distributions. Each IMRT plan was also compared to a reference 3D conformal therapy plan (3DCRT).

Results: Elective target volumes ranged from 530 to 1151 cm^3 with a mean of 780 ± 141 cm^3. Boost volumes ranged from 248 to 832 cm^3 with a mean of 537 ± 165 cm^3. Thirty-two dose plans were generated with static technique and 10 with dynamic. In the static mode, 6.8 ± 3.4 fields were applied on average with 12.5 ± 1.3 segments per field. In the static mode, 264 ± 56 MU per Gy were erogated, whereas in the dynamic mode, 387 ± 126 MU per Gy were erogated, to be compared to 147 ± 20 computed for reference 3DCRT plans. For all target volumes in general conformity was improved compared to 3DCRT (e.g. V_{95} increased from 85% to 93% with $p < 0.001$, or equivalent uniform dose normalized to prescribed dose increased from 0.86 to 0.96 with $p = 0.002$). Irradiation of parotid glands or spinal cord improved, as well: For parotids, $D_{1/3}$ reduced from 59 Gy to 41 Gy ($p < 0.001$). For spinal cord, D_{max} reduced from about 40 Gy to about 30 Gy ($p < 0.001$)

Int. J. Radiation Oncology Biol. Phys., Vol. 58, No. 2, pp. 617–624, 2004

IMRT V/S TOMOTHERAPY

INTENSITY-MODULATED RADIATION THERAPY (IMRT) DOSIMETRY OF THE HEAD AND NECK: A COMPARISON OF TREATMENT PLANS USING LINEAR ACCELERATOR–BASED IMRT AND HELICAL TOMOTHERAPY

KE SHENG, PH.D.,* JANELLE A. MOLLOY, PH.D.,*† AND PAUL W. READ, PH.D., M.D.*

- Dosimetric study (N=10)
- All patients had **oropharyngeal carcinoma** (5 BOT, 5 tonsil)
- 2 sets of plans: IMRT vs Tomotherapy
- **Improved dose homogeneity within the target volume** with HT (SD within the PTV reduced by 71%)
- **Improved critical structure sparing** (EUD of surrounding normal tissue reduced by 17.4% for BOT and 27.1% for tonsil)
- 80% reduction in NTCP of parotid glands

Int. J. Radiation Oncology Biol. Phys., Vol. 65, No. 3, pp. 917-923, 2006

IMRT V/S V-MAT

Volumetric modulated arc radiotherapy for carcinomas of the oro-pharynx, hypo-pharynx and larynx: A treatment planning comparison with fixed field IMRT

Eugenio Vanetti [a], Alessandro Clivio [a], Giorgia Nicolini [a], Antonella Fogliata [a], Sarbani Ghosh-Laskar [b], Jai Prakash Agarwal [b], Ritu Raj Upreti [b], Ashwini Budrukkar [b], Vedang Murthy [b], Deepak Dattatray Deshpande [b], Shyam Kishore Shrivastava [b], Ketayun Ardeshir Dinshaw [b], Luca Cozzi [a,*]

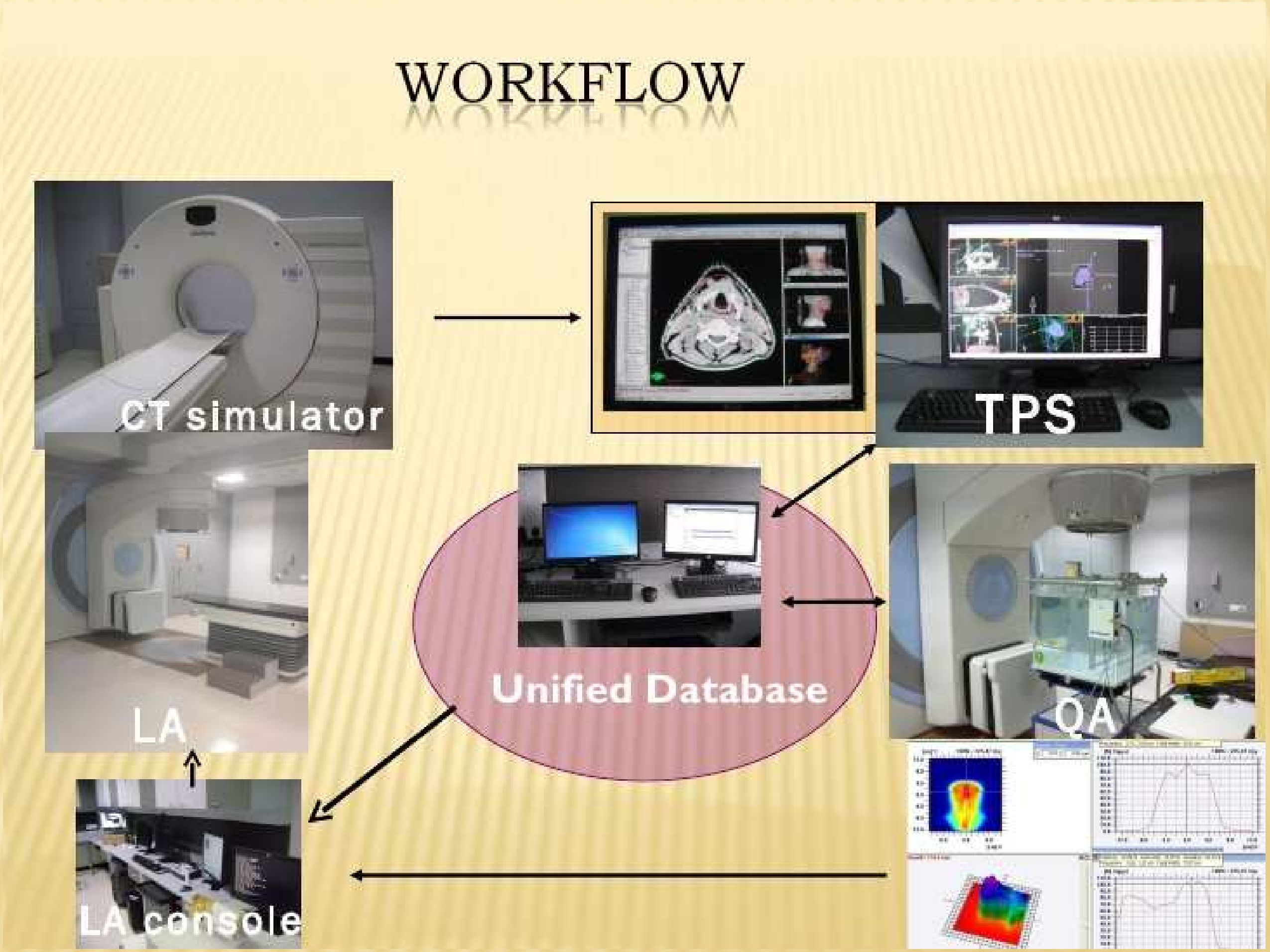
- Dosimetric study (N=29)
- Patients of **carcinoma oropharynx, hypopharynx and larynx**
- Conventional (Sliding Window) IMRT vs Rapid Arc(single arc) vs Rapid Arc (double arc)
- **Both variants of rapid arc were significantly better in sparing normal tissue.** Average doses to ipsilateral parotid were 40 Gy vs 36.2 Gy vs 34.4 Gy & to contralateral parotid were 32.6 Gy vs 30.9 Gy vs 28.2 Gy
- **Rapid arc (double arc) also significantly improved target coverage & homogeneity** with respect to conventional IMRT.

Radiotherapy and Oncology 92 (2009) 111–117

PROCESS OF IMRT PLANNING

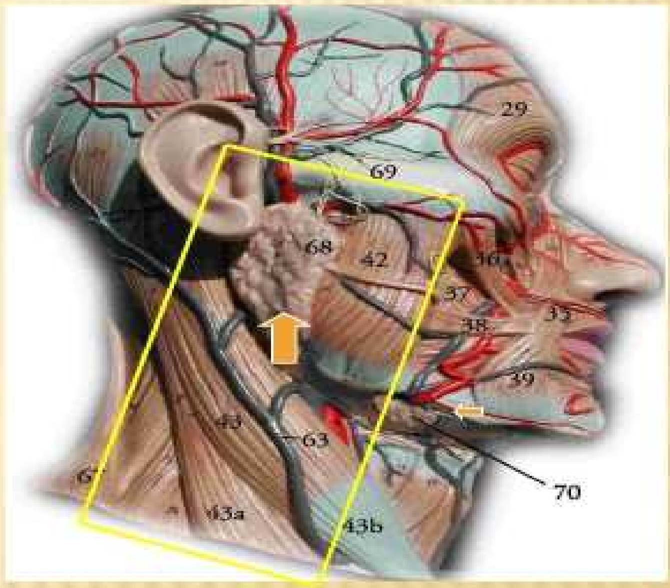
- Immobilization
- Planning CT
- Image transfer
- Contouring of volumes
- Margins
- Treatment planning
- Selection of optimum plan (dose distribution & DVH analysis)
- Plan quality assurance
- Plan implementation
- Position verification (2D/3D)
- Treatment execution

IMRT WORKFLOW



CLINICAL IMPACT OF IMRT

- What happens to the parotid glands in Conventional RT?



PAROTID SPARING

PAROTID DOSE & XEROSTOMIA

- **Eisbruch et al (1999)**: A mean parotid dose of **< 26 Gy** should be planning goal.
- **Eisbruch et al (2007):** Substantial parotid flow recovery (upto 86% of pretreatment levels) at 2 years if mean doses are between 25-30Gy.
- **Eisbruch et al (2010):** Severe xerostomia (<25% of baseline) avoided if mean parotid dose kept to **<20Gy** (if one parotid is to be spared) or **<25 Gy** (if both are to be spared)

PAROTID SPARING

DOES PAROTID-SPARING IMRT HAVE A NEGATIVE IMPACT ON LOCAL CONTROL?

- **Cannon & Lee (2008):** (N=3) All patient had recurrence near a spared parotid gland.
- **Eisbruch et al (2005):** (N=158, all stage III/IV) 19/23 failures occurred in-field, within the high-dose volume. Suggest that clinical rather than dosimetric factors predicted outcome & suggested treatment intensification in these advanced cases.

SUBMANDIBULAR GLAND SPARING

SUBMANDIBULAR GLAND DOSE & XEROSTOMIA

- Xerostomia does not correlate with parotid doses alone.
- If submandibular gland doses are kept to =<39Gy, then also there is good recovery of salivary flow rates at 2 years.

PHARYNGEAL CONSTRICTORS SPARING

CONSTRICTOR DOSE & DYSPHAGIA

- **Levendag et al (2007):** Significant correlation between doses to superior and middle constrictors and incidence of severe dysphagia. Steep dose response curve, with **19%** increase in probability with every 10Gy dose.
- **Bhide et al (2009): No** statistically significant correlation between radiation dose to the pharyngeal constrictors and observer-assessed/ patient-reported severe dysphagia at 1 year

QUALITY OF LIFE

IMRT : IMPACT ON QOL

- Evidence-based review by Nutting et al (2010):
- Significant heterogeneity in data.
- Conflicting results.

CONCURRENT CT & IMRT

CHEMO: BED

HOW MUCH RADIATION IS THE CHEMOTHERAPY WORTH IN ADVANCED HEAD AND NECK CANCER?

MOHIT KASIBHATLA, M.D., JOHN P. KIRKPATRICK, M.D., PH.D., AND DAVID M. BRIZEL, M.D.

Department of Radiation Oncology, Duke University Medical Center, Durham, NC

Conclusions: Chemotherapy increases BED by approximately 10 Gy_{10} in standard and modified fractionated radiotherapy, equivalent to a dose escalation of 12 Gy in 2 Gy daily or 1.2 Gy twice daily. Such an escalation could not be safely achieved by increasing radiation dose alone.

between increase in locoregional control (LRC) and increase in BED with modified vs. standard fractionated radiotherapy. The increase in LRC with chemoradiotherapy vs. radiotherapy alone, the BED of the radiotherapy-alone arms, and the "S" value were used to calculate the BED contribution from chemotherapy and the total BED of chemoradiotherapy from each study.

Int. J. Radiation Oncology Biol. Phys., Vol. 68, No. 5, pp. 1491–1495, 2007

CONCURRENT CT & IMRT

RTOG 00-22 (2010)

- N=69 (14 institutions)
- All patients of **Ca oropharynx**, stage T1-T2,N0-N1,M0
- No chemo was permitted
- RT dose was 66Gy/30# to PTV(gross disease) and 54-60Gy/30# to PTV (subclinical)
- Median FU=2.8 years
- 2-yr LRF was only **9%**.
- **Very low rate of severe (>grade 2) late toxicities**: skin (12%), mucosa(24%). Xerostomia (grade 2) was seen in 55% patients at 6 months but reduced to 16% at 2 years
- Moderately hypofractionated IMRT without chemotherapy in early oropharyngeal carcinomas, is safe & well-tolerated.

Int. J. Radiation Oncology Biol. Phys., Vol. 76, No. 5, pp. 1333–1338, 2010

CONCURRENT CT + IMRT

- SIB-IMRT with conc chemotherapy is well-tolerated and effective for all common head-neck sites.
- Trials included mostly locally advanced cases.
- Locoregional failure rates are around 5-20%.
- Overall survival rates are around 60-85%.
- 2-yr severe xerostomia rates are around 0-30%.

CONCURRENT CT & IMRT

INTENSITY-MODULATED RADIOTHERAPY IN THE TREATMENT OF OROPHARYNGEAL CANCER: AN UPDATE OF THE MEMORIAL SLOAN-KETTERING CANCER CENTER EXPERIENCE

JEREMY SETTON, B.A.,*[1] NICOLA CARIA, M.D.,*[1] JONATHAN ROMANYSHYN, M.D.,* LAWRENCE KOUTCHER, M.D.,* SUZANNE L. WOLDEN, M.D.,* MICHAEL J. ZELEFSKY, M.D.,* NICHOLAS ROWAN, B.A.,* ERIC J. SHERMAN, M.D.,† MATTHEW G. FURY, M.D., PH.D.,† DAVID G. PFISTER, M.D.,† RICHARD J. WONG, M.D.,‡ JATIN P. SHAH, M.D.,‡ DENNIS H. KRAUS, M.D.,‡ WEIJI SHI, M.S.,§ ZHIGANG ZHANG, PH.D.,§ KAREN D. SCHUPAK, M.D.,* DAPHNA Y. GELBLUM, M.D.,* SHYAM D. RAO, M.D., PH.D.,* AND NANCY Y. LEE, M.D.*

CONCURRENT CHEMOTHERAPY AND INTENSITY-MODULATED RADIOTHERAPY FOR LOCOREGIONALLY ADVANCED LARYNGEAL AND HYPOPHARYNGEAL CANCERS

NANCY Y. LEE, M.D.,* WILLIAM O'MEARA, M.D.,* KELVIN CHAN, B.A.,* CESAR DELLA-BIANCA, PH.D.,† JAMES G. MECHALAKOS, PH.D.,† JOANNE ZHUNG, B.A.,* SUZANNE L. WOLDEN, M.D.,* ASHWATHA NARAYANA, M.D.,* DENNIS KRAUS, M.D.,‡ JATIN P. SHAH, M.D.,‡ AND DAVID G. PFISTER, M.D.§

INTENSITY-MODULATED RADIOTHERAPY IN POSTOPERATIVE TREATMENT OF ORAL CAVITY CANCERS

DANIEL R. GOMEZ, M.D.,* JOANNE E. ZHUNG, B.A.,* JENNIFER GOMEZ, B.A.,* KELVIN CHAN, B.A.,* ABRAHAM J. WU, M.D.,* SUZANNE L. WOLDEN, M.D.,* DAVID G. PFISTER, M.D.,† ASHOK SHAHA, M.D.,‡ JATIN P. SHAH, M.D.,† DENNIS H. KRAUS, M.D.,‡ RICHARD J. WONG, M.D.,‡ AND NANCY Y. LEE, M.D.*

IMRT IN HEAD & NECK CANCERS

Lancet Oncol 2008; 9: 367–375

Evidence behind use of intensity-modulated radiotherapy: a systematic review of comparative clinical studies

Liv Veldeman, Indira Madani, Frank Hulstaert, Gert De Meerleer, Marc Mareel, Wilfried De Neve

2 Meta-analyses

Clinical Oncology 22 (2010) 643–657

Contents lists available at ScienceDirect

Clinical Oncology

journal homepage: www.elsevier.com/locate/clon

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Overview

A Review of the Clinical Evidence for Intensity-modulated Radiotherapy

J. Staffurth on behalf of the Radiotherapy Development Board[1]

Cardiff University, Velindre Hospital, Whitchurch, Cardiff, UK

IMRT IN H& N CANCERS

PROSPECTIVE ASSESSMENT OF PATTERNS OF FAILURE AFTER HIGH-PRECISION DEFINITIVE (CHEMO)RADIATION IN HEAD-AND-NECK SQUAMOUS CELL CARCINOMA

TEJPAL GUPTA, M.D., SANDEEP JAIN, M.D., JAI PRAKASH AGARWAL, M.D., SARBANI GHOSH-LASKAR, M.D., REENA PHURAILATPAM, D.R.P., RAJERSHI PAI-SHETTY, D.R.P., AND KETAYUN A. DINSHAW, F.R.C.R.

Department of Radiation Oncology, Advanced Centre for Treatment Research & Education in Cancer/Tata Memorial Hospital, Tata Memorial Centre, Mumbai, India

- Siemens trial (3DCRT vs IMRT)
- N=60
- The aim was to analyse location of site of locoregional failure and their dose-volume correlation
- It was found that the majority of failures (**75%**) were within the high-dose volume & only 25% were marginal.

Int. J. Radiation Oncology Biol. Phys., Vol. 80, No. 2, pp. 522–531, 2011

PARSPORT TRIAL

PARSPORT

Parotid-sparing intensity modulated versus conventional radiotherapy in head and neck cancer (PARSPORT): a phase 3 multicentre randomised controlled trial

Christopher M Nutting[a,b,*], James P Morden[b], Kevin J Harrington[a,b], Teresa Guerrero Urbano[c], Shreerang A Bhide[a], Catharine Clark[d], Elizabeth A Miles[e], Aisha B Miah[a], Kate Newbold[a], MaryAnne Tanay[a], Fawzi Adab[f], Sarah J Jefferies[g], Christopher Scrase[h], Beng K Yap[i], Roger P A'Hern[b], Mark A Sydenham[b], Marie Emson[b], Emma Hall[b], and on behalf of the PARSPORT trial management group[†]

Methods—We undertook a randomised controlled trial between Jan 21, 2003, and Dec 7, 2007, that compared conventional radiotherapy (control) with parotid-sparing IMRT. We randomly assigned patients with histologically confirmed pharyngeal squamous-cell carcinoma (T1–4, N0–3, M0) at six UK radiotherapy centres between the two radiotherapy techniques (1:1 ratio). A dose of 60 or 65 Gy was prescribed in 30 daily fractions given Monday to Friday. Treatment was not masked. Randomisation was by computer-generated permuted blocks and was stratified by centre and tumour site. Our primary endpoint was the proportion of patients with grade 2 or worse xerostomia at 12 months, as assessed by the Late Effects of Normal Tissue (LENT SOMA) scale. Analyses were done on an intention-to-treat basis, with all patients who had assessments included. Long-term follow-up of patients is ongoing. This study is registered with the International Standard Randomised Controlled Trial register, number ISRCTN48243537.

Lancet Oncol. 2011 February ; 12(2): 127–136.

PARSPORT TRIAL

Findings—47 patients were assigned to each treatment arm. Median follow-up was 44·0 months (IQR 30·0–59·7). Six patients from each group died before 12 months and seven patients from the conventional radiotherapy and two from the IMRT group were not assessed at 12 months. At 12 months xerostomia side-effects were reported in 73 of 82 alive patients; grade 2 or worse xerostomia at 12 months was significantly lower in the IMRT group than in the conventional radiotherapy group (25 [74%; 95% CI 56–87] of 34 patients given conventional radiotherapy *vs* 15 [38%; 23–55] of 39 given IMRT, p=0·0027). The only recorded acute adverse event of grade 2 or worse that differed significantly between the treatment groups was fatigue, which was more prevalent in the IMRT group (18 [41%; 99% CI 23–61] of 44 patients given conventional radiotherapy *vs* 35 [74%; 55–89] of 47 given IMRT, p=0·0015). At 24 months, grade 2 or worse xerostomia was significantly less common with IMRT than with conventional radiotherapy (20 [83%; 95% CI 63–95] of 24 patients given conventional radiotherapy *vs* nine [29%; 14–48] of 31 given IMRT; p<0·0001). At 12 and 24 months, significant benefits were seen in recovery of saliva secretion with IMRT compared with conventional radiotherapy, as were clinically significant improvements in dry-mouth-specific and global quality of life scores. At 24 months, no significant differences were seen between randomised groups in non-xerostomia late toxicities, locoregional control, or overall survival.

IMAGE GUIDED RADIOTHERAPY

- incorporates imaging, and matching the co-ordinates with the treatment plan to be delivered, to ensure the patient is properly aligned in the treatment room
- improves accuracy of the radiation field placement
- reduces the exposure of healthy tissue during the treatment

WHY IMAGE GUIDANCE ?

- Organ motion types:
  - Interfraction motion
  - Intrafraction motion
- Even intracranial structures can move – 1.5 mm shift when patient goes from sitting to supine!!

- Types of movement:
  - Translations:
    - Craniocaudal
    - Lateral
    - Vertical
  - Rotations:
    - Roll
    - Pitch
    - Yaw
  - Shape:
    - Flattening
    - Balloning
    - Pulsation

ADAPTIVE RADIOTHERAPY

- A technique by which a conformal radiation dose plan, is modified to conform to a deformable and mobile target.
- Two components:
  - adapt to tumour motion
  - adapt to tumour/organ deformation and volume changes.

ADAPTIVE RADIOTHERAPY

- During treatment, large variations occurs in the anatomy of the treatment area due to

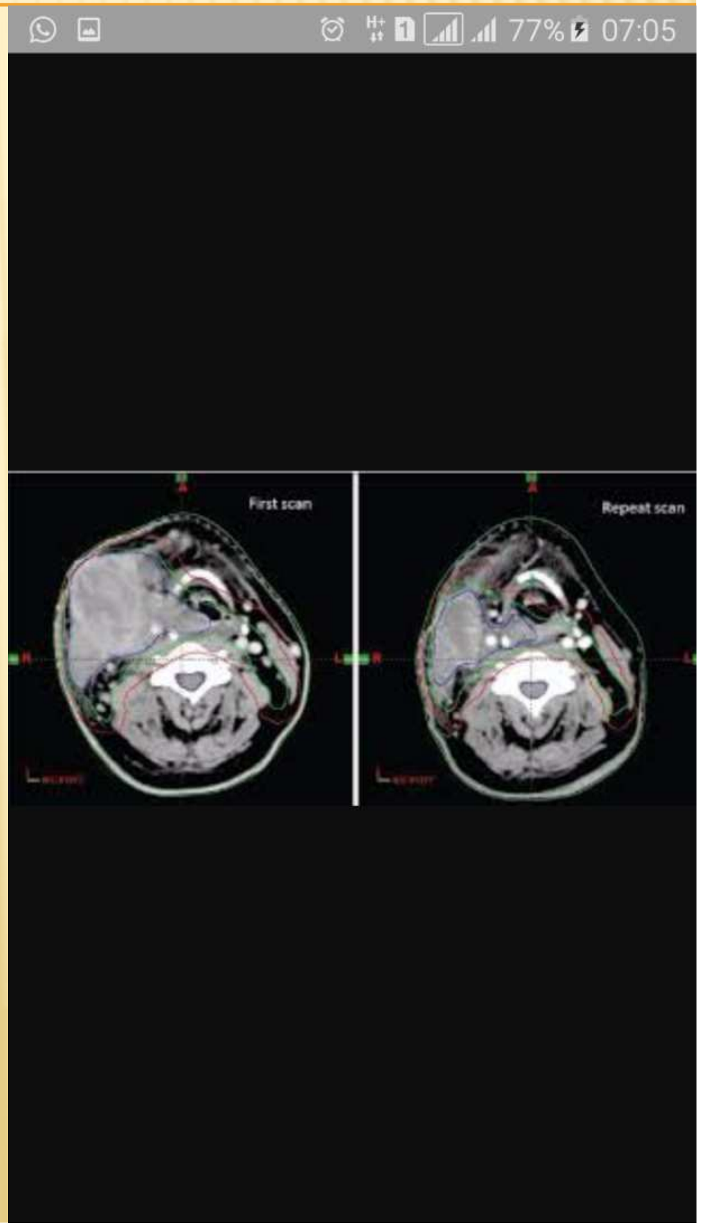
  tumour regression

  weight loss

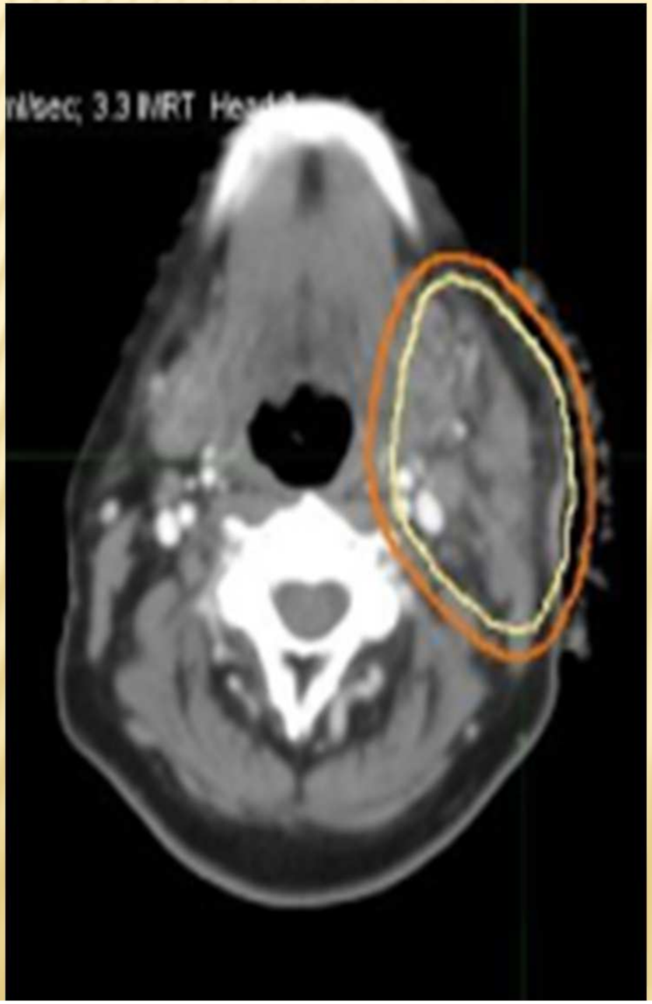
so, high chances of tumour miss

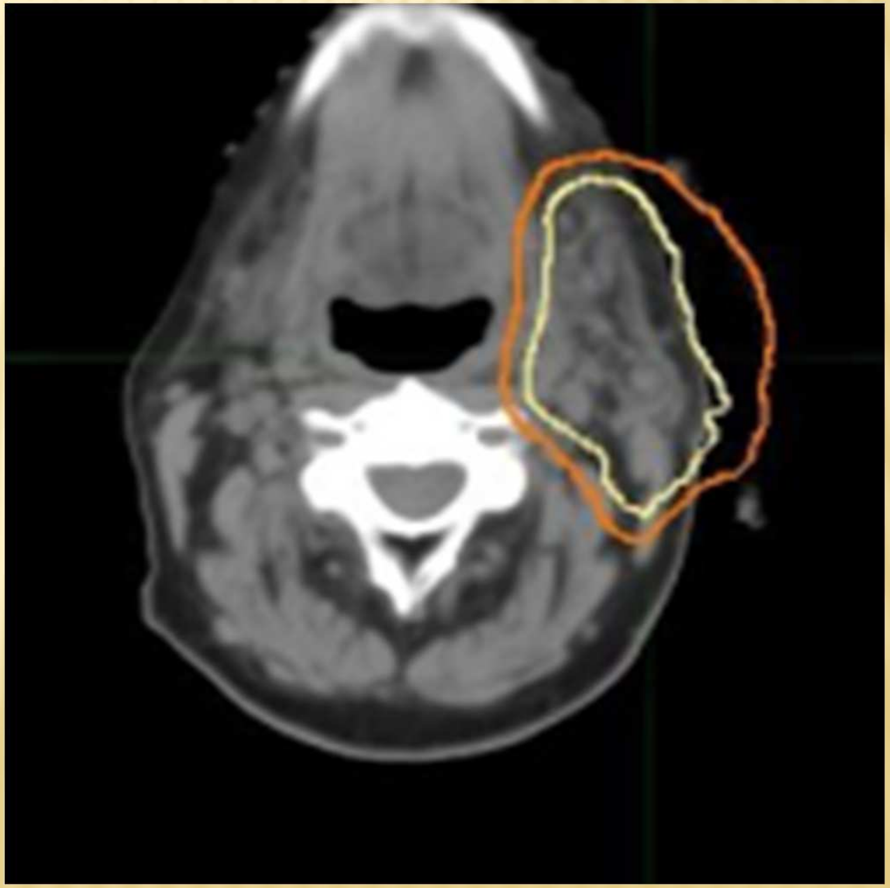
higher dose to OAR

- Weekly imaging and modification of the initial plan according to anatomical changes.

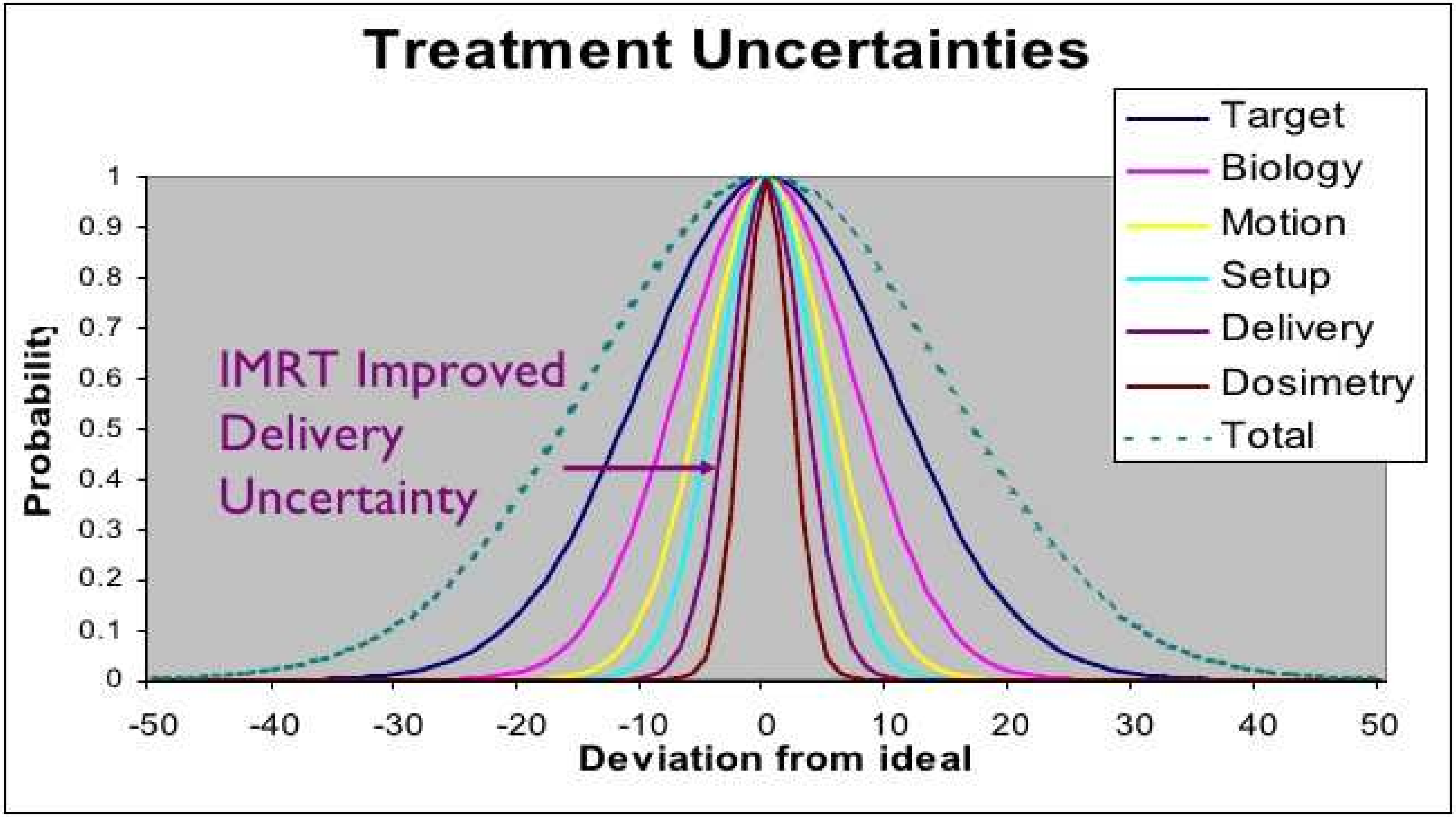


AS PATIENT UNDERGOES 6-7 WEEKS OF IMRT THERE ARE MARKED ANATOMICAL CHANGES





Where is the greatest uncertainty now?



WEIGHT LOSS AND VOLUME CHANGES

- GTV decreases throughout treatment:

  -9% (+38 to -54%)

- weight loss during reatment.

  mean weight change: -4.7% (+2.8 to -15.5%)

CONTD….

- Hansen et al – mean reduction in Parotid volume 15- 21.5%
- Duprez et al - Parotid shrinkage of 24%
- Castadot et al –mean shrinkage of Parotid 0.9-1%/day.

  -moving medially by mean distance 3.4 mm

Mean reduction in Parotid vol by15-25% by the end of treatment and also moves medially potentially into the high dose region.

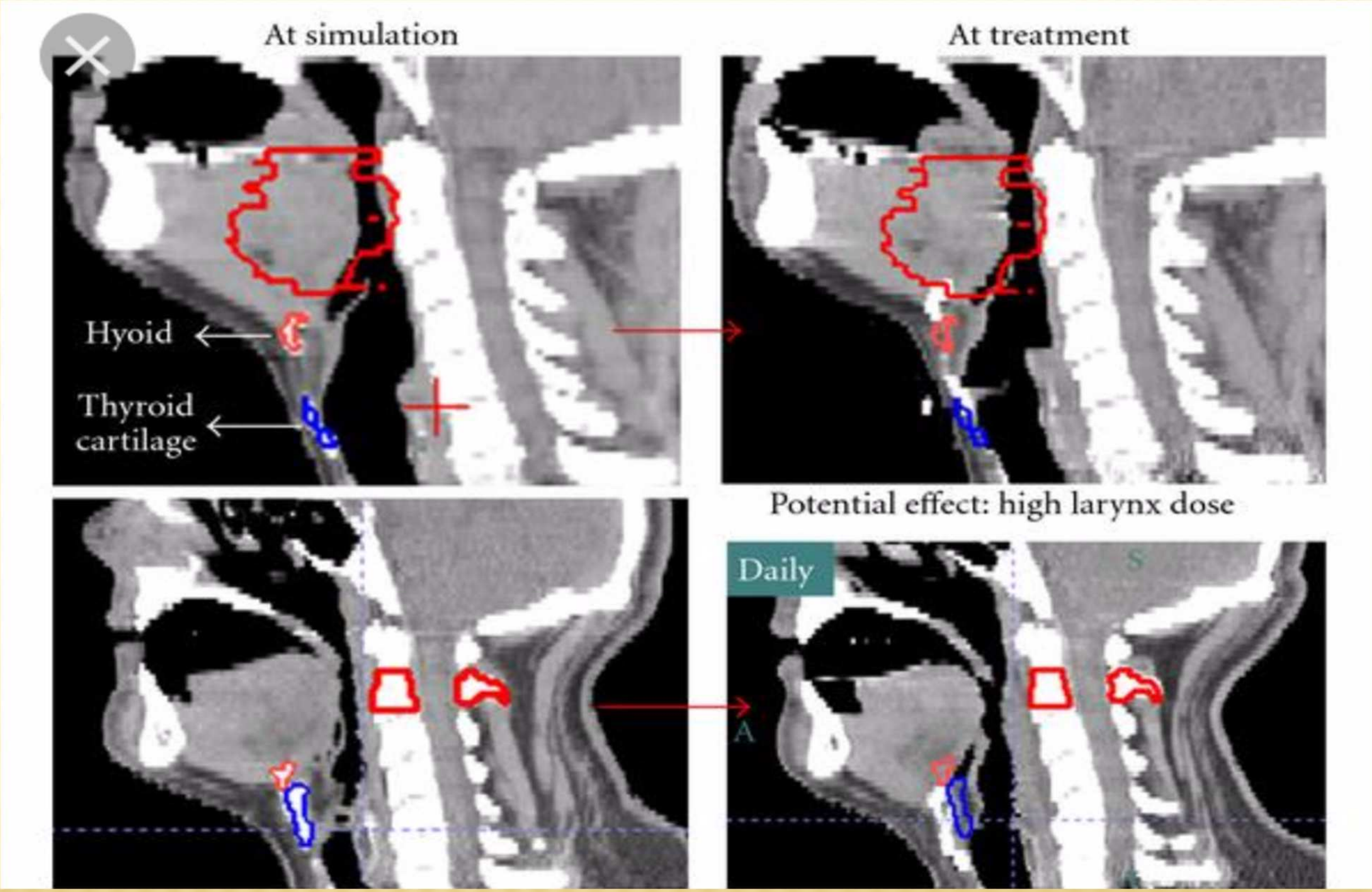
VOLUME AND POSITIONAL CHANGE IN PAROTIDS

- mean volume reduction in parotid 24.4% (0 - 53.6%) in 80-90% of the patients.

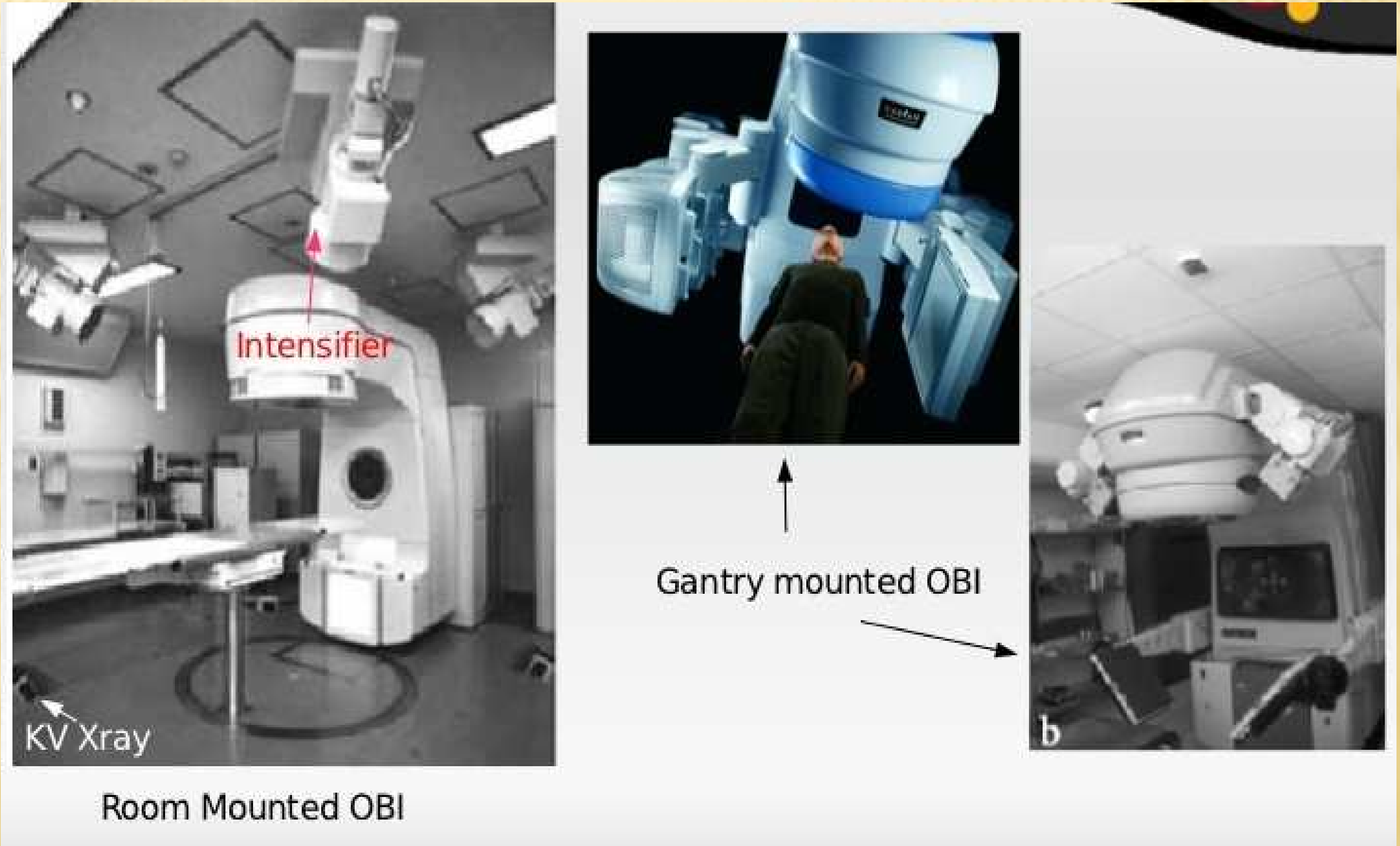
- more pronounced in the contralateral parotid - (mean vol loss -27% *vs* -22%)
- mean parotid volume loss 0.7%/day (0 - 1.5%)

- Parotid shifts - medially by mean 3.4mm (2 - 6.7mm)
  posteriorly by mean 2.7mm (0 - 8mm)

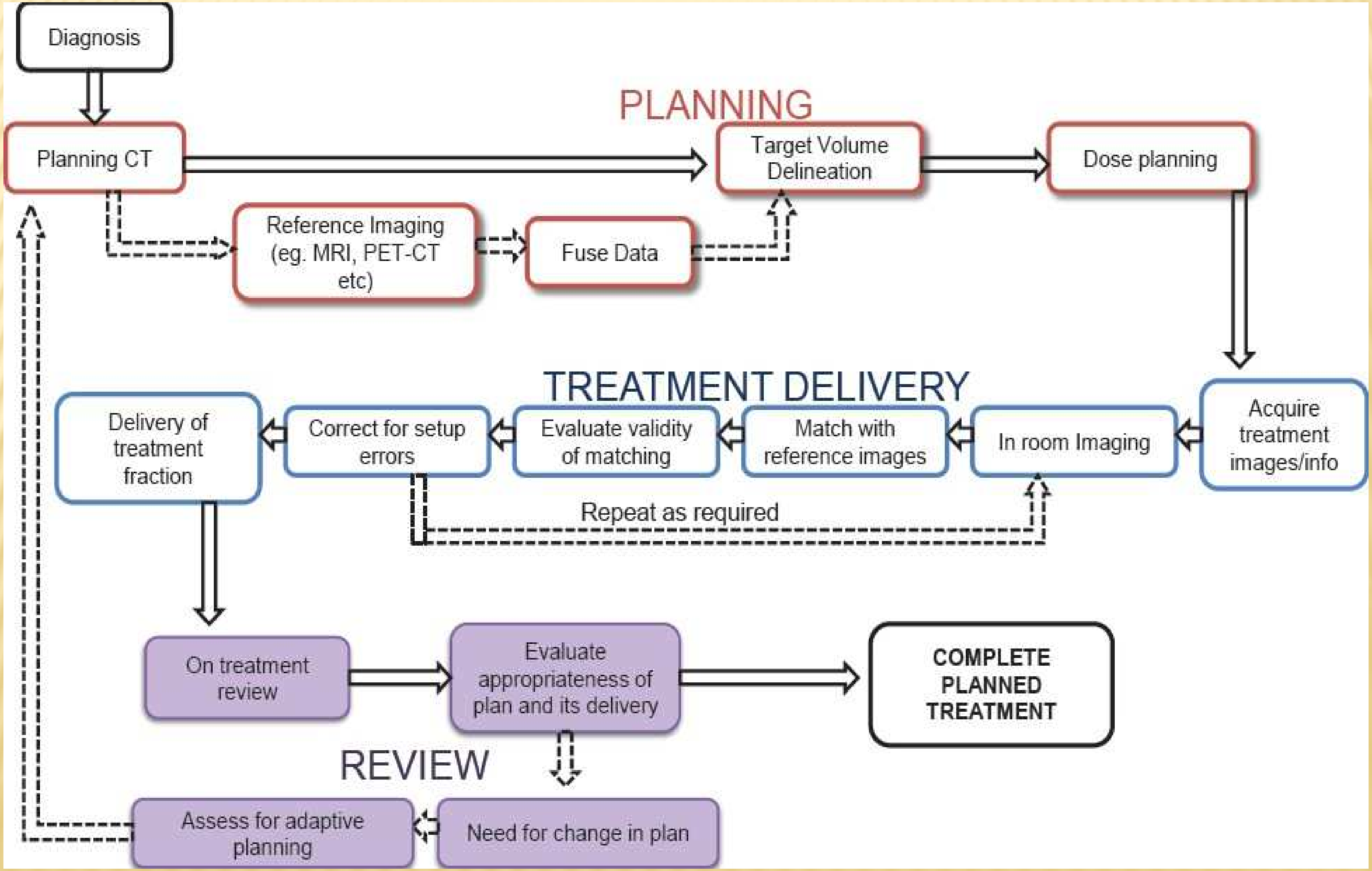
ADAPTIVE RT


At simulation
At treatment
Hyoid
Thyroid cartilage
Potential effect: high larynx dose
Daily
A

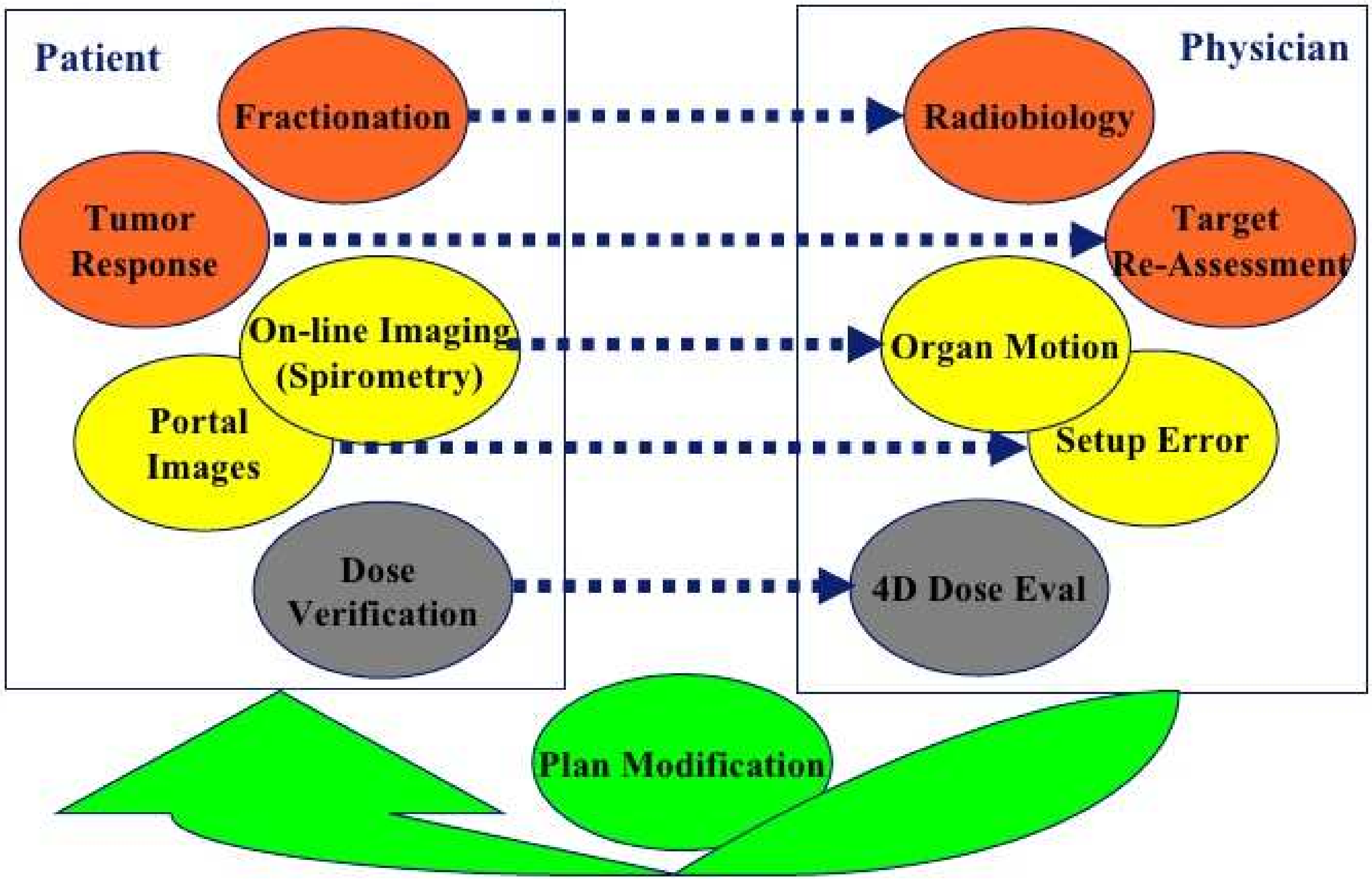
ON BOARD IMAGING



ADAPTIVE RT WORKFLOW



4D Radiotherapy Adaptation Considerations



TAKE HOME MESSAGE

Technology is a good servant but a bad master..

Use technology judiciously…

Thank You
For Your Attention…