2 D to 3 D planning in Carcinoma of Oesophagus

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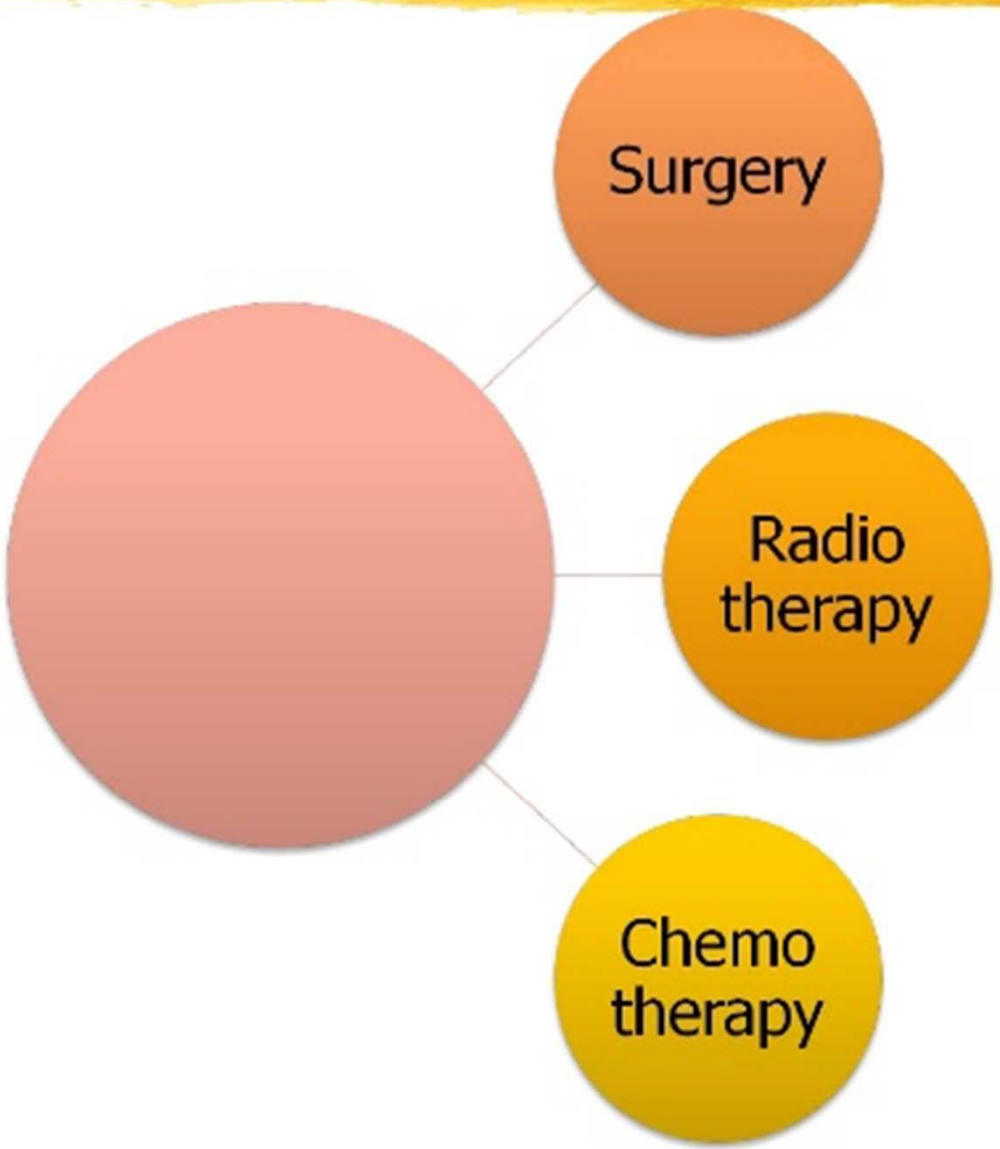
Treatment



Management depends upon:

- Site of disease
- Extent of disease involvement
- Co-morbid conditions
- Patient preference.

Radiotherapy

- Curative
  - Radical RT
  - Pre-Op RT
  - Post Op RT
  - Concurrent chemo-radiation
- Palliative
- EBRT
- Brachytherapy

The design and delivery of radiation therapy for esophageal cancer requires a knowledge of the –

- Natural history of the disease
- Patterns of failure
- Anatomy,
- Radiobiologic principles.
- Use of proper equipment
- Implementation of methods to decrease treatment-related toxicity
- Close collaboration with the physics and technology staff are essential.
- As radiation oncology is both an art and a science.

TECHNIQUES OF RADIATION THERAPY

- External beam radiotherapy
- Important considerations for RT

- Nearby vital structures: spinal cord. lungs, heart
- Movement in target tissue and vital structures: lungs, heart
- Variable density of tissues: lungs

SIMULATION

- Extent of the disease should be known based on imaging
- Barium swallow,
- CT,
- PET
- Endoscopy.
- During simulation, the patient is positioned, straightened, and immobilized on the simulation table.
- Arms are generally placed overhead.
- Palpable neck disease should be marked with a radio-opaque wire
- Administration of oral contrast to delineate the esophagus is used.
- Some authors recommend placing the patient in the prone position for treatment to displace the esophagus away from the spinal cord

EBRT Techniques

- Patient Positioning:
  - CERVICAL ESOPHAGUS: Supine with arms by the side
  - MID AND LOWER THIRD:
    - SUPINE With arms above their head if AP – PA portals are being planned
    - PRONE if posterior obliques are being included.
      - Esophagus is pulled anteriorly and spinal cord can be spared.
- IMMOBILISATION :
  - Perspex cast
  - Vertebral column should be as parallel to couch as possible.
- Barium swallow contrast to delineate the esophageal lumen and stomach.

EBRT TECHNIQUES

Conventional technique

TREATMENT PORTALS

Parallel opposed AP-PA fields

Initial phase (39.6-41.4 Gy)

- 5cm prox and distal margins
- 2 cm lateral margins

EBRT – Cervical Esophagus

Field Portals:

- AP – PA foll. by opposed oblique pair.
- 2 anterior obliques and 1 posterior field.
- 2 posterior obliques and 1 anterior field
- 4 field box with soft tissue compensators foll by obliques (Univ of Florida tech)

- SUPERIOR BORDER: At C 7
- INFERIOR BORDER : At T 4 (carina)
- 2 cm lateral margins.
- SC nodes irradiated electively.
- SC nodes will be underdosed if oblique portals are used to treat primary; can be boosted by a separate field if required.

EBRT – Mid & Lower1/3rd

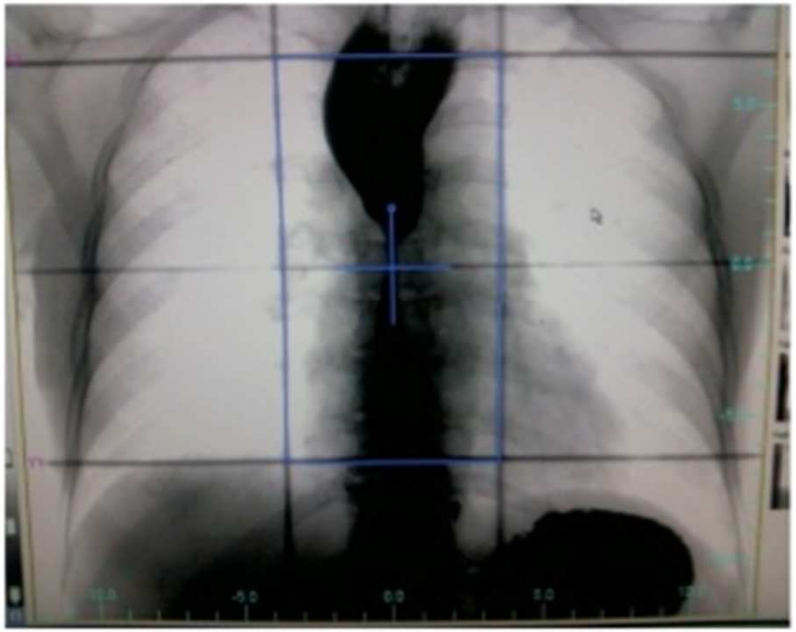
→ AP – PA followed by 1 Ant and 2 Post oblique pair

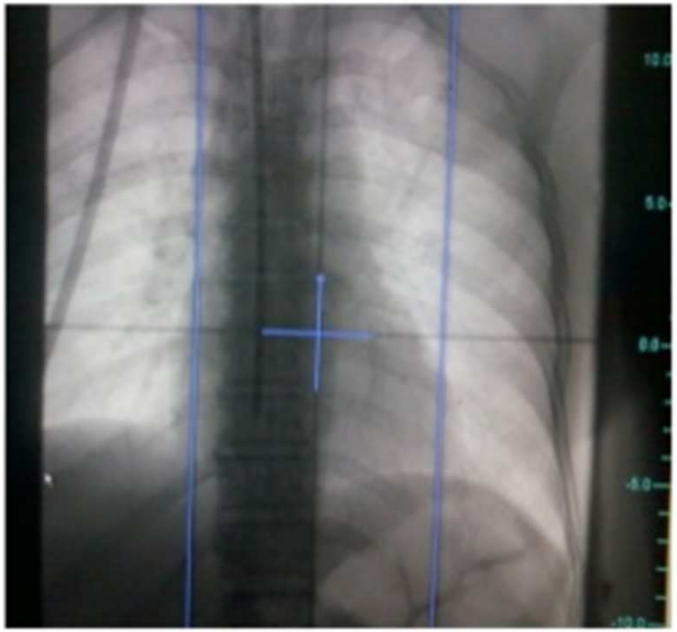
→ 4 FIELD : AP-PA & opposed laterals – for mid 1/3rd lesions with patient in prone position.

→ AP-PA upto 43 Gy foll by 2 Post obliques upto 50 Gy (gross disease boosted to 60 Gy)

- SUPERIOR BORDER: 5 cm proximal to superior extent of disease.
- INFERIOR BORDER:
  - MID 1/3RD – AT GE jn. As visualised by Barium swallow
  - LOWER 1/3RD - Coeliac plexus (L 1) to be included.

Radiotherapy for CA esophagus



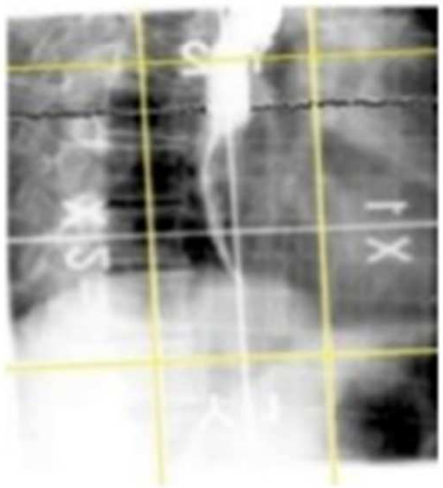


EBRT - DOSES

- Energy
  - 6 – 10 MV linac or Co^{60}
- Chemoradiation:
  - 50.4 Gy in 28 # at 1.8 Gy per #
  - Boost to 60 – 66 Gy for residual disease
- Radical RT:
  - 45 Gy / 25 # / 1.8 Gy per #
  - boost with 2 cm margin to total dose of 60Gy
- Dose limitations
  - Spinal cord Dmax:45 Gy at 1.8 Gy/fx
  - Lung: Limit 70% of both lungs <20 Gy
  - Heart: Limit 50% of ventricles <25 Gy

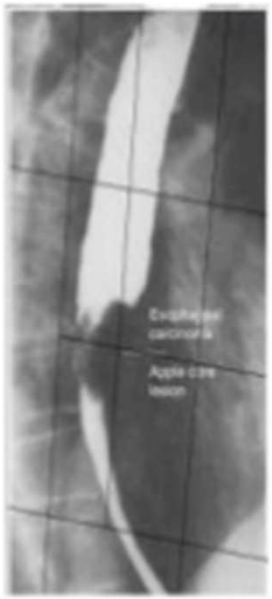
Off cord Boost: After 40-44Gy

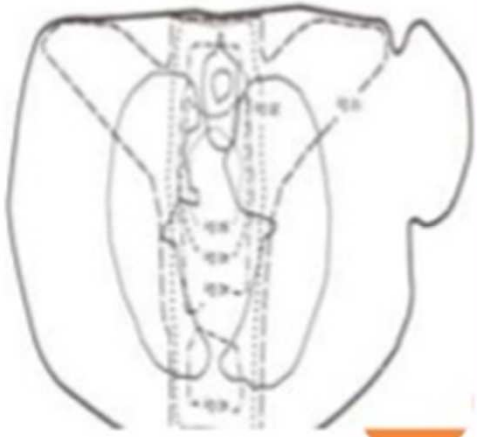
3 field technique -- one direct anterior and two lateral/ posterior oblique



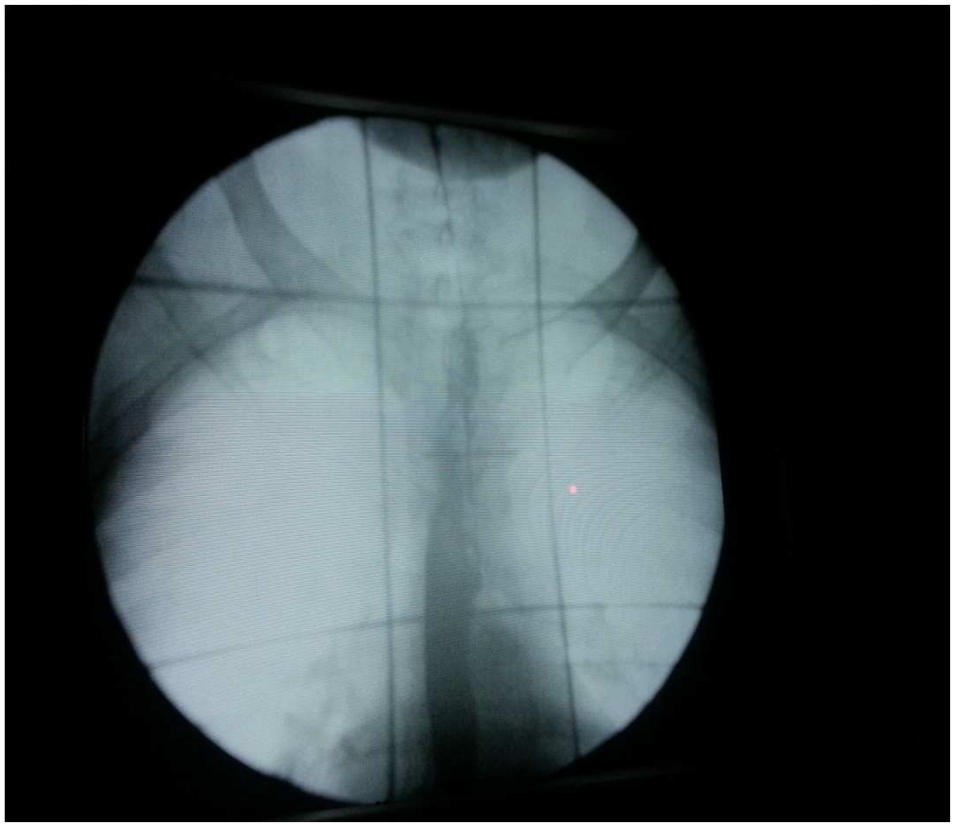
Advantages

- Homogeneous dose distribution
- Tumor better covered
- Critical organs are out of the field





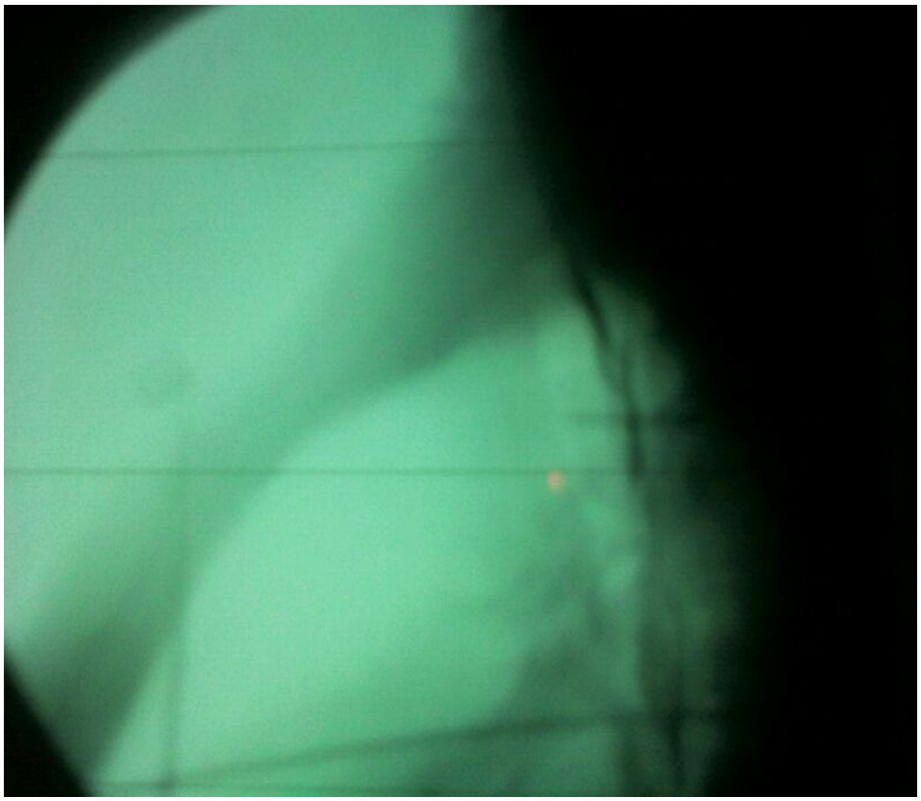
3 field planning

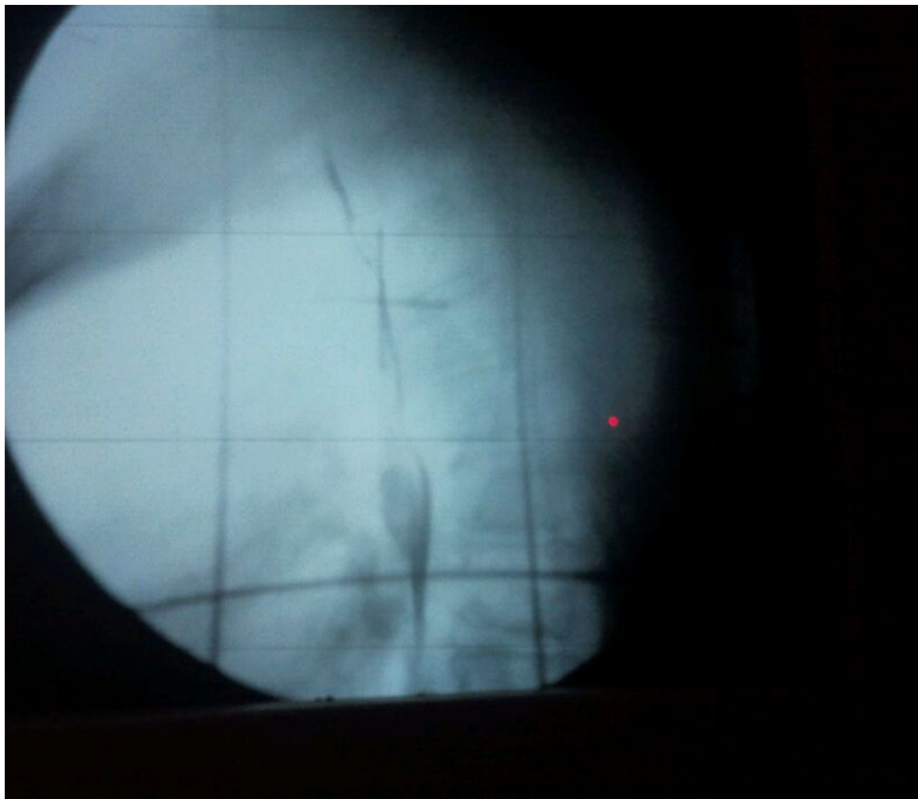


✓3 field planning

skin to centre

centre to spine





NORMAL TISSUE TOLERANCE

Organ	TD5/5 Gy	TD50/5 Gy	Field size
Spinal cord	47 50	- 70	20cm 5-10cm
Heart	40 60	50 70	Whole 1/3rd
Lung	17.5 45	24.5 65	Whole 1/3rd

Lung	Whole organ	3D-CRT	Symptomatic pneumonitis	V20 ≤ 30%	<20	For combined lung. Gradual dose response
	Whole organ	3D-CRT	Symptomatic pneumonitis	Mean dose = 7	5	Excludes purposeful whole lung irradiation
	Whole organ	3D-CRT	Symptomatic pneumonitis	Mean dose = 13	10	
	Whole organ	3D-CRT	Symptomatic pneumonitis	Mean dose = 20	20	
	Whole organ	3D-CRT	Symptomatic pneumonitis	Mean dose = 24	30	
	Whole organ	3D-CRT	Grade ≥2 acute esophagitis	V70 <20%	<50	
Heart	Pericardium	3D-CRT	Pericarditis	Mean dose <26	<15	Based on single study
	Pericardium	3D-CRT	Pericarditis	V30 <46%	<15	
	Whole organ	3D-CRT	Long-term cardiac mortality	V25 <10%	<1	Overly safe risk estimate based on model predictions

(Continued)

PROBLEMS WITH TRIMODALITY

TUMOUR CONTROL

TOXICITY

- Haematological toxicity – 30 %
- Mucositis Gr 3,4
- Oesophagitis
- Pulm complications (ARDS) 14 %
- Surgical complications -
- anastomotic leak 6 %
- Local recurrence 6 %
- Operative deaths 6 %

MANAGING COMPLICATIONS

- Smoking cessation
- Nutrition maintenance:
  - Assess radiation tolerability before starting radiation
  - Plenty of fluids, frequent sips of cool liquids
  - Disprin and local anesthetic gargles
  - Avoid hot spicy, dry food
  - Ryles tube insertion: Grade 3-4 dysphagia/ <1500kcal/day
- Respiratory physiotherapy: to improve pulmonary function
- During radiation, check patient status at least once a week
- Antiemetics, Antacids, soothening agents be prescribed when needed
- Treatment interruptions or dose reductions for manageable acute toxicities should be avoided.

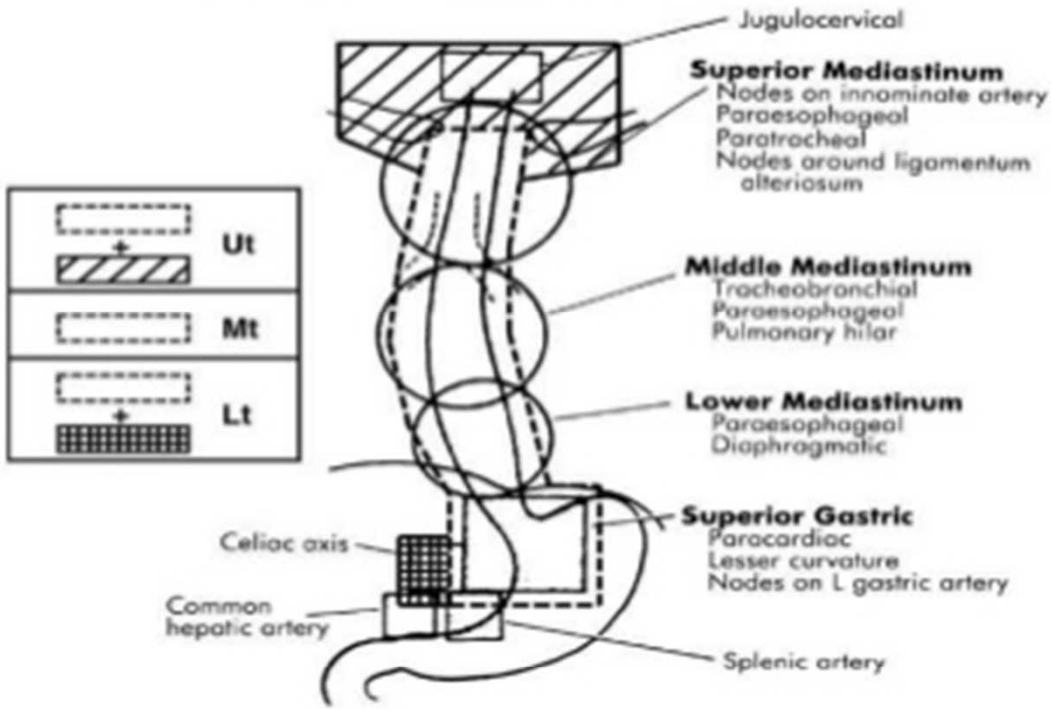
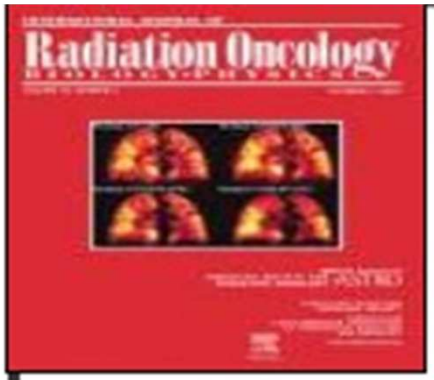


Fig. 1. A schema of each radiation field.

APPROPRIATE TARGET VOLUME AND NEED OF ELECTIVE NODAL IRRADIATION IN CONFORMAL THERAPIES



Int. J. Radiation Oncology Biol. Phys., Vol. 76, No. 2, pp. 446–451, 2010

0360-3016/10/$–see front matter

doi:10.1016/j.ijrobp.2009.02.078

CLINICAL INVESTIGATION **Esophagus**

THREE-DIMENSIONAL CONFORMAL RADIATION THERAPY FOR ESOPHAGEAL SQUAMOUS CELL CARCINOMA: IS ELECTIVE NODAL IRRADIATION NECESSARY?

KUAI-LE ZHAO, M.D.,[†] JIN-BO MA, M.D.,[‡] GUANG LIU, M.D.,[§] KAI-LIANG WU, M.D.,[†] XUE-HUI SHI, M.D.,[†] AND GUO-LIANG JIANG, M.D.*[†]

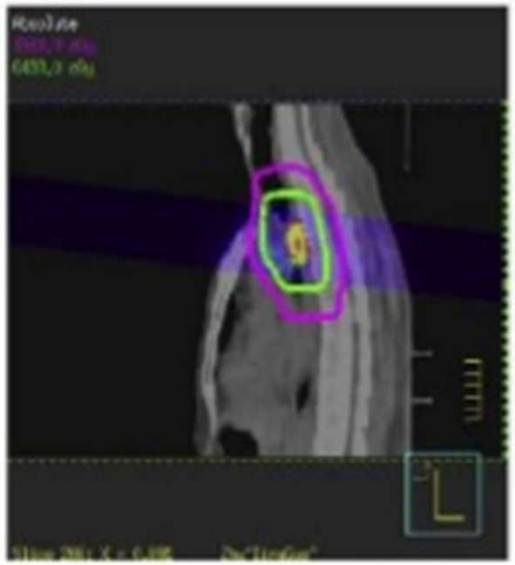
- In patients treated with 3D-CRT for esophageal SCC, the omission of elective nodal irradiation was not associated with a significant amount of failure in lymph node regions not included in the planning target volume.
- Local failure and distant metastases remained the predominant problems.
- A longitudinal margin of 3 cm from the GTV to the CTV1 is probably enough

BASIS OF OMITTING ENI

(a) CT before treatment

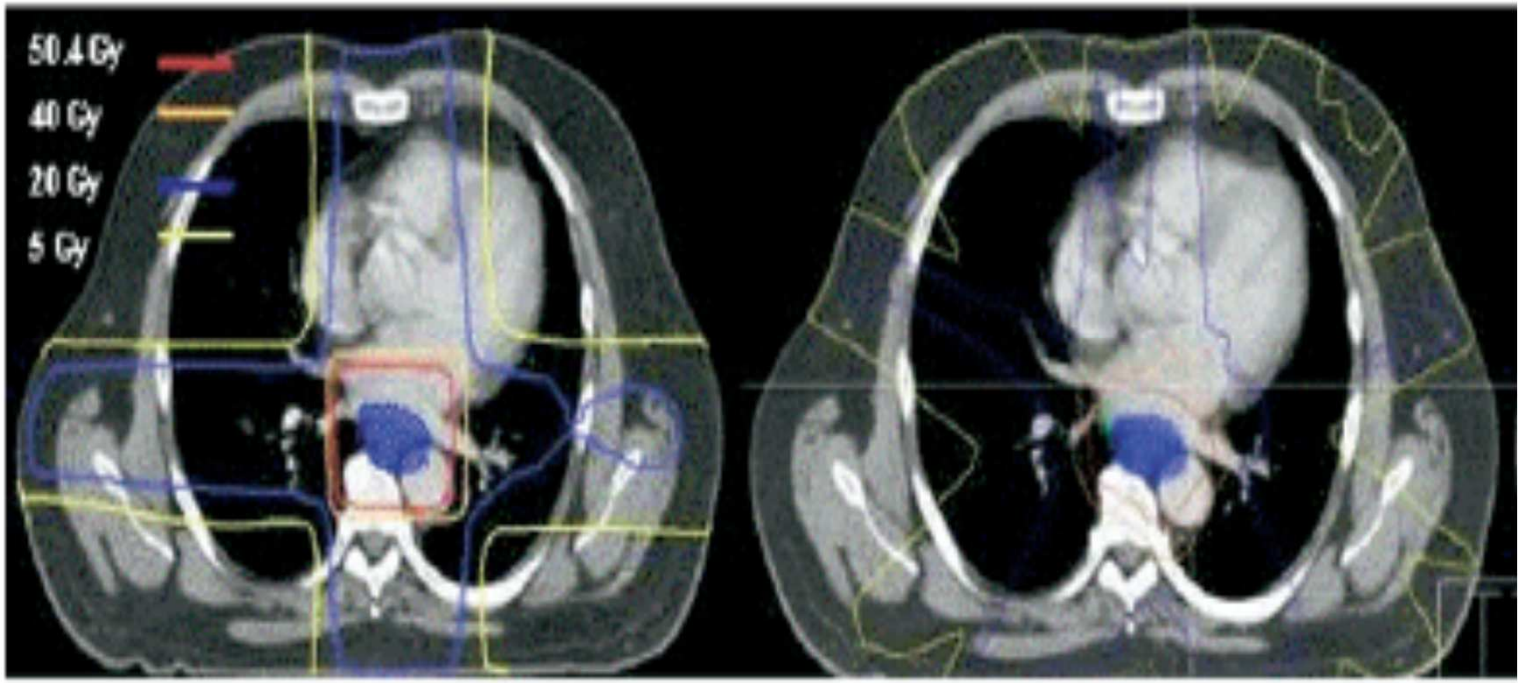
(b) FDG-PET after recurrence

(c) Fusion of PET/CT

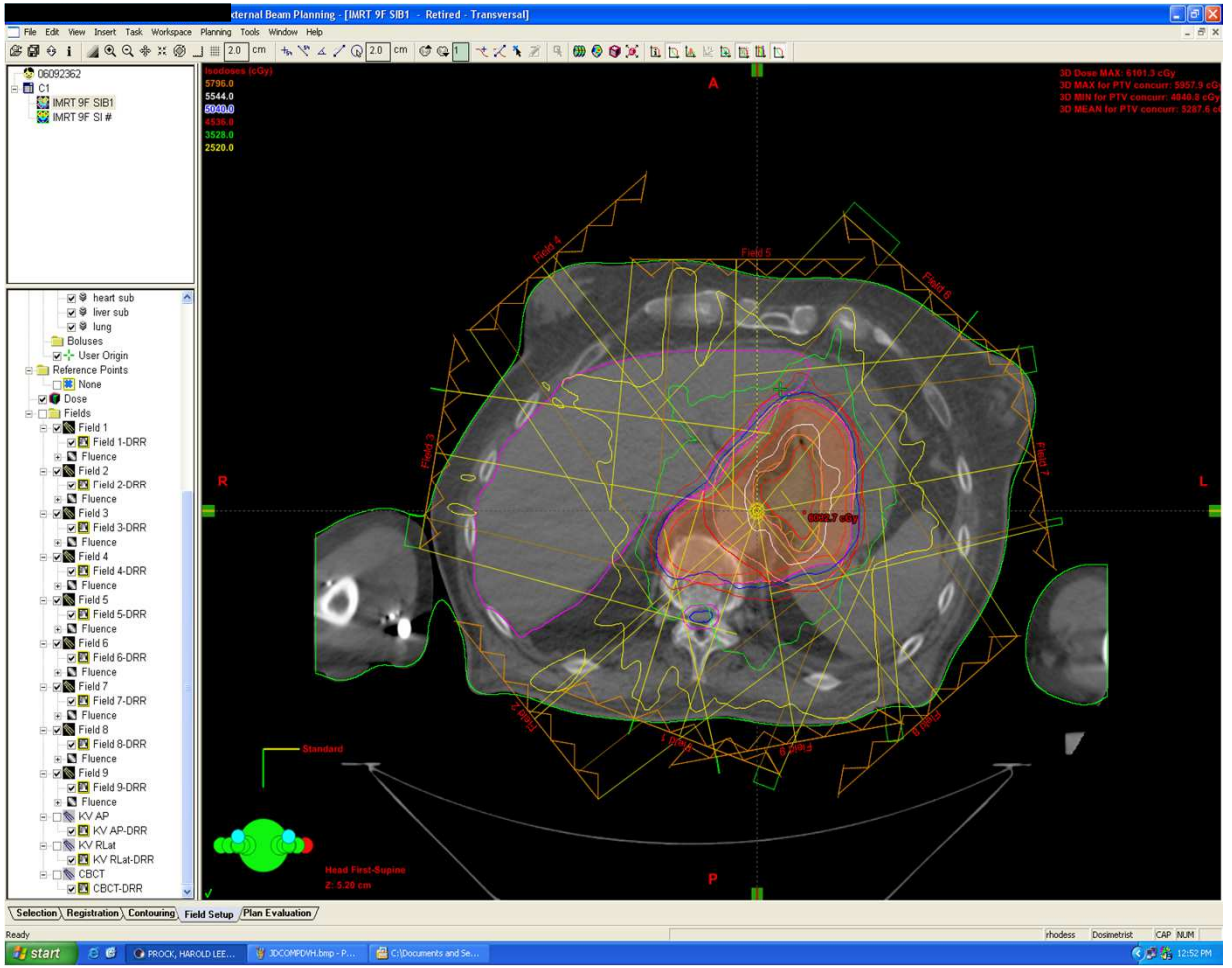


Recurrence was with in GTV

3 D vs. IMRT



IMRT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IMRT 9F SIB1
IMRT 9F SI #
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5544.0
5040.0
4536.0
3528.0
2520.0
3D Dose MAX: 6101.3 cGy
3D MAX for PTV concurr: 5957.9 cGy
3D MIN for PTV concurr: 4840.8 cGy
3D MEAN for PTV concurr: 5287.6 cGy
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Z: 5.20 cm
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User Origin
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Field 2-DRR
Field 3
Field 3-DRR
Field 4
Field 4-DRR
Field 5
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Field 6
Field 6-DRR
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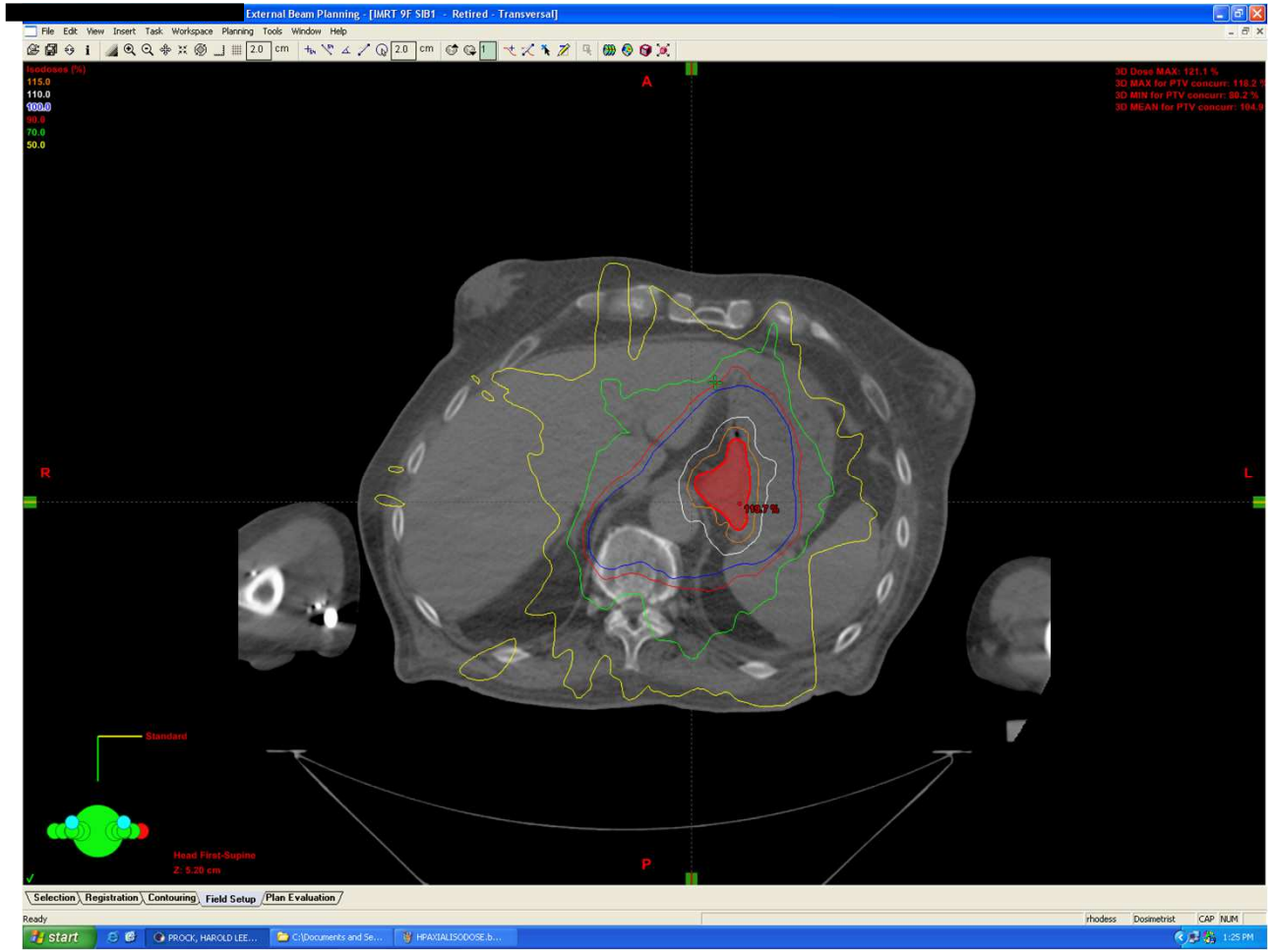
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Isodoses (%)
115.0
110.0
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3D Dose MAX: 121.1 %
3D MAX for PTV concurr: 118.2 %
3D MIN for PTV concurr: 98.2 %
3D MEAN for PTV concurr: 104.9
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IMRT


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3D MIN for PTV concurr: 80.2 %
3D MEAN for PTV concurr: 104.9
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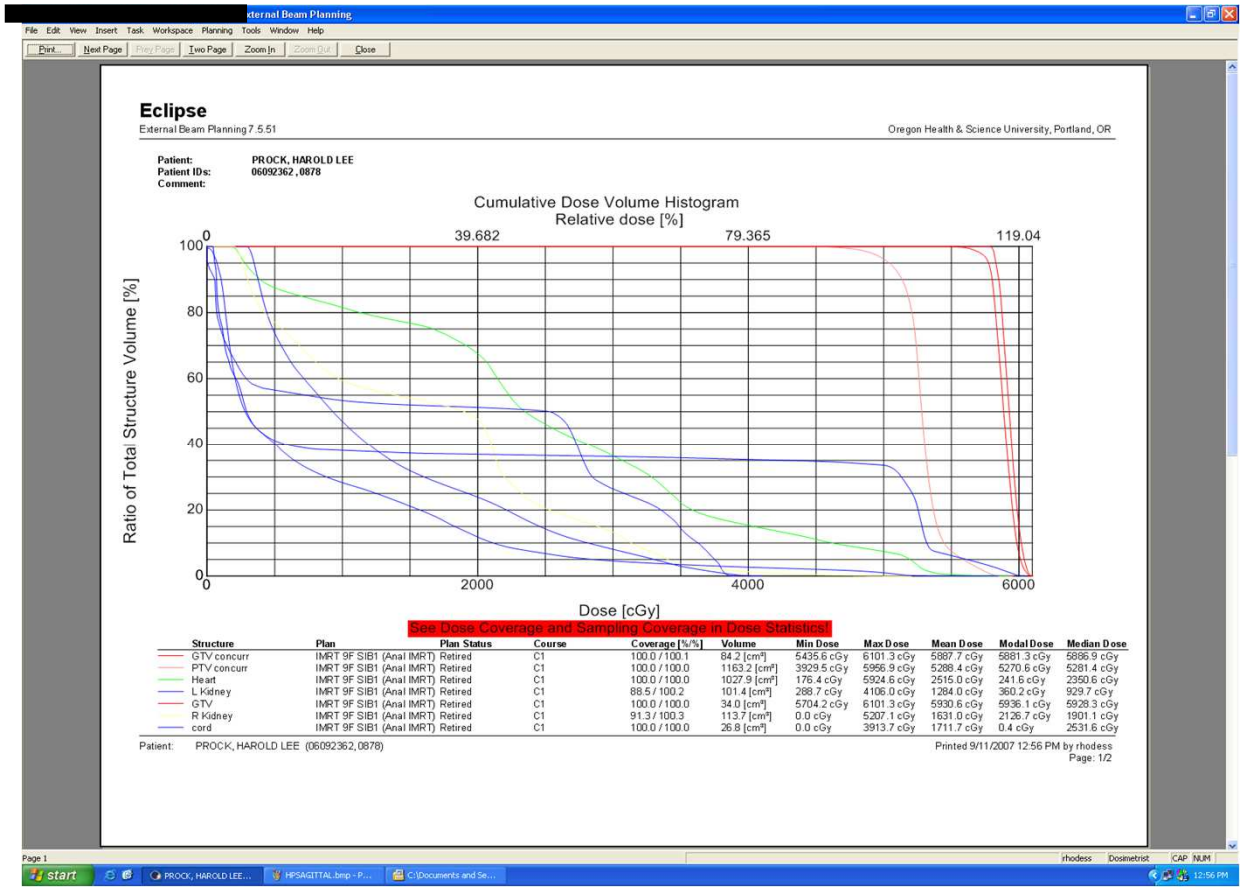
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External Beam Planning 7.5.51
Oregon Health & Science University, Portland, OR
Patient: PROCK, HAROLD LEE
Patient IDs: 06092362 , 0878
Comment:
Cumulative Dose Volume Histogram
Relative dose [%]
0
39.682
79.365
119.04
100
80
60
40
20
0
Ratio of Total Structure Volume [%]
0
2000
4000
6000
Dose [cGy]
See Dose Coverage and Sampling Coverage in Dose Statistics!
Structure Plan Plan Status Course Coverage [%/%] Volume Min Dose Max Dose Mean Dose Modal Dose Median Dose
GTV concurr IMRT 9F SIB1 (Anal IMRT) Retired C1 100.0 / 100.1 84.2 [cm³] 5435.6 cGy 6101.3 cGy 5887.7 cGy 5881.3 cGy 5886.9 cGy
PTV concurr IMRT 9F SIB1 (Anal IMRT) Retired C1 100.0 / 100.0 1163.2 [cm³] 3929.5 cGy 5956.9 cGy 5288.4 cGy 5270.6 cGy 5281.4 cGy
Heart IMRT 9F SIB1 (Anal IMRT) Retired C1 100.0 / 100.0 1027.9 [cm³] 176.4 cGy 5924.6 cGy 2515.0 cGy 241.6 cGy 2350.6 cGy
L Kidney IMRT 9F SIB1 (Anal IMRT) Retired C1 88.5 / 100.2 101.4 [cm³] 288.7 cGy 4106.0 cGy 1284.0 cGy 360.2 cGy 929.7 cGy
GTV IMRT 9F SIB1 (Anal IMRT) Retired C1 100.0 / 100.0 34.0 [cm³] 5704.2 cGy 6101.3 cGy 5930.6 cGy 5936.1 cGy 5928.3 cGy
R Kidney IMRT 9F SIB1 (Anal IMRT) Retired C1 91.3 / 100.3 113.7 [cm³] 0.0 cGy 5207.1 cGy 1631.0 cGy 2126.7 cGy 1901.1 cGy
cord IMRT 9F SIB1 (Anal IMRT) Retired C1 100.0 / 100.0 26.8 [cm³] 0.0 cGy 3913.7 cGy 1711.7 cGy 0.4 cGy 2531.6 cGy
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J Radiat Oncol
DOI 10.1007/s13566-012-0048-5

ORIGINAL RESEARCH

Outcomes of definitive or preoperative IMRT chemoradiation for esophageal cancer

Ravi Shridhar · Michael D. Chuong · Jill Weber · Jessica Freilich · Khaldoun Almhanna · Domenico Coppola · William Dinwoodie · Thomas J. Dilling · Daniel Fernandez · Richard C. Karl · Kenneth L. Meredith · Sarah E. Hoffe

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Abstract
Objectives Intensity-modulated radiation therapy (IMRT) is evolving for the treatment of gastrointestinal cancers. The purpose of this study is to analyze our outcomes utilizing IMRT chemoradiation for esophageal cancer.
Methods IMRT was incorporated into esophageal cancer treatment at our center in 2006. Patients treated between 2006 and 2011 with either preoperative or definitive IMRT chemoradiation to 50–60 Gy prescribed to the gross tumor volume and 45–50.4 Gy to the clinical target volume concurrently with chemotherapy were evaluated. IMRT techniques included multifield segmented step and shoot, compensator-based, and volumetric arc therapy. Overall survival (OS) and disease-free survival (DFS) were analyzed by Kaplan–Meier and log-rank analysis. Multivariate analysis (MVA) for OS and DFS were performed with a Cox proportional hazard ratio model.
Results We identified 108 patients with a median follow-up of 19 months. Median OS and DFS were 32 and 21.6 months, respectively. Fifty-eight (53.7 %) patients underwent surgical resection. There was no difference in OS or DFS in patients who underwent surgery compared to patients treated definitively without surgery. Median weight loss was 5.5 %. Rates of hospital admissions, feeding tube placement, stent placement, dilation, and radiation pneumonitis were 15.7, 7.4 4.6, 12, and 1.9 %, respectively. Long-term radiation pneumonitis was observed in six (5.6 %) patients. MVA revealed that age, stage, and surgery were prognostic for DFS, while gender and histology were not. Gender, histology, and stage were prognostic of OS on MVA, while surgery and age were not.
Conclusions IMRT chemoradiation for esophageal cancer is safe and effective when compared to published series of 2D or 3D conformal radiation therapy. This is the largest single institutional series with long-term follow-up, confirming that IMRT is a viable treatment option for the curative treatment of esophageal cancer.

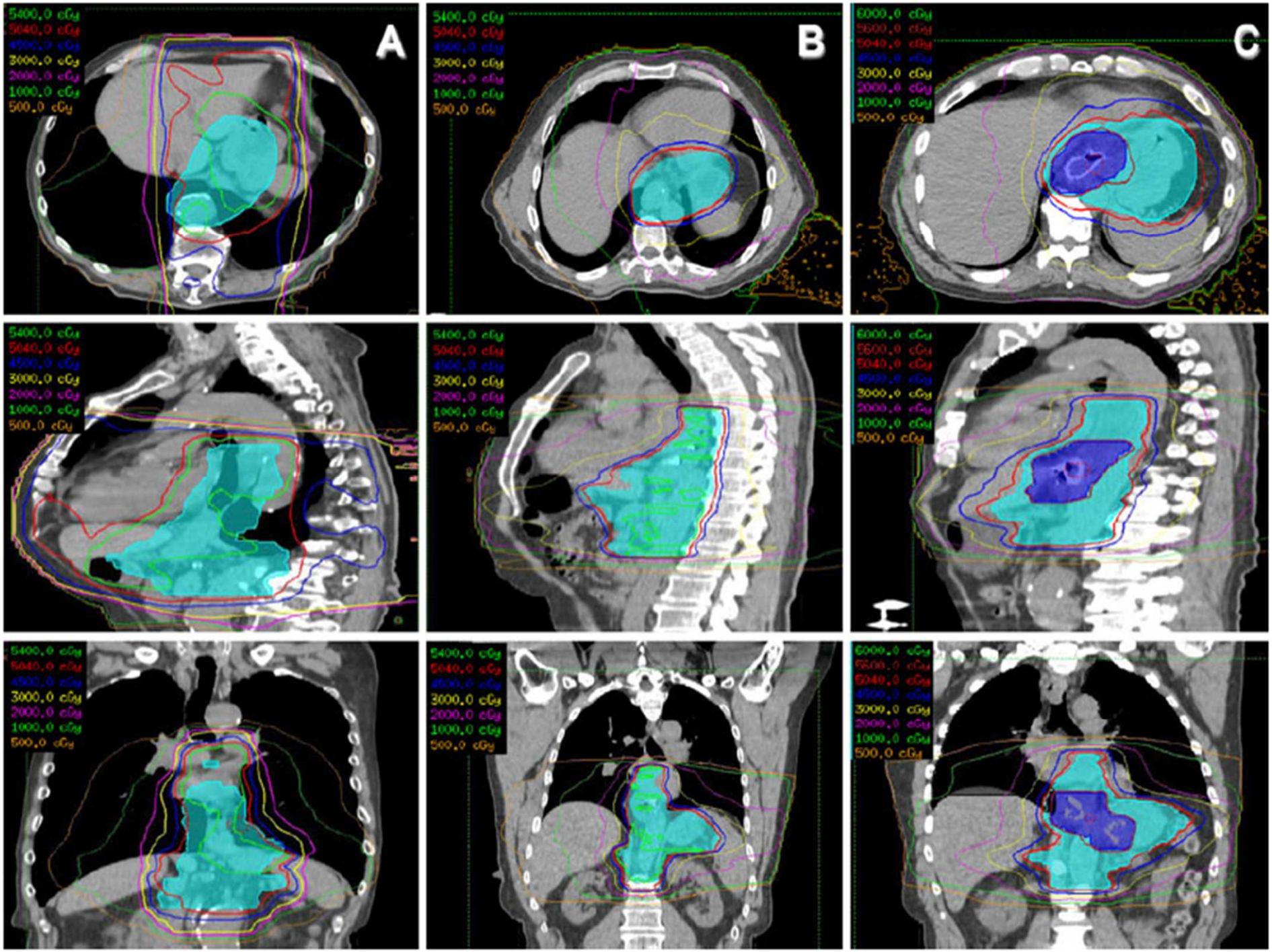
Keywords Intensity-modulated radiation therapy · Chemoradiation · Esophageal cancer · Survival · Toxicity · Surgery

IMRT

- **IMRT Dose Constraints**

Organ	Constraint
Lung	Mean < 16 Gy V20 < 30% *V5 < 60%
Cord	50 Gy max
Heart	Mean < 30 Gy
Liver	30% < 30 Gy

- *MD Anderson Data for ARDS; Wang et al. Int. J. Radiation Oncology Biol. Phys., Vol. 64, No. 3, pp. 692–699, 2006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2000.0 cGy
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5600.0 cGy

Experience with IMRT

- ✓ Tumor identification with PET-CT and fiducials is crucial to employing advanced techniques
- ✓ Respiratory motion has to be accounted for when using advanced techniques
- ✓ Daily IGRT should be employed when possible given the tight margins used in IMRT
- ✓ Dose-escalation doesn’t improve survival, however, it dramatically improves response rates providing more long term palliation
- ✓ IMRT significantly reduces grade 3 toxicity without compromising survival or increase postop morbidity

Stage	Recommended treatment
Stage I–III and IVA resectable medically-fit	definitive chemo-RT (preferred for cervical esophagus)
	Or, Pre-op chemo-RT → surgery. Surgery preferred for adenocarcinoma regardless of response to chemo-RT.
	Or, surgery. (noncervical T1N0 and young T2N0 patients with primaries of lower esophagus or gastroesophageal junction. Indications for post-op chemo-RT include: unfavorable T2N0, T3/4, LN+, and/or close/+ margin.
Stage I–III inoperable	Definitive chemo-RT
Stage IV palliative	Concurrent chemo-RT (5-FU *+ cisplatin, 50 Gy)* or RT alone (e.g., 2.5 Gy × 14 fx) or chemo alone or best supportive care.
	Pain: medications ± RT
	Bleeding: endoscopic therapy, surgery, or RT


THANK YOU