Weill Cornell Medical College

NewYork-Presbyterian
The University Hospital of Columbia and Cornell

Columbia University
College of Physicians and Surgeons

Quality Variation and Clinical Impact in Head and Neck IMRT

6th IMRT Symposium, New York

Sep. 20, 2010

K.S. Clifford Chao, MD

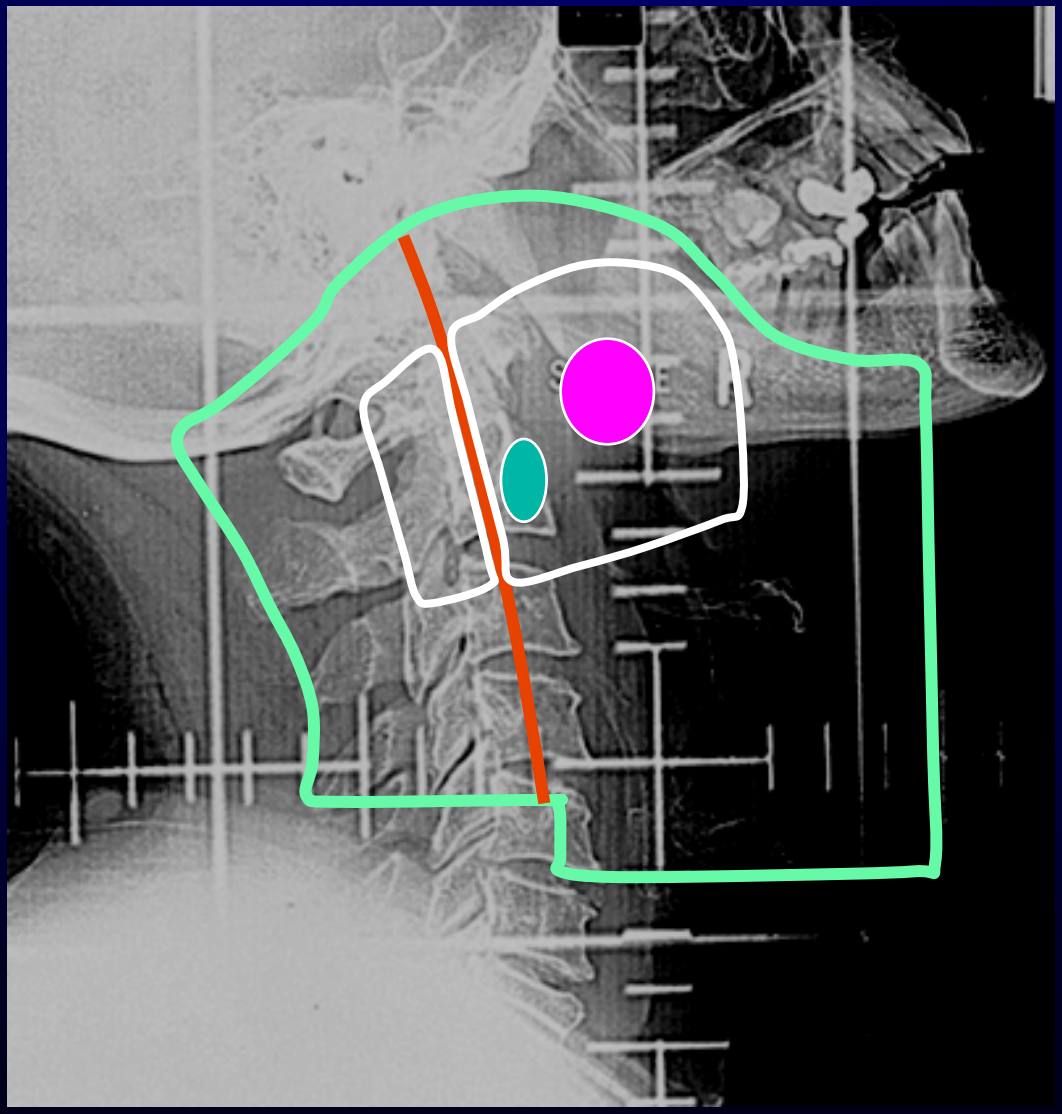
Chairman, Combined Radiation Oncology, New York Presbyterian Hospital
Chairman, Radiation Oncology, Columbia University College of P & S
Chief, Radiation Oncology, Weill Cornell Medical College

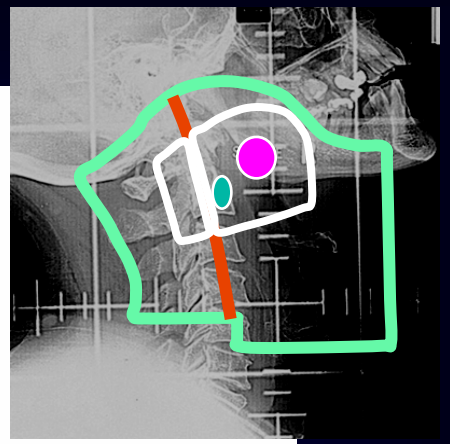
Tumor Control by IMRT vs non-IMRT in Patients with Oropharyngeal Carcinoma

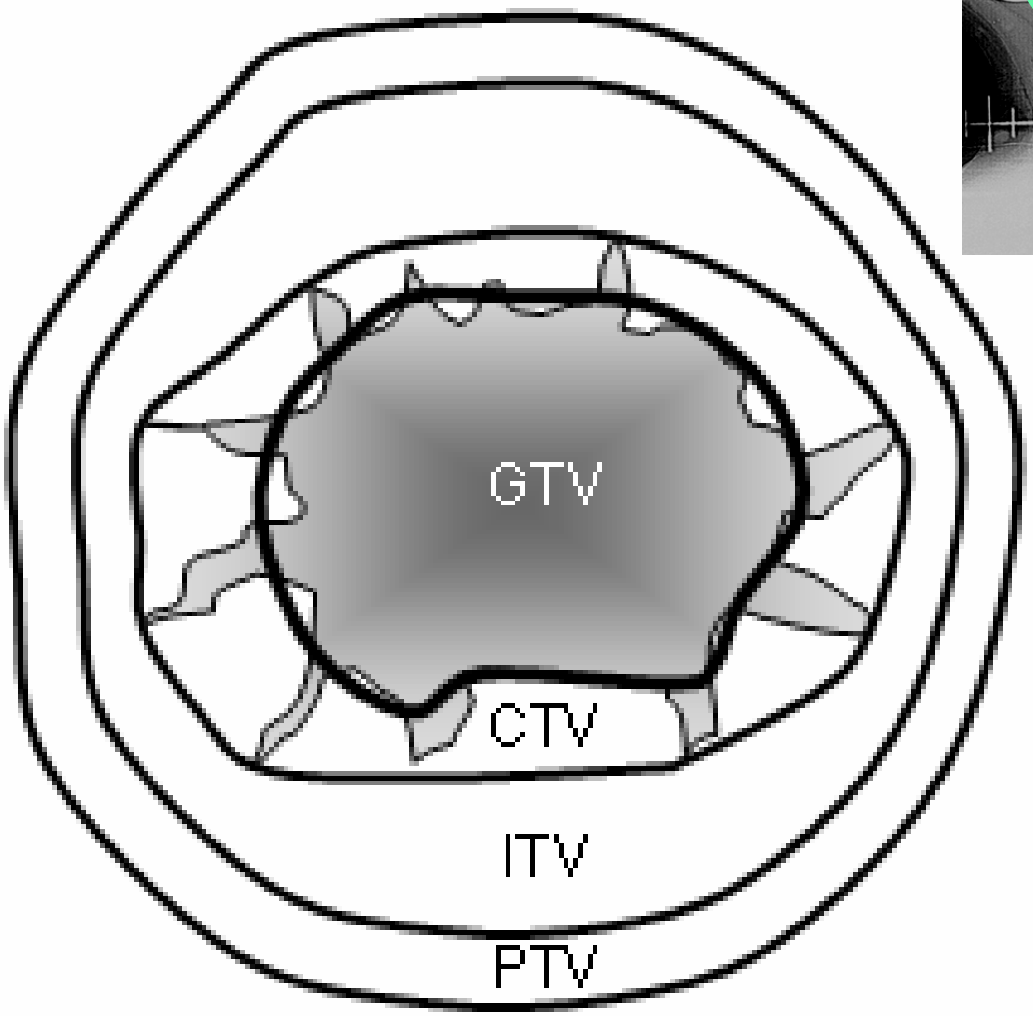
	Patient No.	Median F/U	2yr LRC	2yr DFS
Def. Non-IMRT	153	3.5 yr (1.6-17.7)	68.3%	58.4%
Def. IMRT	31	3 yr (12-58)	87.5%	73.5%
Post-op Non-IMRT	142	3.9 yr (1.3-19.8)	75.7%	73.5%
Post-op IMRT	43	2.8 yr (9-60)	95.0%	94.3%

Data compiled from Chao et al. Radiotherapy & Oncology, 61:275, 2001 and Chao et al. IJROBP 59:43-50, 2004

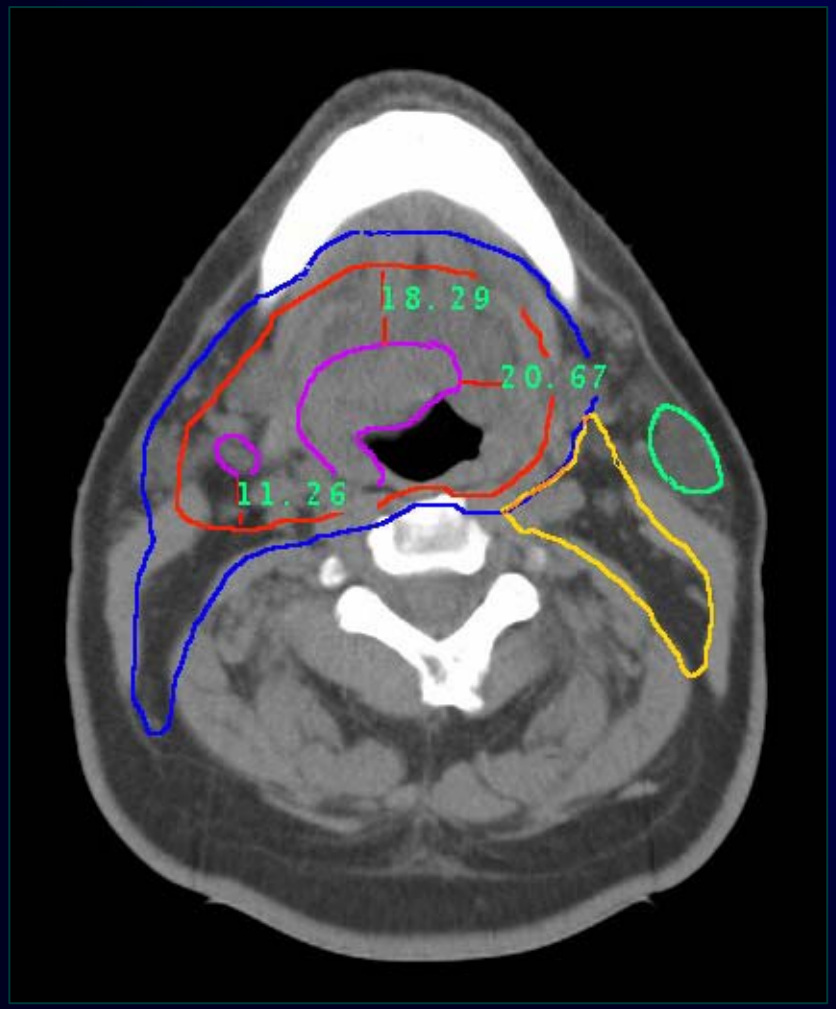
T2N1M0 SCC of Base of the Tongue

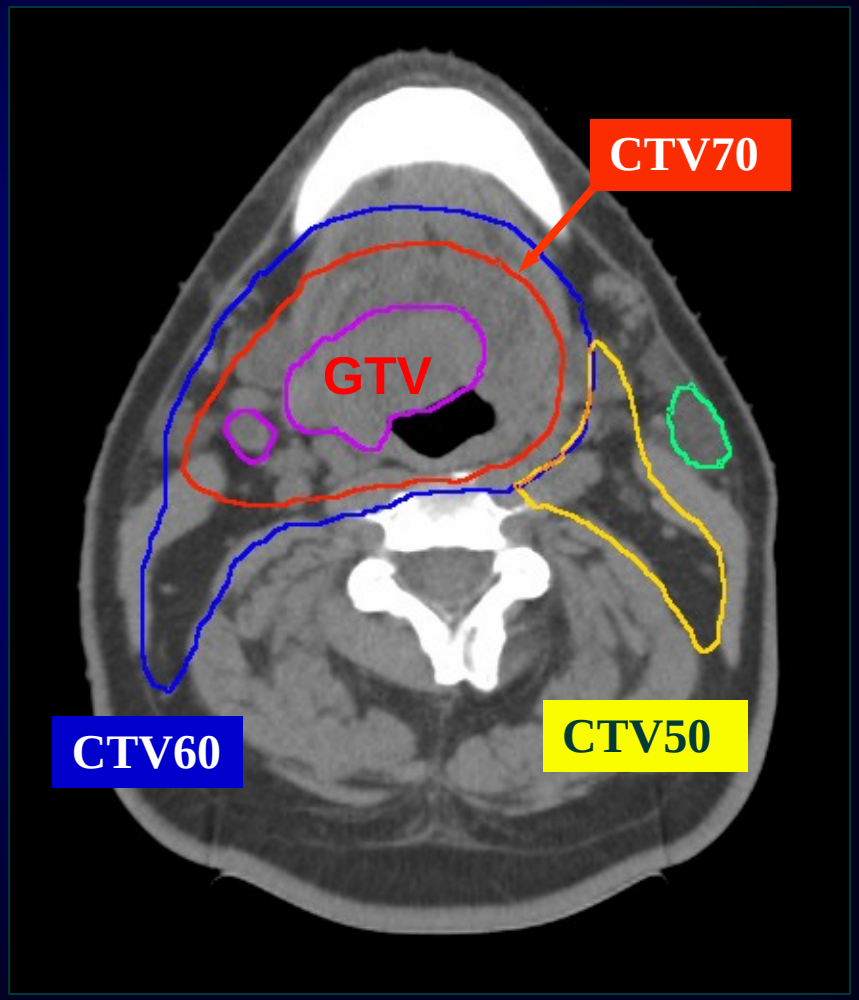





GTV
CTV
ITV
PTV

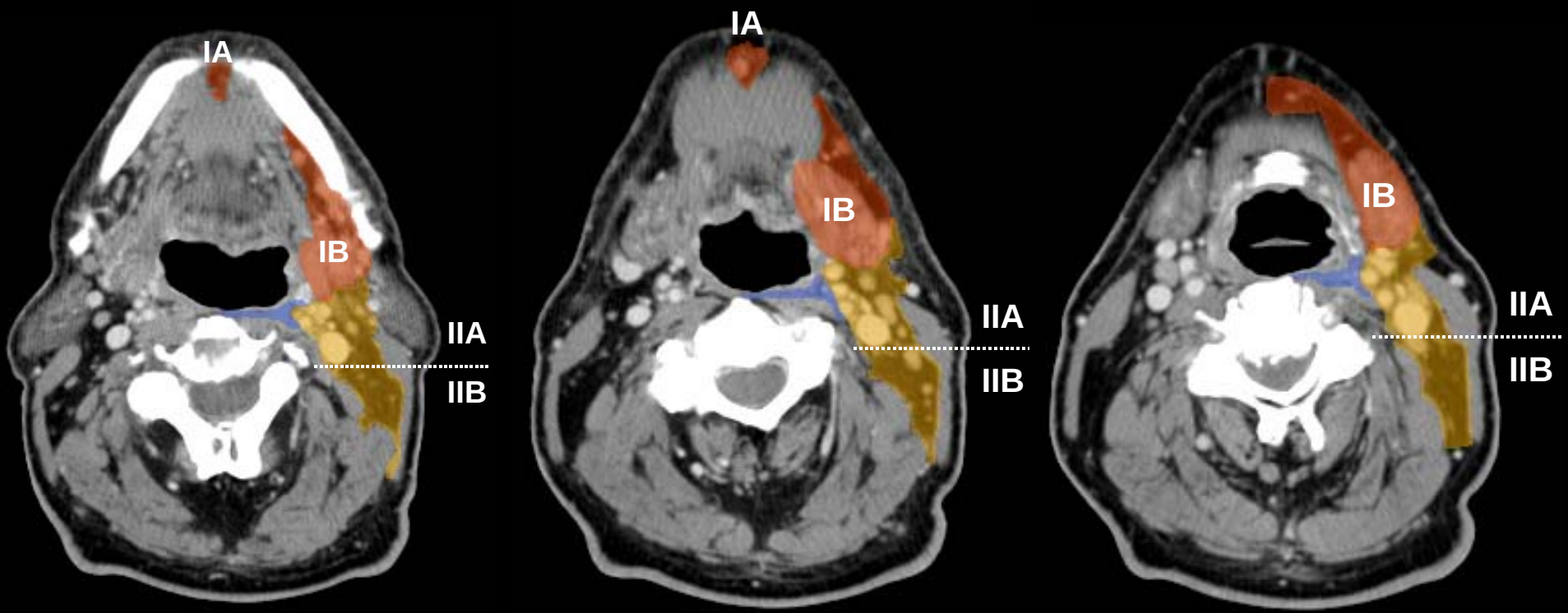
T2N1M0 SCC of Base of the Tongue



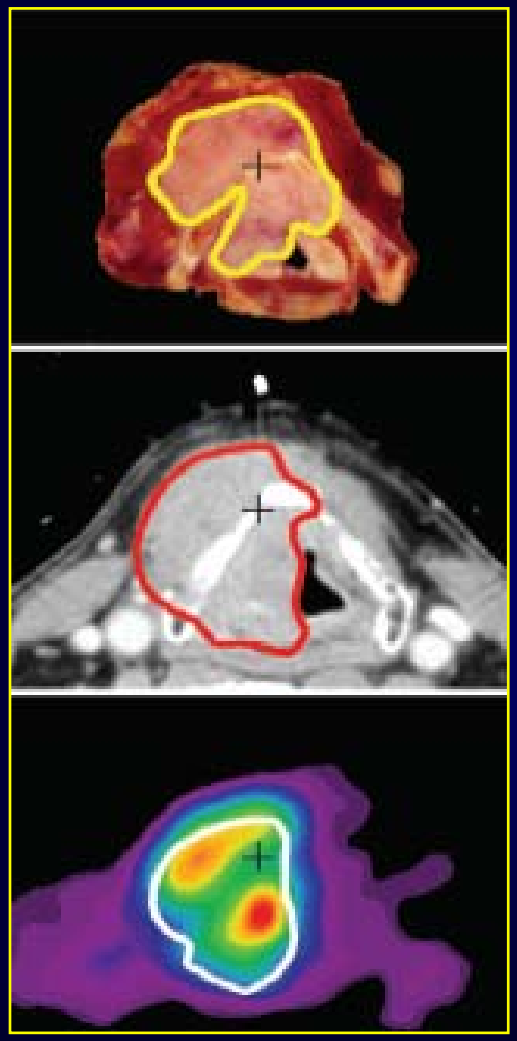


Chao et al. Int J Radiat Oncol Biol Phys. 2004 May 1;59(1):43-50.

Consensus on Nodal Level Delineation
UCL, Erasmus, RTOG, EORTC, DAHANCA, GORTEC



PET/MRI/CT— GTV Boundary

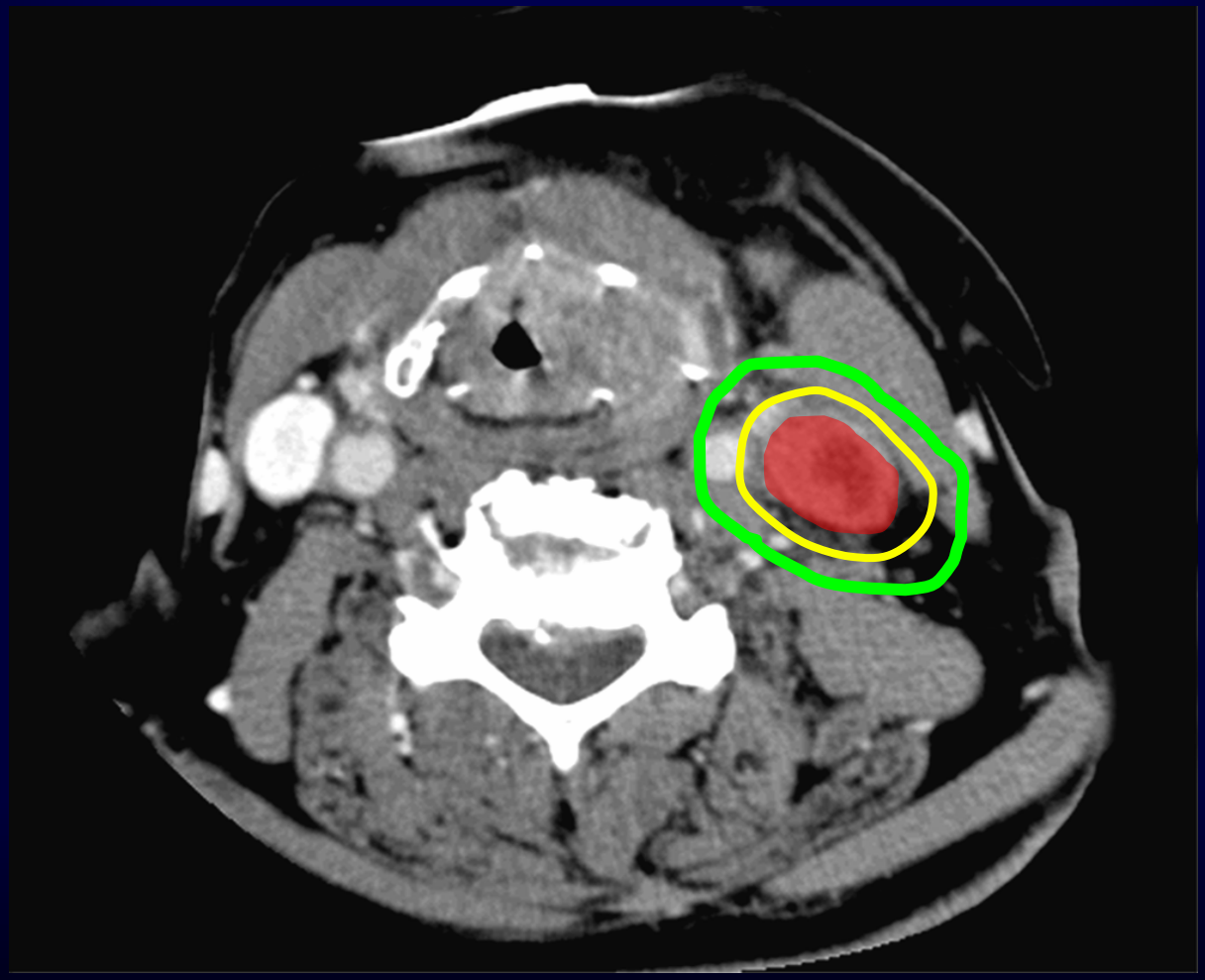


Average Mismatch of Laryngeal GTVs between Imaging Modalities and the Surgical Specimen

Pair	Mismatched Volume (%)
CT	
To MR imaging	26 (6.2/23.8)
To FDG PET	48 (7.8/16.3)
To specimen	81 (10.2/12.6)
MR imaging	
To CT	45 (9.3/20.8)
To FDG PET	67 (11.0/16.3)
To specimen	107 (13.4/12.6)
FDG PET	
To CT	17 (3.5/20.8)
To MR imaging	15 (3.6/23.8)
To specimen	46 (5.8/12.6)
Specimen	
To CT	10 (2.0/20.8)
To MR imaging	9 (2.2/23.8)
To FDG PET	13 (2.1/16.3)

Daisne et. al. *Radiology* 233(1):93-100, 2004

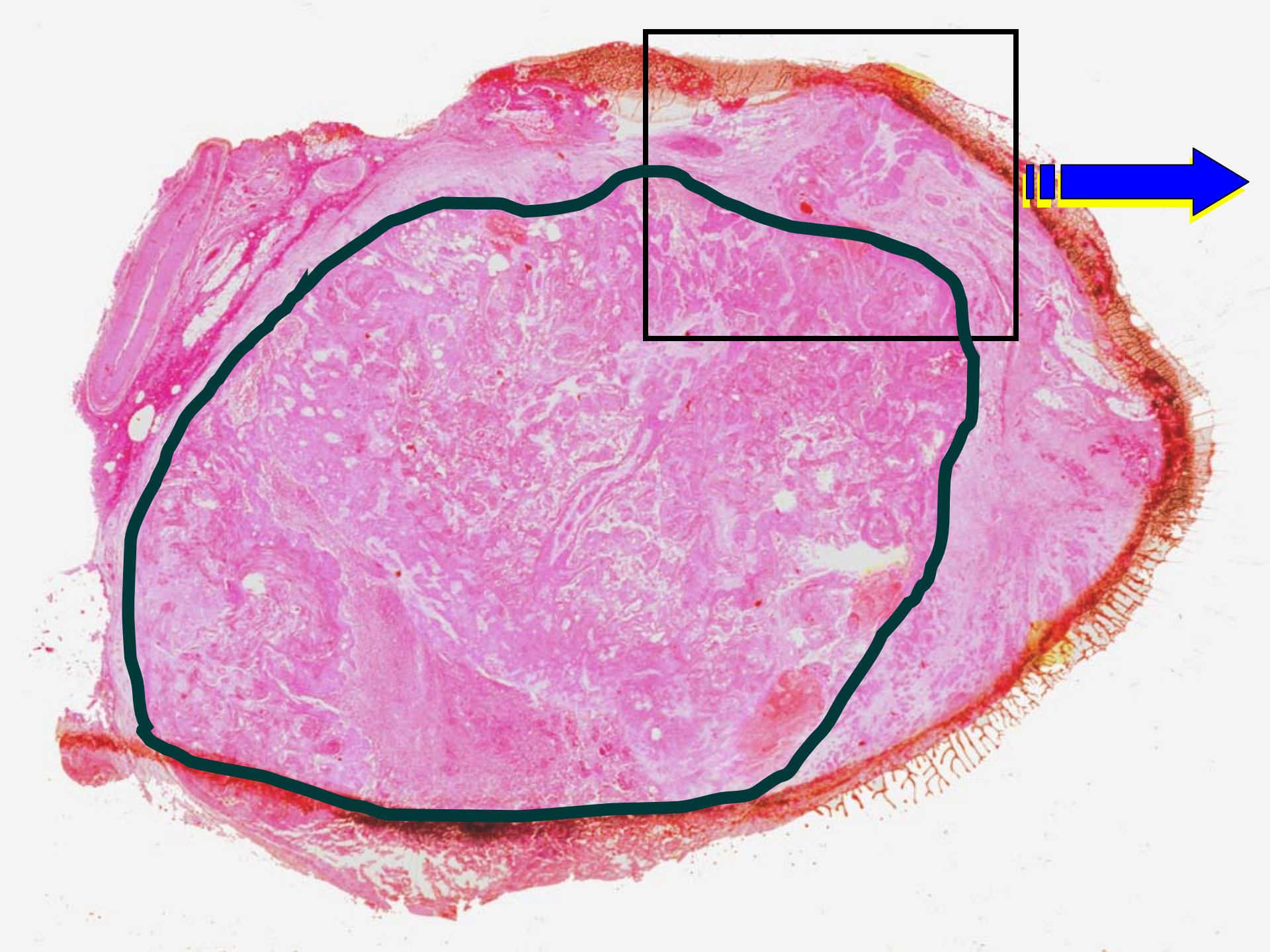
Nodal CTV Delineation – Margin?



Microscopic Tumor Extension outside Nodal Capsule

- 97 ECE+ LNs from 49 patients
- Tumor extension through the LN capsule by:
  - Actual presence of tumor cells
  - Desmoplasia (associated stromal reaction)
  - Giant cell reaction to keratin
- Greatest linear distance perpendicular from external capsule border to furthest extent of tumor
  - Nearest tenth of millimeter with micrometer
  - Extrapolation when appropriate
- Largest axial diameter of LN

Apisarnthanarax et al. Int J Radiat Oncol Biol Phys. 64:678, 2006

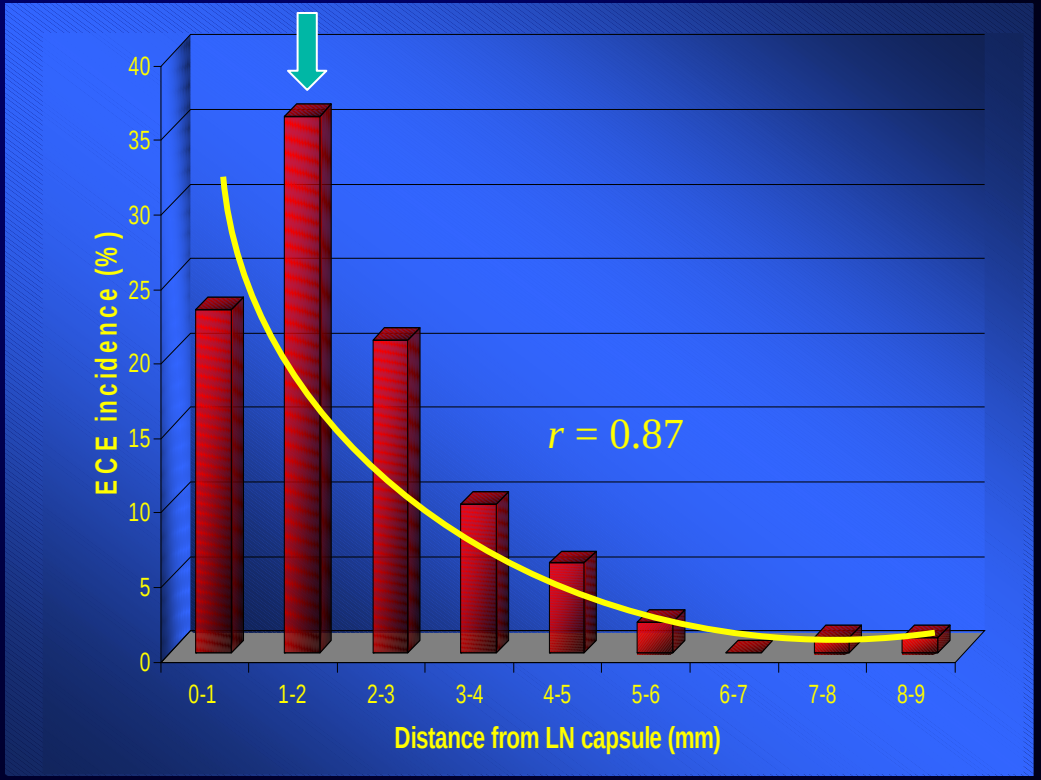



C
T
T
C


2 mm

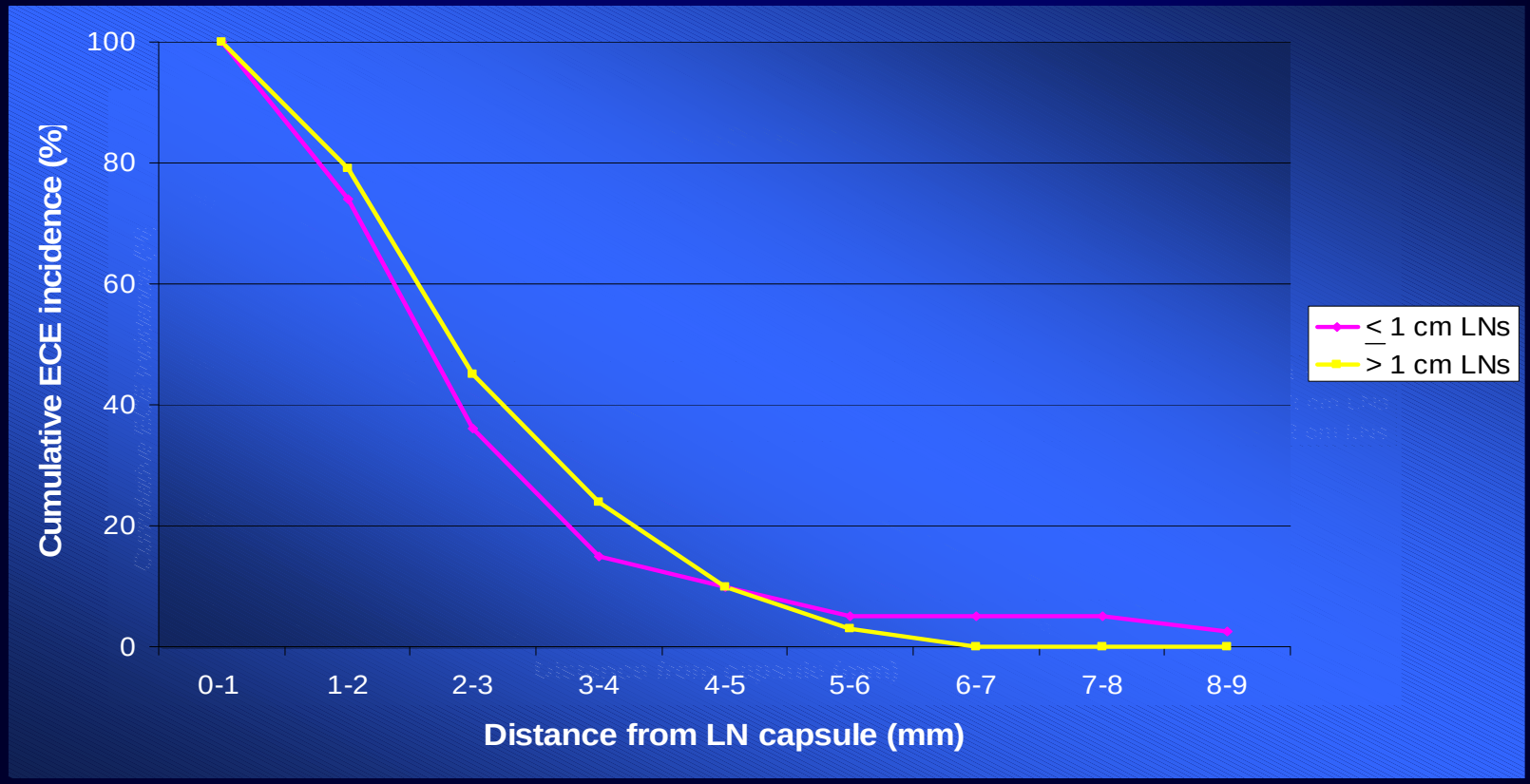
Results

- **96% ECE within 5 mm of capsule**
- **None beyond 10 mm**
- **Inverse correlation between ECE incidence and distance from capsule**



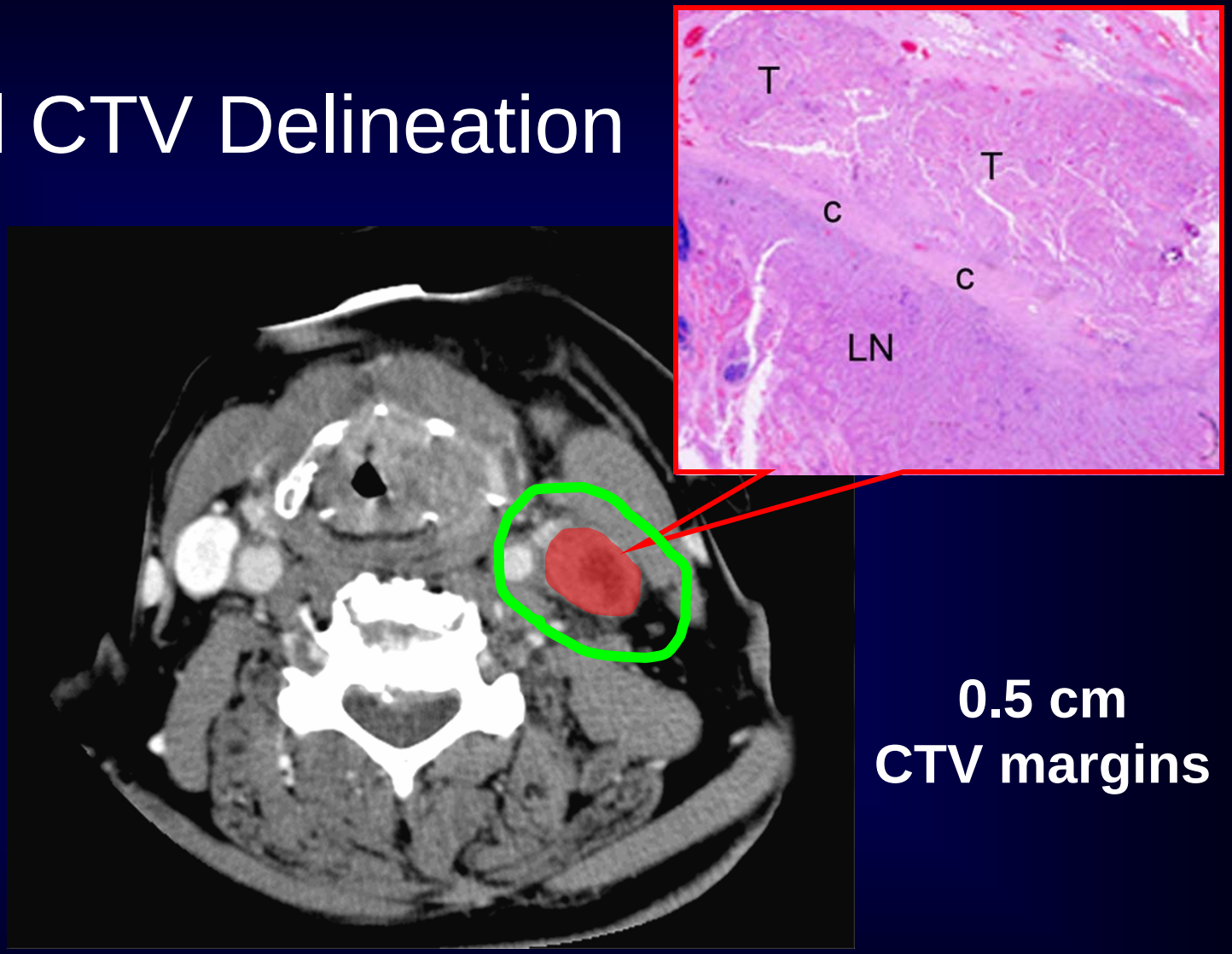
Apisarnthanarax et al. Int J Radiat Oncol Biol Phys. 64:678, 2006

Results



- **No correlation between LN and extent of ECE**
- **Mean ECE**
  - **LN < 1 cm: 2.1 mm**
  - **LN > 1 cm: 2.2 mm**

Nodal CTV Delineation



0.5 cm CTV margins

Apisarnthanarax et al. Int J Radiat Oncol Biol Phys. 64:678, 2006

HN IMRT Challenges Ahead

- Significant growth of IMRT accompanied by increase in time-consuming contouring

- Significant variation in target determination and delineation

Cancer, 1977

Variation among RadOnc Physicians Exists

THE STUDY OF THE PATTERNS OF CANCER CARE IN RADIATION THERAPY

SIMON KRAMER, MD

EVALUATION OF THE QUALITY OF CARE HAS become a critical issue in medical practice, and it is particularly important in the management of cancer patients where we are almost always dealing with life-threatening illness. The

practice with a wide geographic distribution (Table 1). Dr. David F. Herring has been an important contributor since inception of the study.

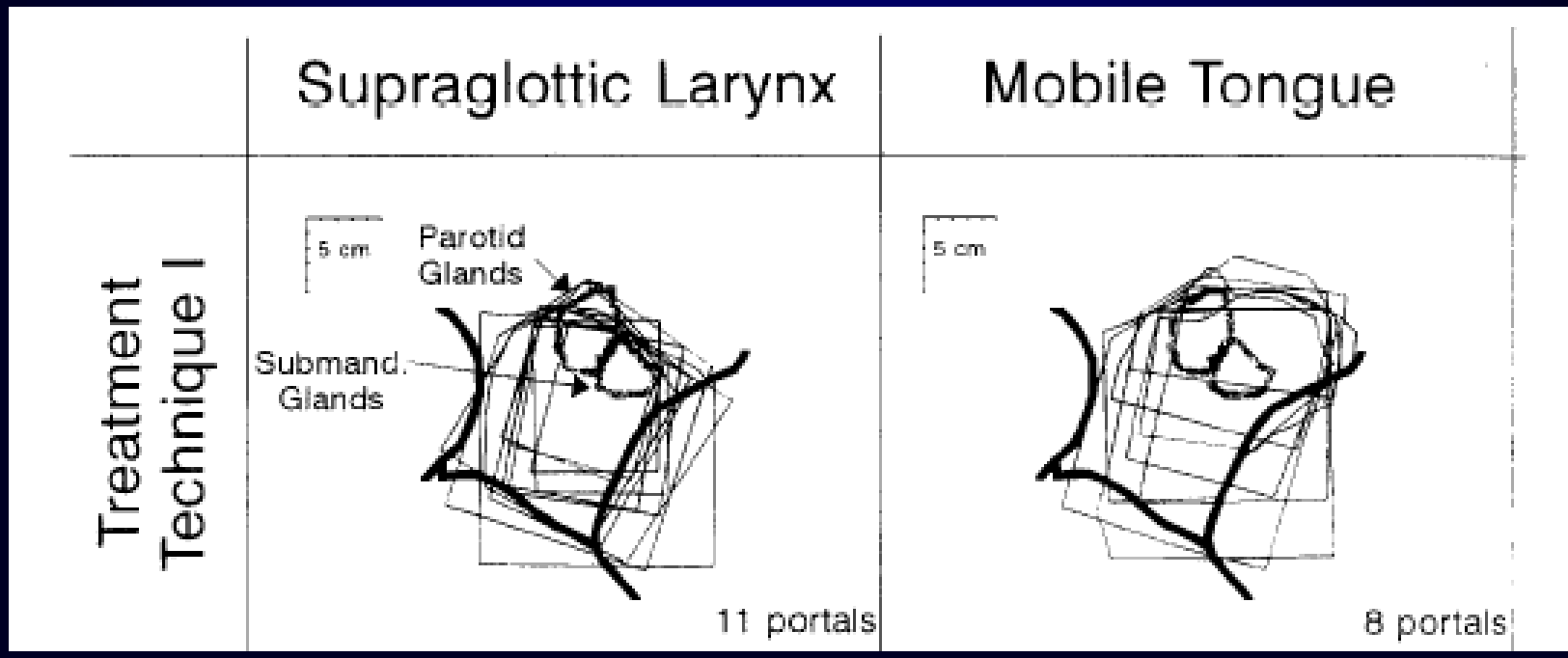
We have felt it extremely important to estab-

"I must hasten to add that for disease sites examined, many more variances appear, ….."

Treatment portals for elective radiotherapy of the neck: an inventory in The Netherlands

Peter Nowak*, Erik van Dieren, John van Sörnsen de Koste, Henry van der Est, Ben Heijmen, Peter Levendag

Department of Radiation Oncology, Dr. Daniel den Hoed Cancer Center/University Hospital Rotterdam–Dijkzigt, Groene Hilledijk 301, 3075 EA, Rotterdam, The Netherlands



Radiotherapy and Oncology 43 (1997) 81–86

Int J Radiat Oncol Biol Phys. 2007 Mar 15;67(4):972-5

CLINICAL INVESTIGATION Head and Neck

AN EVALUATION OF THE VARIABILITY OF TUMOR-SHAPE DEFINITION DERIVED BY EXPERIENCED OBSERVERS FROM CT IMAGES OF SUPRAGLOTTIC CARCINOMAS (ACRIN PROTOCOL 6658)

JAY S. COOPER, M.D.,* SURESH K. MUKHERJI, M.D.,†‡ ALICIA Y. TOLEDANO, SC.D.,§ CLIFFORD BELDON, M.D.,¶ ILONA M. SCHMALFUSS, M.D.,‖ ROBERT AMDUR, M.D.,# SCOTT SAILER, M.D.,** LAURIE A. LOEVNER, M.D.,†† PHIL KOUSOUBORIS, M.D.,‡‡ K. KIAN ANG, M.D., PH.D.,§§ JEAN CORMACK, PH.D.,§ AND JOREAN SICKS, M.S.§

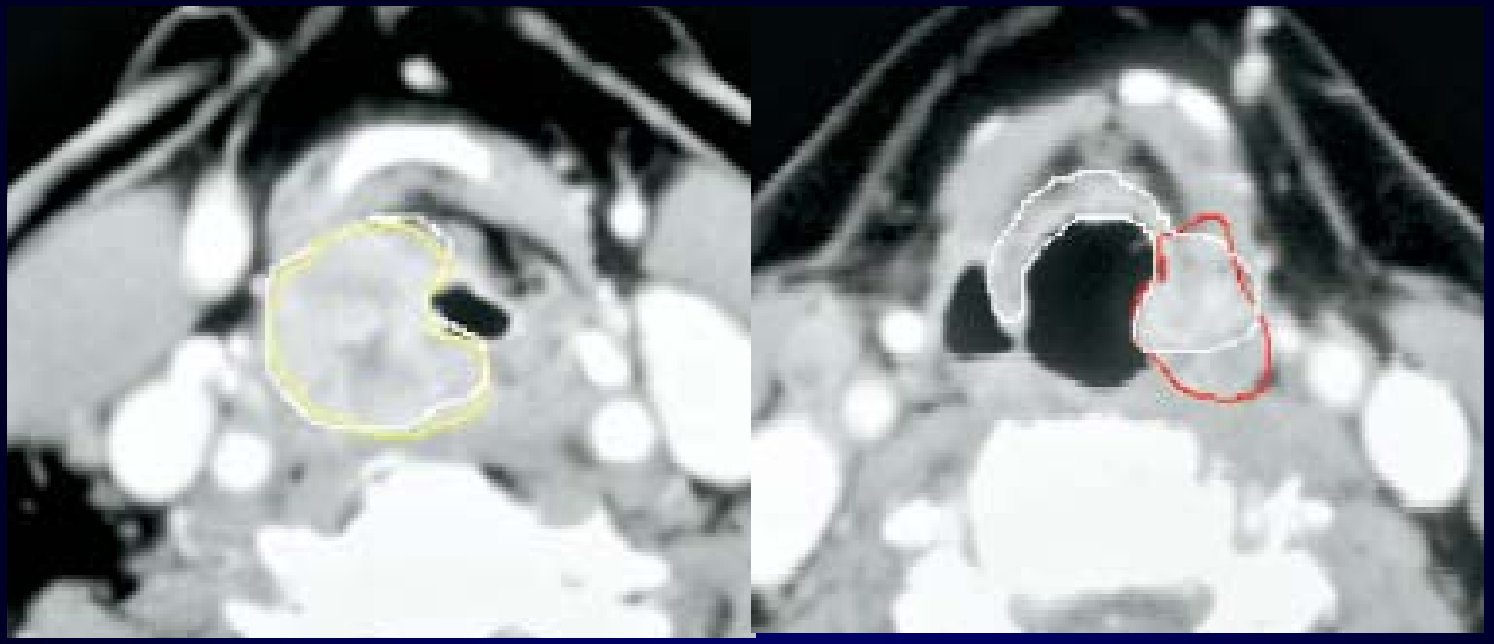
Four neuroradiologists
Four radiation oncologists

↓

Contoured GTV on 20 laryngeal cancer CT images

↓

One to one comparison of concordance



Degree of GTV Agreement

↓

Range from 0% to 81.8%

Average 53.17 +/- 3.8%

Variations in CTV Target Delineation for Head and Neck IMRT

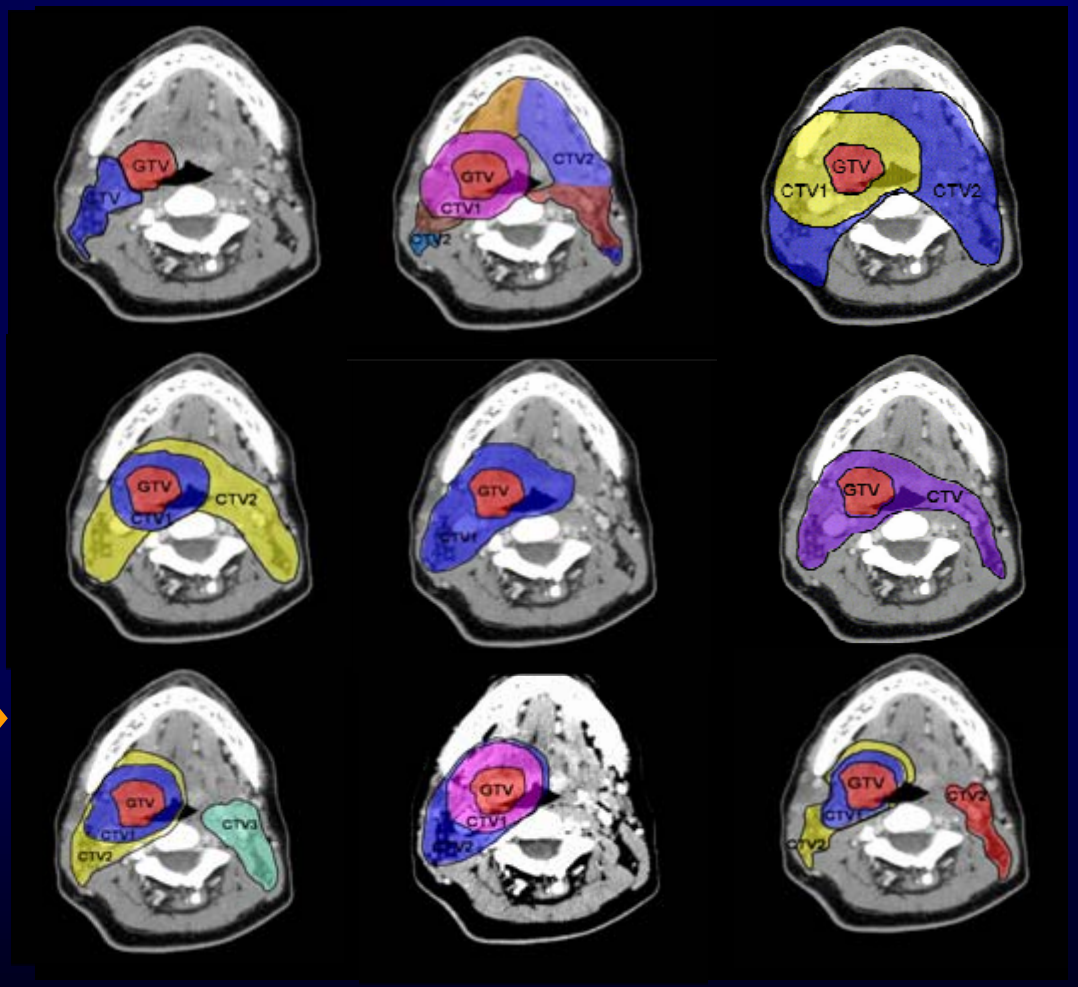
An International Survey

Theodore S. Hong,
Wolfgang A. Tomé,
Richard J. Chappell,
Paul M. Harari

University of Wisconsin
Department of Human Oncology

20 institutions

H&N IMRT Practice Heterogeneity

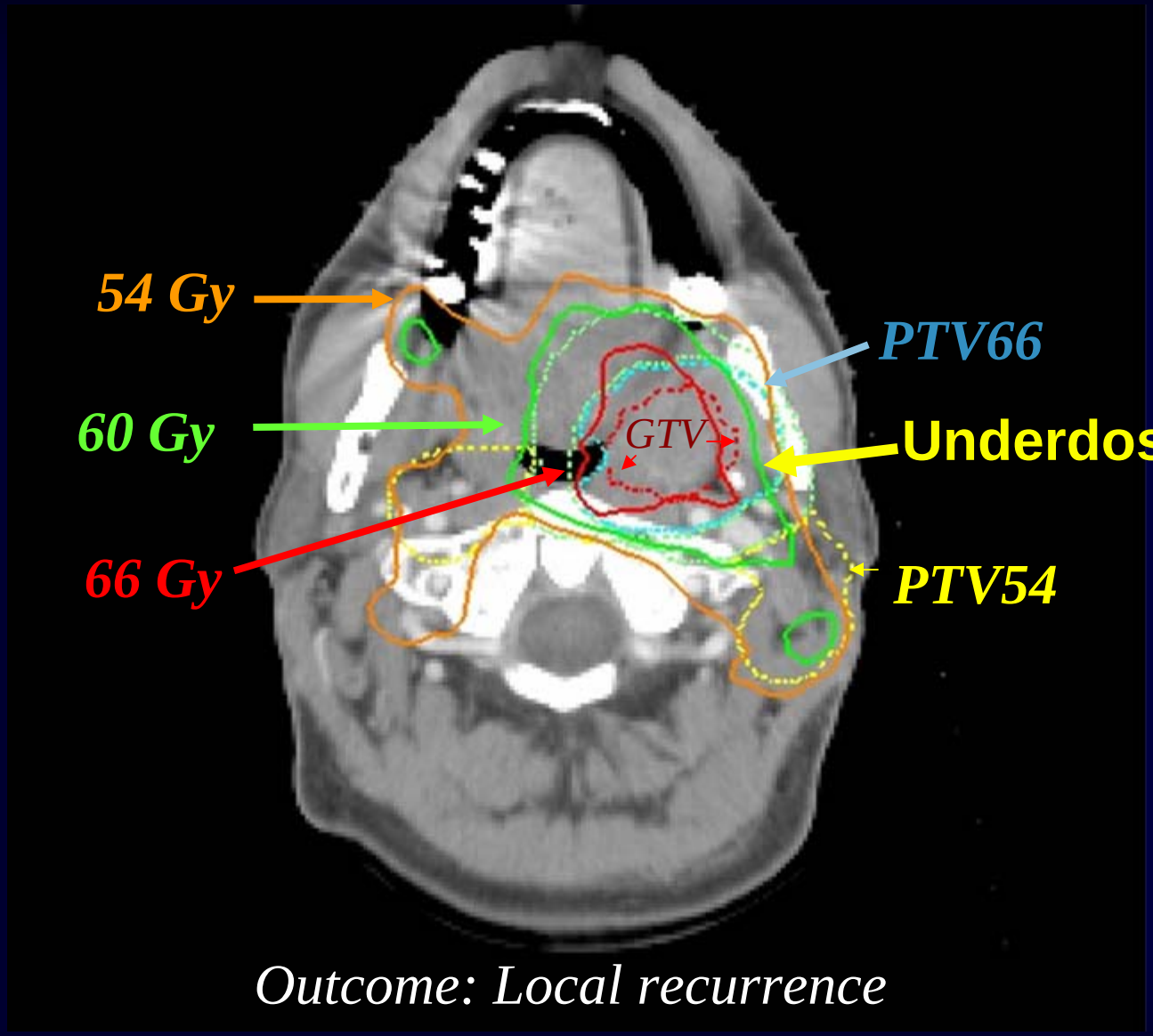


Courtesy of Dr. Harari

Local failure in RTOG-0022 protocol variations

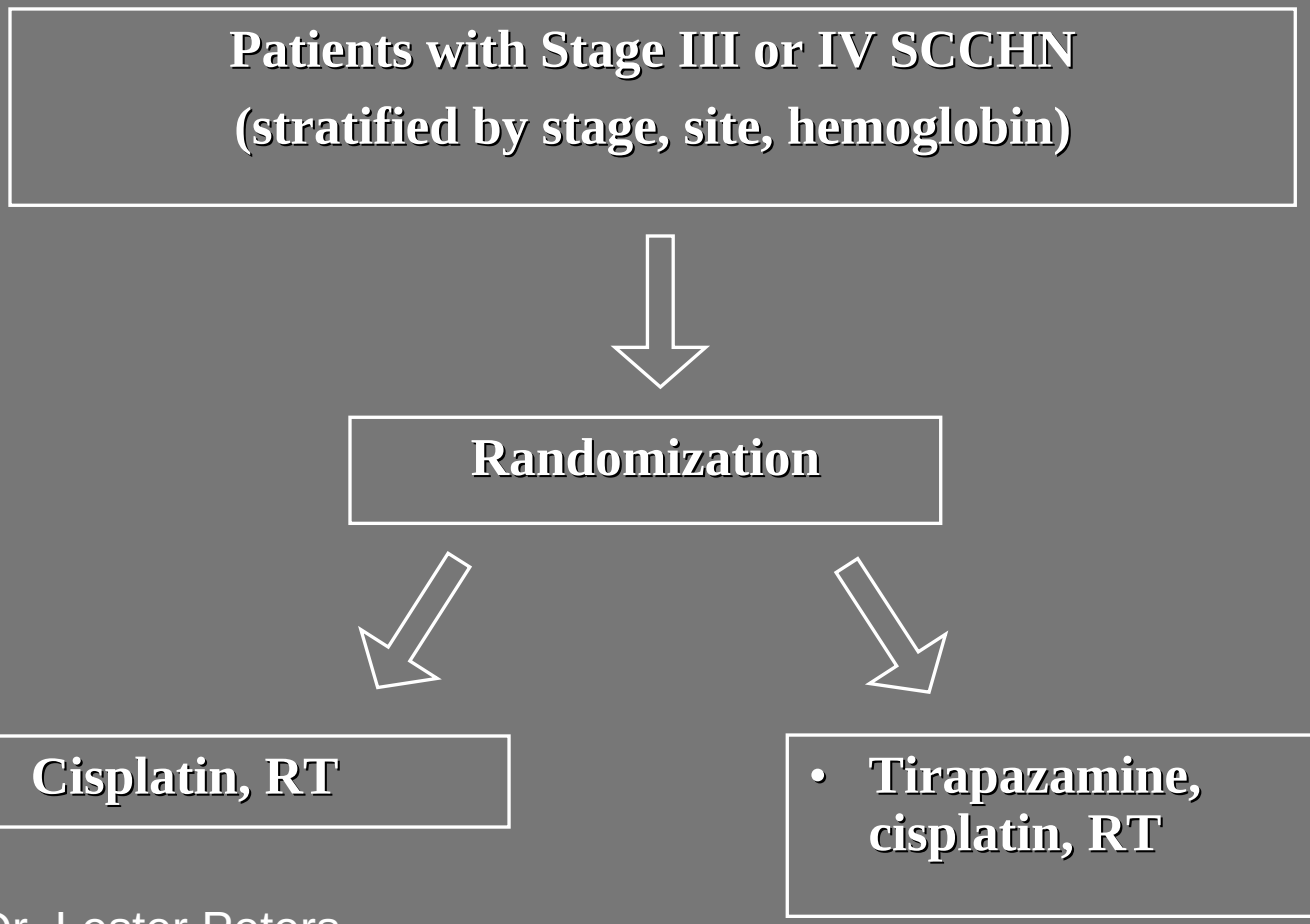
- 4 of 53 patients with evaluable plans had major protocol variations due to underdose of PTV66.

- Local recurrence:
  - 2/4 (50%) patients with major PTV66 variation (underdose)
  - 3/49 (6%) patients without major PTV66 variations
  - P=0.04



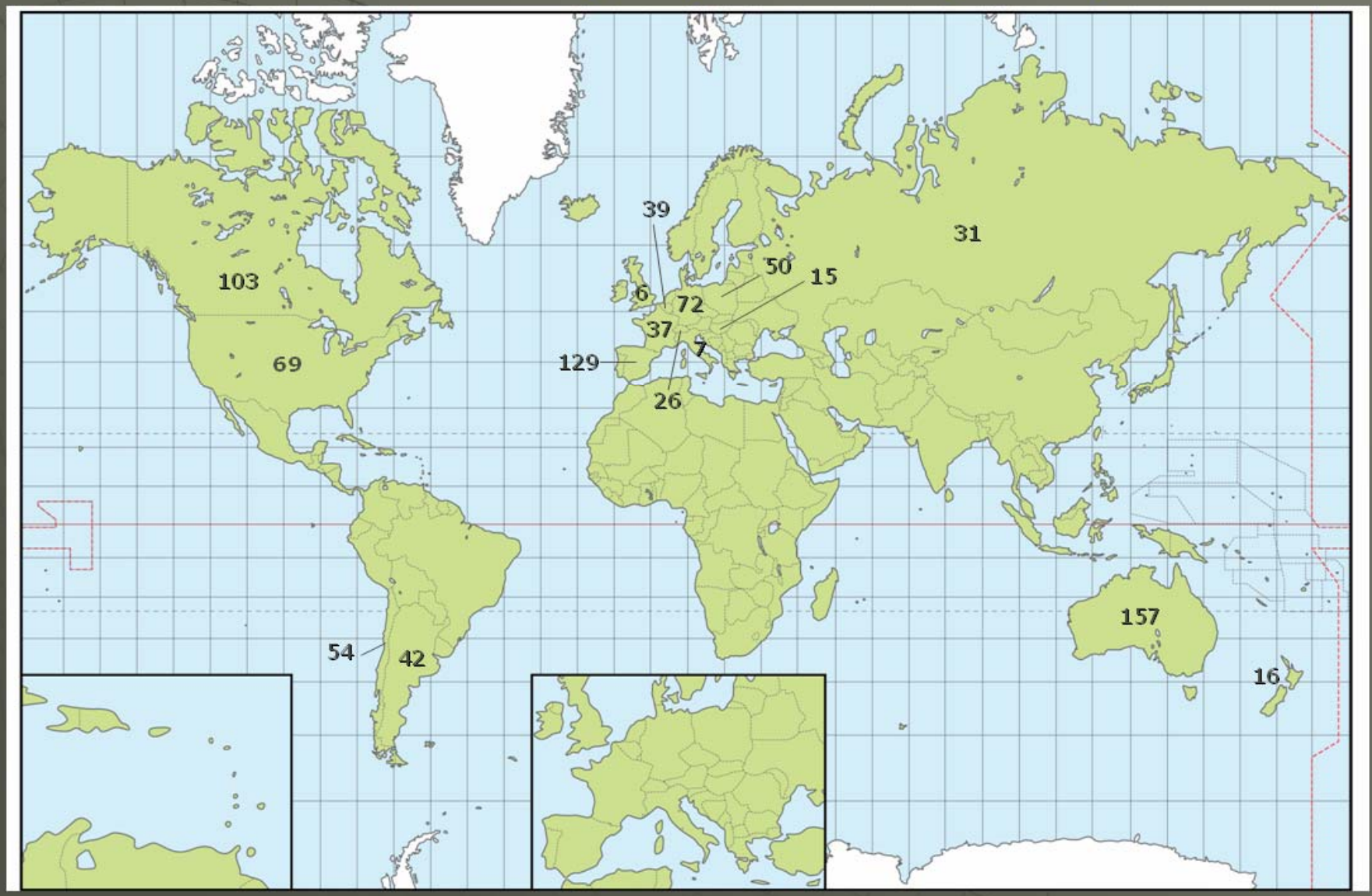
Treatment plan of a patient with a major PTV66 underdose

Phase III Registration Trial
TROG 02.02 (HeadSTART)



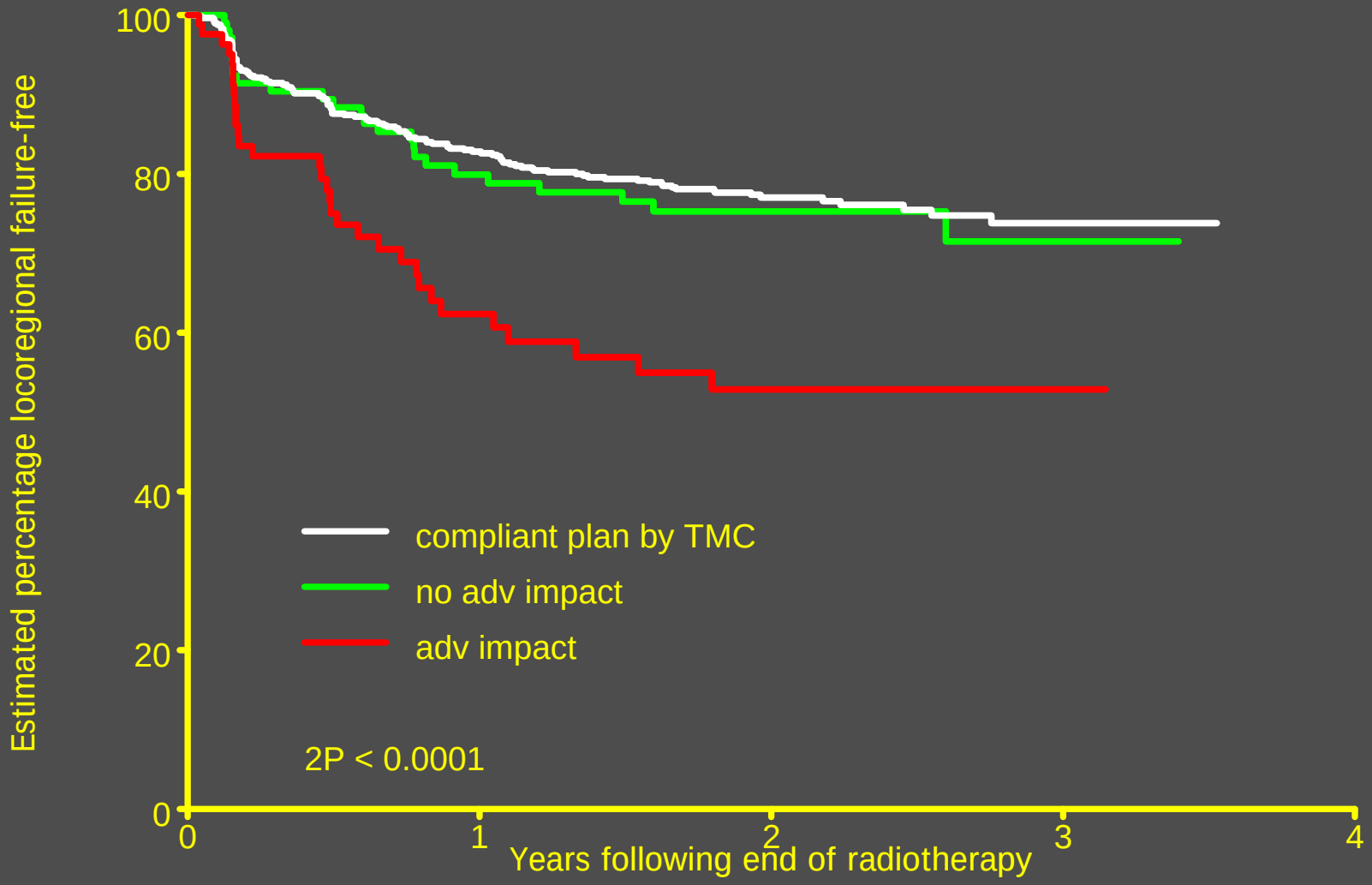
Courtesy of Dr. Lester Peters

Accrual - 861 patients from 89 sites in 16 countries (Sep 02 – Apr 05)

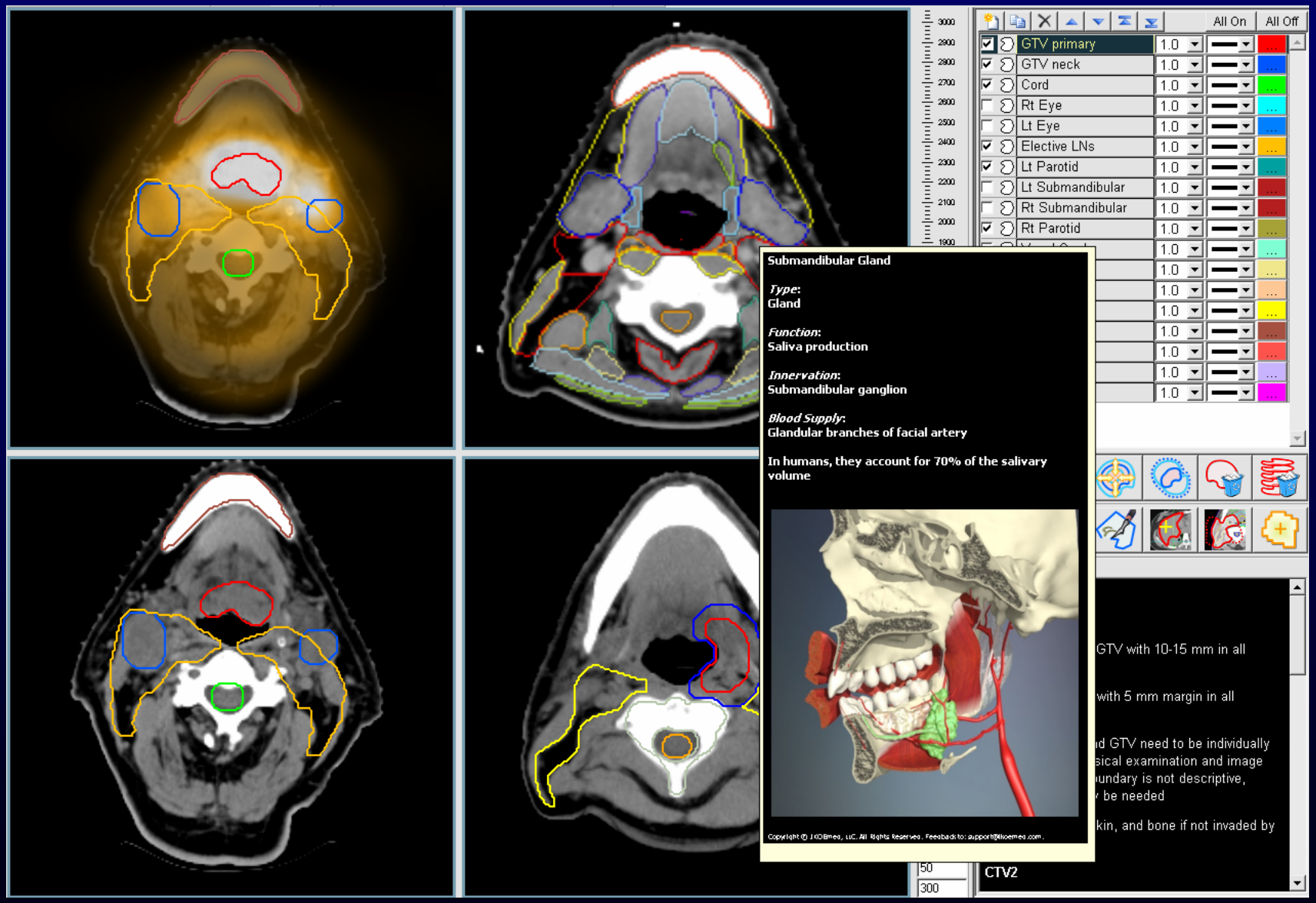


RT Volume Variation Adversely Impacts Tumor Control

Patients who had received at least 60Gy of RT to PTV2



Advanced Knowledge-based Intelligent Tool



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0360-3016/07/$–see front matter

ELSEVIER

doi:10.1016/j.ijrobp.2007.04.037

PHYSICS CONTRIBUTION

REDUCE IN VARIATION AND IMPROVE EFFICIENCY OF TARGET VOLUME DELINEATION BY A COMPUTER-ASSISTED SYSTEM USING A DEFORMABLE IMAGE REGISTRATION APPROACH

K. S. Clifford Chao, M.D.,* Shreerang Bhide, FRCR,† Hansen Chen, M.S.,‡ Joshua Asper, PAC,# Steven Bush, M.D.,§ Gregg Franklin, M.D., Ph.D.,§ Vivek Kavadi, M.D.,‖ Vichaivood Liengswangwong, M.D.,¶ William Gordon, M.D.,# Adam Raben, M.D.,‡ Jon Strasser, M.D.,‡ Christopher Koprowski, M.D.,‡ Steven Frank, M.D.,* Gregory Chronowski, M.D.,* Anesa Ahamad, M.D.,* Robert Malyapa, M.D., Ph.D.,** Lifei Zhang, Ph.D.,†† and Lei Dong, Ph.D.††

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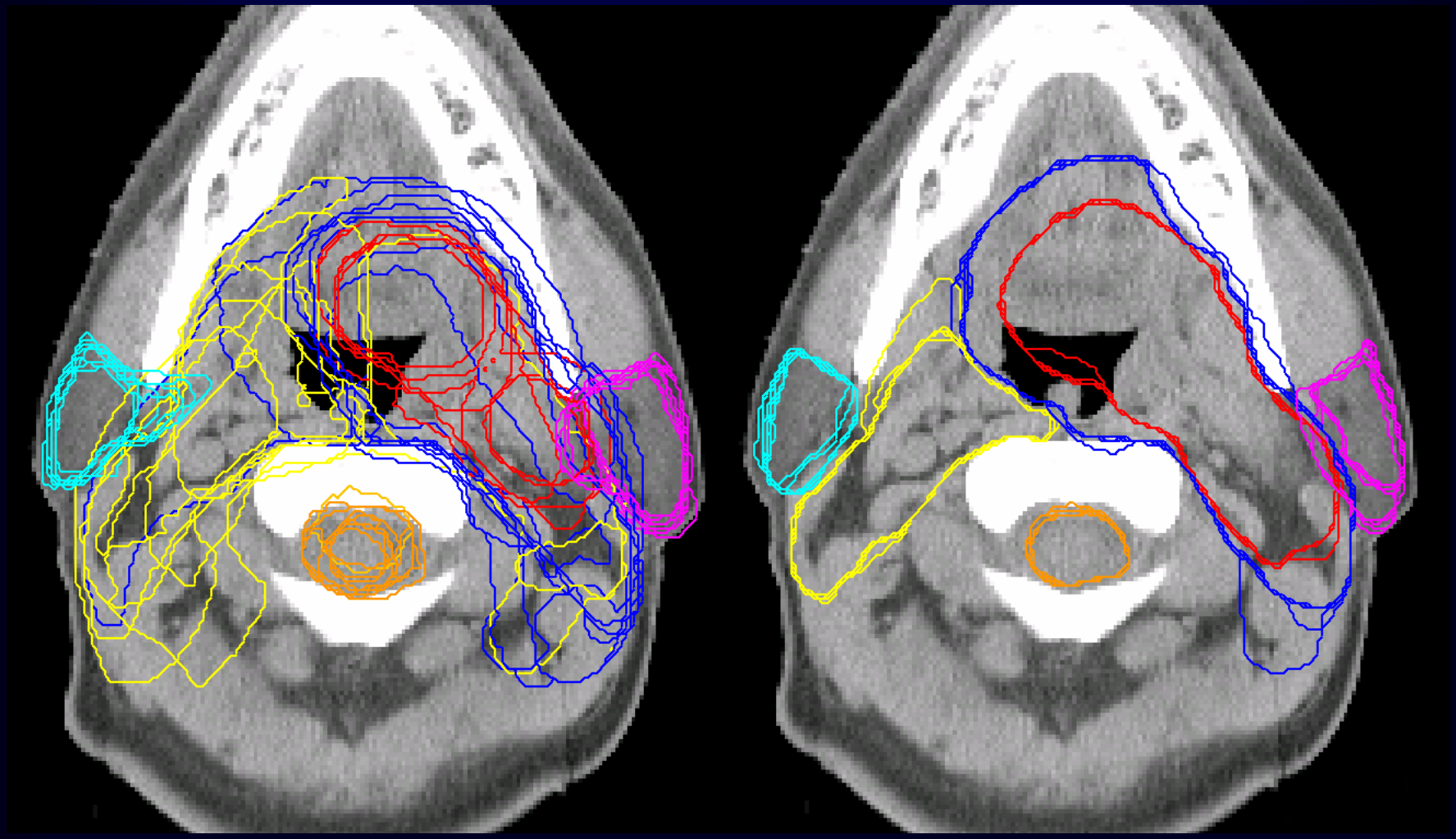
IJROBP 68:1512-1521, 2007

Knowledge-based Computer-assisted Target Delineation



Contouring from scratch

Computer-assisted Contouring

Winston-Salem, March 29, 2007

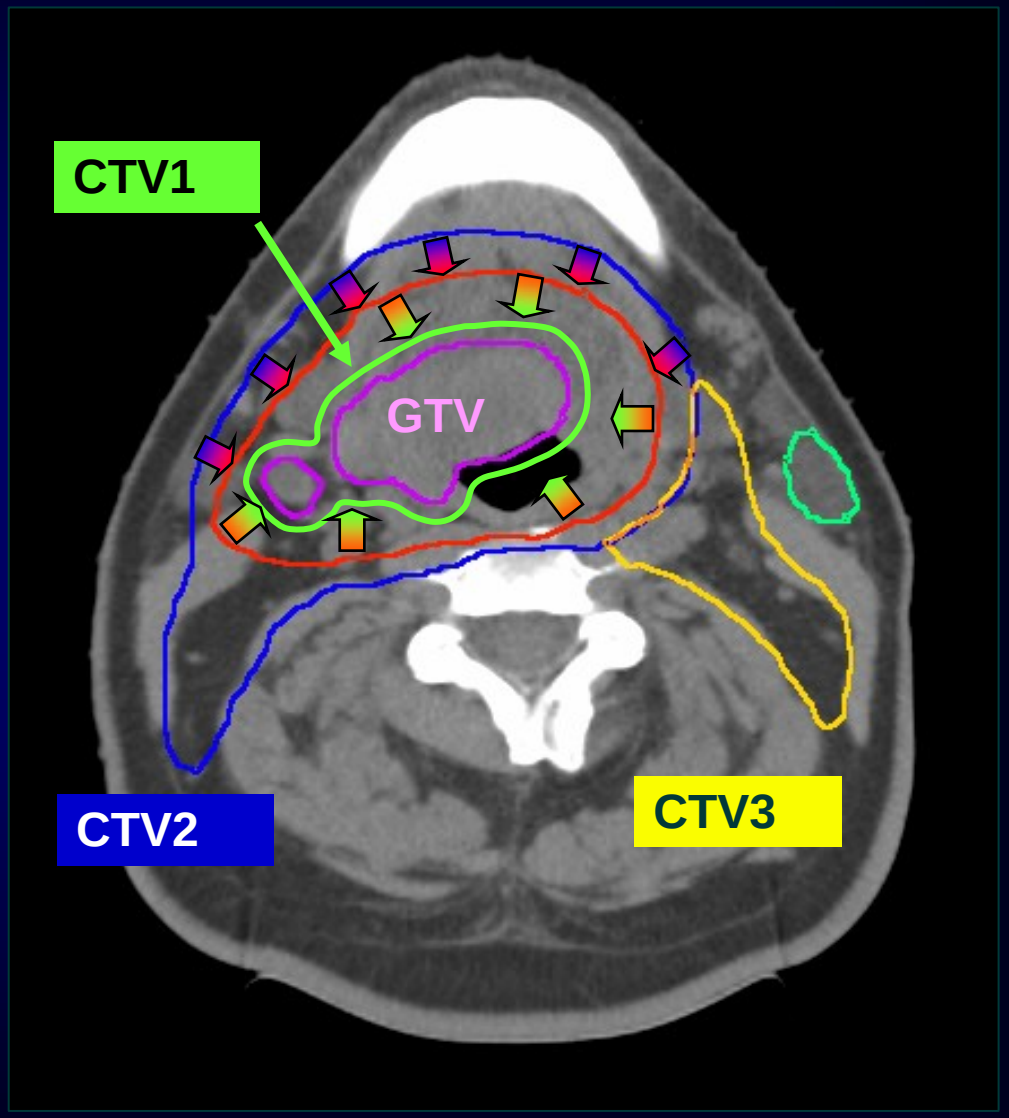
IMRT Target Dose Specification

Target Volume	H&N IMRT			
	Butler	RTOG H-0022	Lee	Chao
Concurrent Chemotherapy	NO All Sites	NO Early Oropharynx	Yes NPC	Yes All Sites
CTV1 70Gy/35fx	**60/2.4Gy 25fx**	**66/2.2Gy 30fx**	**70/2.12Gy 33fx**	**70/2Gy 35fx**
CTV2 60Gy/30fx	-	**60/2Gy**	**59.4/1.8Gy**	**63/1.8Gy**
CTV3 50Gy/25fx	**50/2Gy**	**54/1.8Gy**	**54/1.64Gy**	**56/1.6Gy**

Target Delineation and Dose Spec in 2010

Definitive	CTV1	CTV2	CTV3
IMRT 35 fx	70/2.0	63/1.8	56/1.6
IMRT 33 fx	70/2.1	60/1.8	54/1.6
2D 35 fx	70/2.0	60/2.0	50/2.0

Post-op	CTV1	CTV2	CTV3
IMRT 30 fx	63/2.1	60/2.0	54/1.8
2D 30 fx	66/2.0	60/2.0	50/2.0



T2N1M0 SCC of Base of the Tongue

Summary

- Do no harm with evidence-based guidance
- Image-pathological study to refine GTV-CTV
- Bridging knowledge gap