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Universitätsklinikum Mannheim

Konturierung für IMRT

Frank Lohr
Department of Radiotherapy and Radiooncology, University Medical Center, Mannheim

FEMKE O. B. SPOELSTRA, M.D.,* SURESH SENAN, M.R.C.P., F.R.C.R., PH.D.,* CECILE LE PÉCHOUX, M.D.,† SATOSHI ISHIKURA, M.D., PH.D.,‡ FRANCESC CASAS, M.D.,§ DAVID BALL, M.B., B.S., M.D., F.R.A.N.Z.C.R.,¶ ALLAN PRICE, F.R.C.P., F.R.C.R., PH.D.,‖ DIRK DE RUYSSCHER, M.D., PH.D.,** AND JOHN R. VAN SÖRNSEN DE KOSTE, PH.D., * LUNG ADJUVANT RADIOTHERAPY TRIAL INVESTIGATORS GROUP

*Radiation Oncology, VU University Medical Center, Amsterdam, The Netherlands, †Radiation Oncology, Institut Gustave Roussy, Villejuif, France, ‡Clinical Trials and Practice Support Division, National Cancer Center, Tokyo, Japan, §Radiation Oncology, Hospital Clínic, Barcelona, Spain, ¶Radiation Oncology, Peter MacCallum Cancer Centre, Melbourne, Australia, ‖Radiation Oncology, Western General Hospital, Edinburgh, United Kingdom, and **Radiation Oncology (Maastro clinic), Maastricht University Medical Center, Grow, Maastricht, The Netherlands

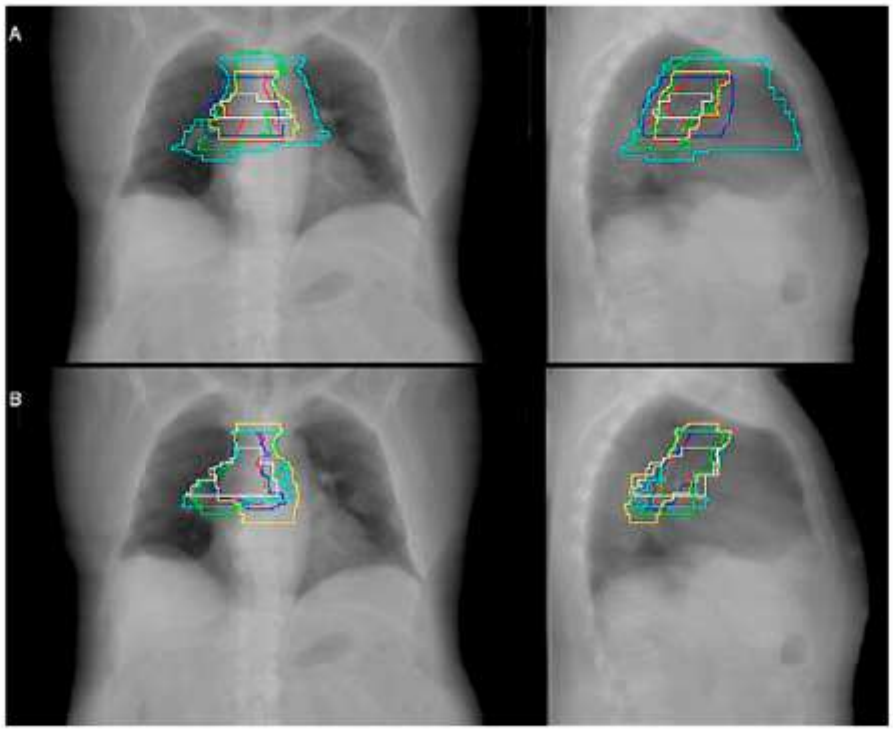


Fig. 1. Routine clinical target volumes (CTVs) (upper panel) and protocol CTVs (lower panel) from six observers projected on a digital reconstruction of a computed tomography dataset from the postlobectomy patient.

Allerdings:

Oft basieren die Entscheidungen, ein bestimmtes Volumen zu behandeln, auf

Befalls***wahrscheinlichkeiten,***

deren Behandlung mit unterschiedlich hohen

Nebenwirkungs***wahrscheinlichkeiten***

einhergeht, und diese Wahrscheinlichkeiten werden individuell unterschiedlich bewertet

Welche Fragen sind wirklich zu klären?

- Basics Konturierung für IMRT

- Wo wissen wir, was wir tun?

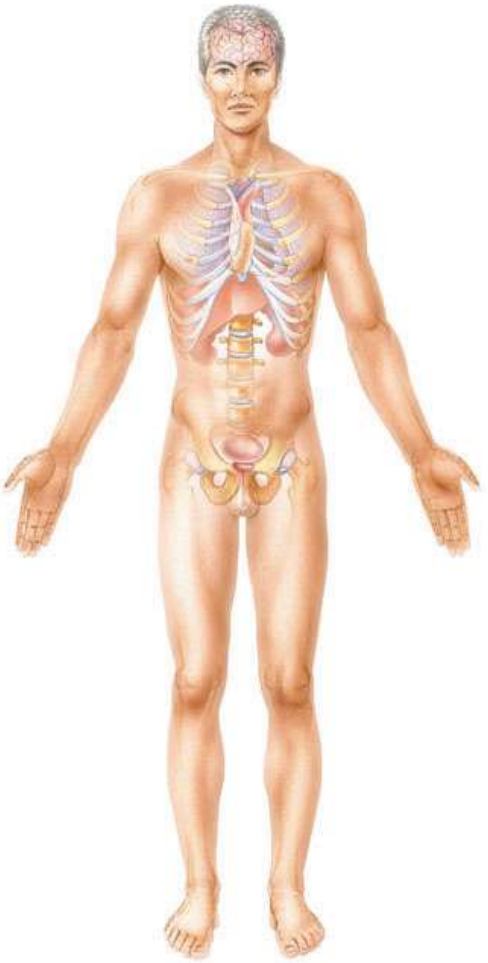
- Wo wissen wir‘s noch nicht und was können wir dagegen tun?

Most important indications

1. **Metastases (CNS, Lung, Liver)**
2. **Head and Neck Cancer**
3. **Rectal Cancer**

4. **Gastric cancer**
5. **Prostate / Pelvis**

6. **Lung Cancer**
7. **Anal Cancer**



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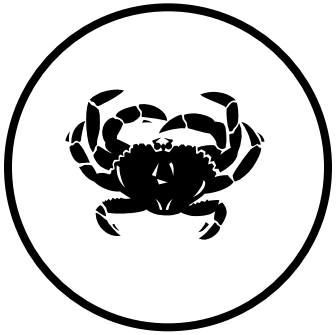
Volume Concepts – ICRU50

GTV – gross tumor volume



Volume Concepts – ICRU50

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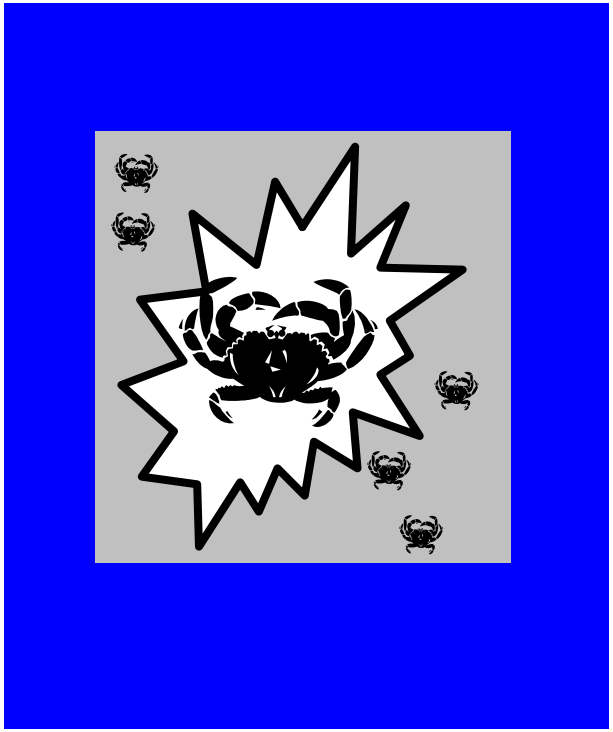
Volume Concepts – ICRU50

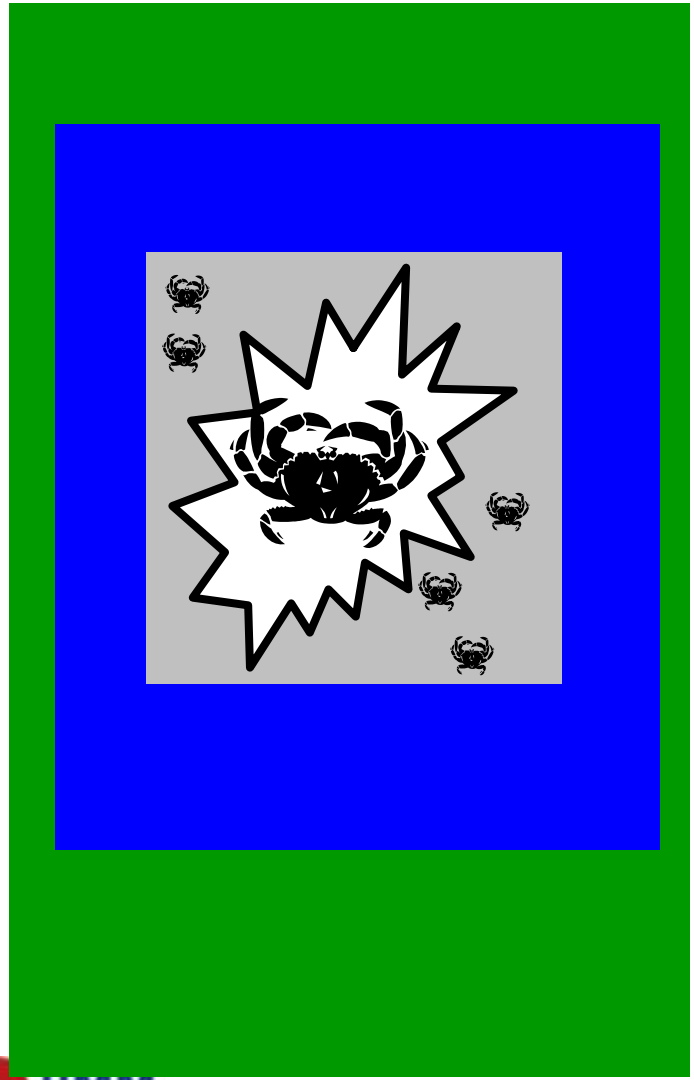
GTV – gross tumor volume
CTV – clinical target volume

Volume Concepts – ICRU50



GTV – gross tumor volume
CTV – clinical target volume
PTV – planning target volume
deformation
organ movement
intrafraction
interfraction
set-up error

Volume Concepts – ICRU50



GTV – gross tumor volume
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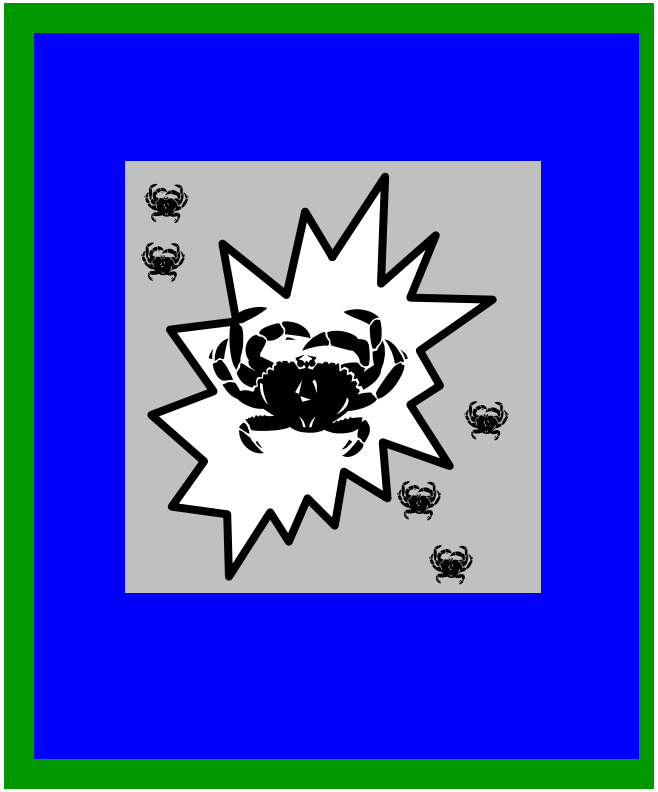
TV - treatment volume

Volume Concepts – ICRU50



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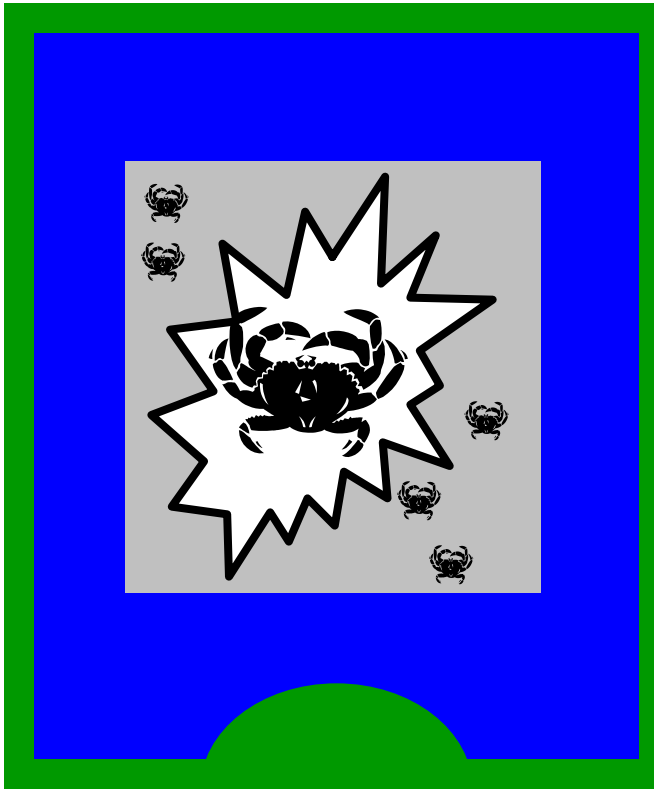
3D conformal radiotherapy

Volume Concepts – ICRU50



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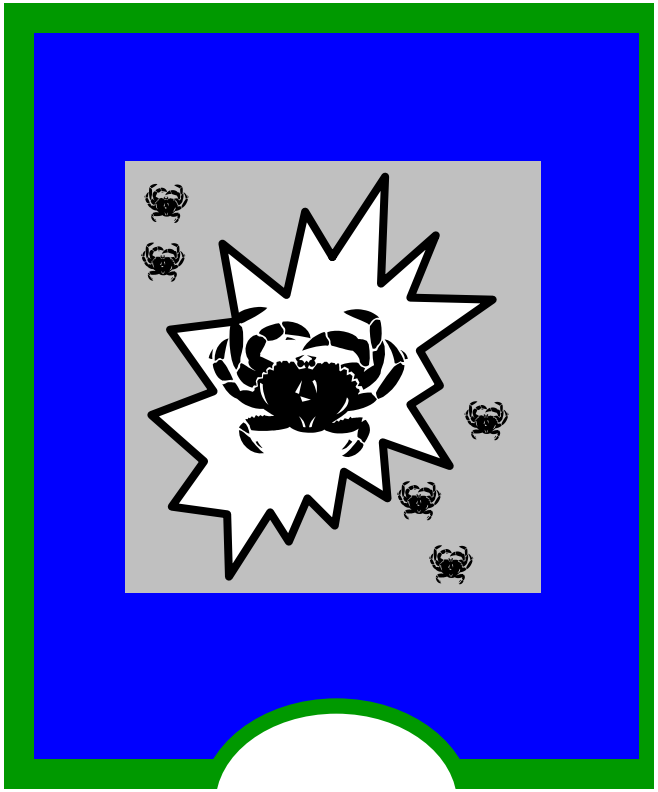

GTV – gross tumor volume
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3D conformal radiotherapy
intensity modulated radiotherapy

Volume Concepts – ICRU50

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deformation
organ movement
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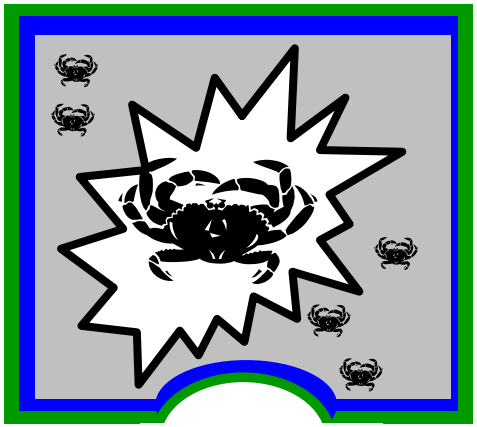
TV - treatment volume

3D conformal radiotherapy
intensity modulated radiotherapy
image guided radiotherapy

Volume Concepts – ICRU50



GTV – gross tumor volume
CTV – clinical target volume
PTV – planning target volume
- deformation
- organ movement
  - intrafraction
  - interfraction
- set-up error

TV - treatment volume

3D conformal radiotherapy
intensity modulated radiotherapy
image guided radiotherapy
adaptive radiotherapy

On-Line Image-Guidance reduces PTV-CTV Margin
-> as a first approximation PTV under on-line image guidance may equal CTV

This presentation therefore concentrates on CTV definition

If not, appropriate PTV margins have to be calculated according to:

THE PROBABILITY OF CORRECT TARGET DOSAGE: DOSE-POPULATION HISTOGRAMS FOR DERIVING TREATMENT MARGINS IN RADIOTHERAPY

MARCEL VAN HERK, PH.D., PETER REMEIJER, PH.D., COEN RASCH, M.D, AND JOOS V. LEBESQUE, M.D., PH.D.

Radiotherapy Department, The Netherlands Cancer Institute/Antoni van Leeuwenhoek Huis, Amsterdam, The Netherlands

Purpose: To provide an analytical description of the effect of random and systematic geometrical deviations on the target dose in radiotherapy and to derive margin rules.

Methods and Materials: The cumulative dose distribution delivered to the clinical target volume (CTV) is expressed analytically. Geometrical deviations are separated into treatment execution (random) and treatment preparation (systematic) variations. The analysis relates each possible preparation (systematic) error to the dose distribution over the CTV and allows computation of the probability distribution of, for instance, the minimum dose delivered to the CTV.

Results: The probability distributions of the cumulative dose over a population of patients are called dose-population histograms in short. Large execution (random) variations lead to CTV underdosage for a large number of patients, while the same level of preparation (systematic) errors leads to a much larger underdosage for some of the patients. A single point on the histogram gives a simple "margin recipe." For example, to ensure a minimum dose to the CTV of 95% for 90% of the patients, a margin between CTV and planning target volume (PTV) is required of 2.5 times the total standard deviation (SD) of preparation (systematic) errors (Σ) plus 1.64 times the total SD of execution (random) errors (σ') combined with the penumbra width, minus 1.64 times the SD describing the penumbra width (σ_p). For a σ_p of 3.2 mm, this recipe can be simplified to $2.5\ \Sigma + 0.7\ \sigma'$. Because this margin excludes rotational errors and shape deviations, it must be considered as a lower limit for safe radiotherapy.

Conclusion: Dose-population histograms provide insight into the effects of geometrical deviations on a population of patients. Using a dose-probability based approach, simple algorithms for choosing margins were derived.

Table 2. Summary of Published Margin Recipes for Target, Respiration (Target) and Organs of Risk

Author	*Application*	*Recipe*	*Assumptions*
Bel et al, 1996b[59]	Target	$0.7\ \sigma$	Random errors only (linear approximation) Monte Carlo
Antolak and Rosen, 1999[81]	Target	$1.65\ \sigma$	Random errors only, block margin?
Stroom et al, 1999[51]	Target	$2\ \Sigma + 0.7\ \sigma$	95% dose to on average 99% of CTV tested in realistic plans
Van Herk et al, 2000[43]	Target	$2.5\ \Sigma + 0.7\ \sigma$ or (more correct): $2.5\ \Sigma + 1.64\ (\sigma - \sigma_p)$	Minimum dose to CTV is 95% for 90% of patients. Analytical solution for perfect conformation
McKenzie et al, 2000[60]	Target	$2.5\ \Sigma + \beta\ (\sigma - \sigma_p)$	Extension of van Herk et al for fringe dose due to limited number of beams
Parker et al, 2002[82]	Target	$\Sigma + \sqrt{(\sigma^2 + \Sigma^2)}$	95% minimum dose and 100% dose for 95% of volume. Probability levels not specified
Van Herk et al, 2002[52]	Target	$2.5\ \Sigma + 0.7\ \sigma - 3$ mm or (more correct): $\sqrt{2.7^2\ \Sigma^2 + 1.6^2\ \sigma^2} - 2.8$ mm	Monte Carlo based test of 1% TCP loss due to geometrical errors for prostate patients
Van Herk et al, 2003[69]	Target	M − 2 mm M − 5 mm	Correction for nonuniform cell density
Ten Haken et al, 1997[83] and Engelsman et al, 2001[84]	Respiration (liver and lung)	0 A	No margin for respiration but compensation by dose escalation to iso-NTCP, reducing target dose homogeneity constraints
McKenzie et al 2000[60]	Respiration	A	Margin for respiration on top of other margins when respiration dominates other errors
van Herk et al, 2003[47]	Respiration (lung)	0.25 A (caudally) 0.45 A (cranially)	Margin for (random) respiration combined with 3 mm random SD, when respiration dominates other errors (A > 1 cm)
McKenzie et al, 2002[85]	OAR	$1.3\ \Sigma$ +/− $0.5\ \sigma$	Margins for small and/or serial organs at risk in low (+) or high (−) dose region

Abbreviations: Σ, SD of systematic errors; σ, SD of random errors; σ_p, describes width of beam penumbra fitted to a Gauss function; A, peak-peak amplitude of respiration; M, margin before adjustment for described effect.

From the Department of Radiotherapy, The Netherlands Cancer Institute/Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands.

Address reprint requests to Marcel van Herk, PhD, Department of Radiotherapy, The Netherlands Cancer Institute/Antoni van Leeuwenhoek Hospital, Plesmanlaan 121, 1066 CX Amsterdam, The Netherlands.

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doi:10.1053/j.semradonc.2003.10.003

Table 1. Overview of prostate irradiation uncertainties (standard deviations of translations) as obtained by different studies from our group

	Treatment execution (random) errors (mm)			Treatment preparation (systematic) errors (mm)		
	LR	SI	AP	LR	SI	AP
Target volume delineation (2)				1.7	2–3.5*	2.0
Organ motion (5)	0.9	1.7	2.7	0.9	1.7	2.7
Setup error (6)	2.0	1.8	1.7	2.6†	2.4†	2.4†
Total SD (quadratic sum)	2.2	2.5	3.2	3.2	3.6–4.5*	4.1

Abbreivations: LR, left-right; SI, superior-inferior; AP, anterior-posterior.
* These values are due to the larger uncertainty in target volume delineation near the apex and the seminal vesicles.
† These values are estimates of the systematic error without the use of a correction protocol.

Structure (Target/Organ) Definition

1. Initially, define targets similar to what you are used to with 3D-IMRT.
2. Make sure no „lost“ structures are left (e.g., structures created accidentally).
3. Try to create structures with smooth edges in all three dimensions. Ragged edges will cause the planning system to create an inefficient plan.
4. Be aware of your patient fixation and repositioning accuracy when designing planning volumes and prescribing doses.
5. Be aware, that the planning system will put dose everywhere according to your definition of structures, e.g. if you don‘t define an organ like the inner ear or the temporal lobes as a structure at risk with certain constraints, the planning system might put high doses there.
6. Don‘t create „sloppy“ structures, unintentionally extended into air or to the skin. Dose coverage may be physically impossible and this may impair the plan quality because, for example, the planning system tries to compensate for build-up inappropriately.
7. High dose conformality may be improved by designing a „help structure“ that covers all patient tissue with the exception of the target and a margin of 2 cm around the target. It is dealt with as an organ at risk and the dose limit should be set to approximately 60% of the target goal

Example for a not-so-much-thought about OAR: Inner Ear

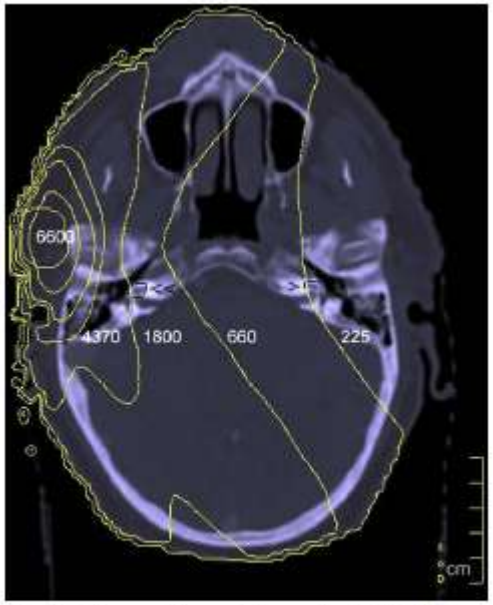

Fig. 1. Axial computed tomography scan of patient treated for parotid gland disease. Intensity-modulated radiotherapy resulted in isodose distribution of 6,600; 4,370; 1,800; 660; and 225 cGy. Left (>) and right (<<) cochlea delineated to assess locally applied radiation dose.

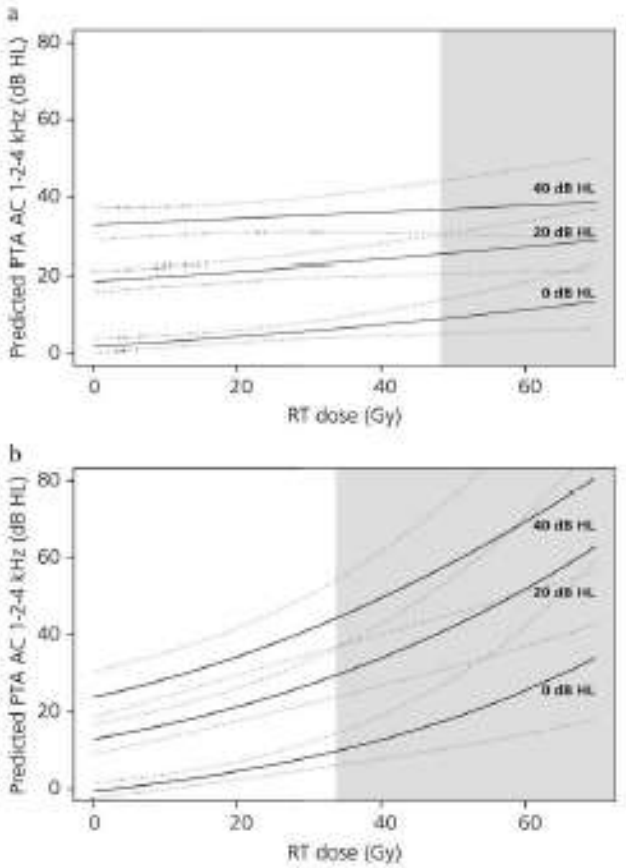

Fig. 3. Predicted hearing level (decibels of hearing loss [dB HL]) 3 months after radiotherapy (RT) at pure tone average (PTA) air-conduction (AC) 1-2-4 kHz for (a) whole population and (b) patients with green eyes. Three lines shown for ears with excellent pretreatment hearing at PTA AC 1-2-4 kHz (0 dB HL), moderate pretreatment hearing loss (20 dB HL), and severe pretreatment hearing loss (40 dB HL), respectively. Dotted lines represent 95% confidence intervals. Shaded area indicates where confidence intervals started to overlap.

← Green Eyes!

Zuur et al., IJROBP, 2009

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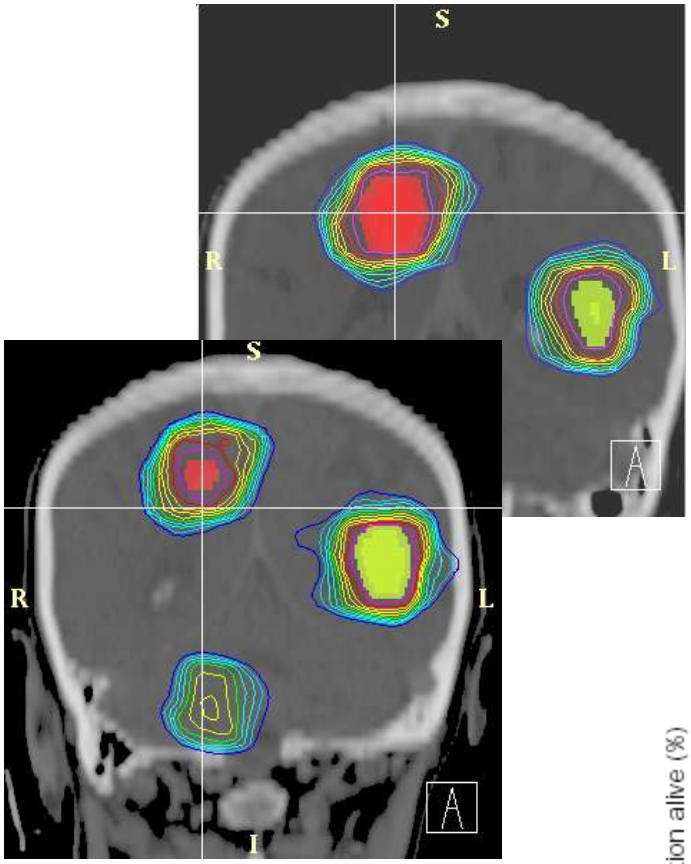
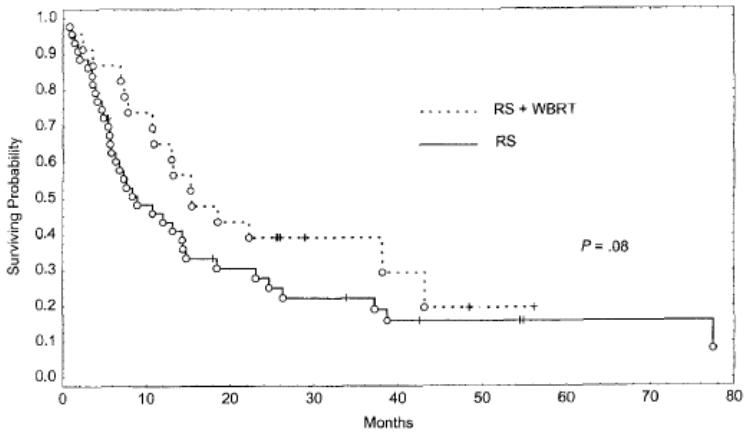
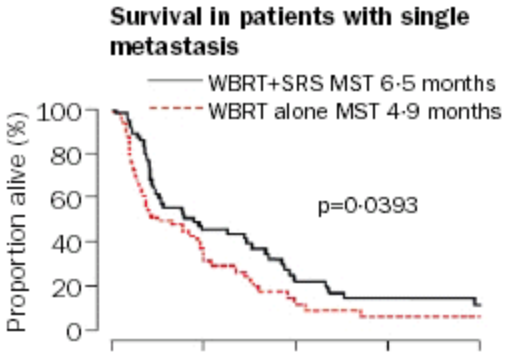
Metastasen

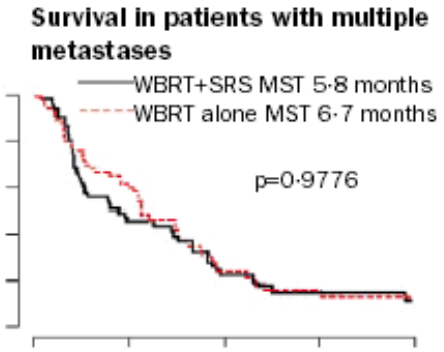
Inoperable Brain Metastases





Pirzkall, Debus, Lohr et al., 1998



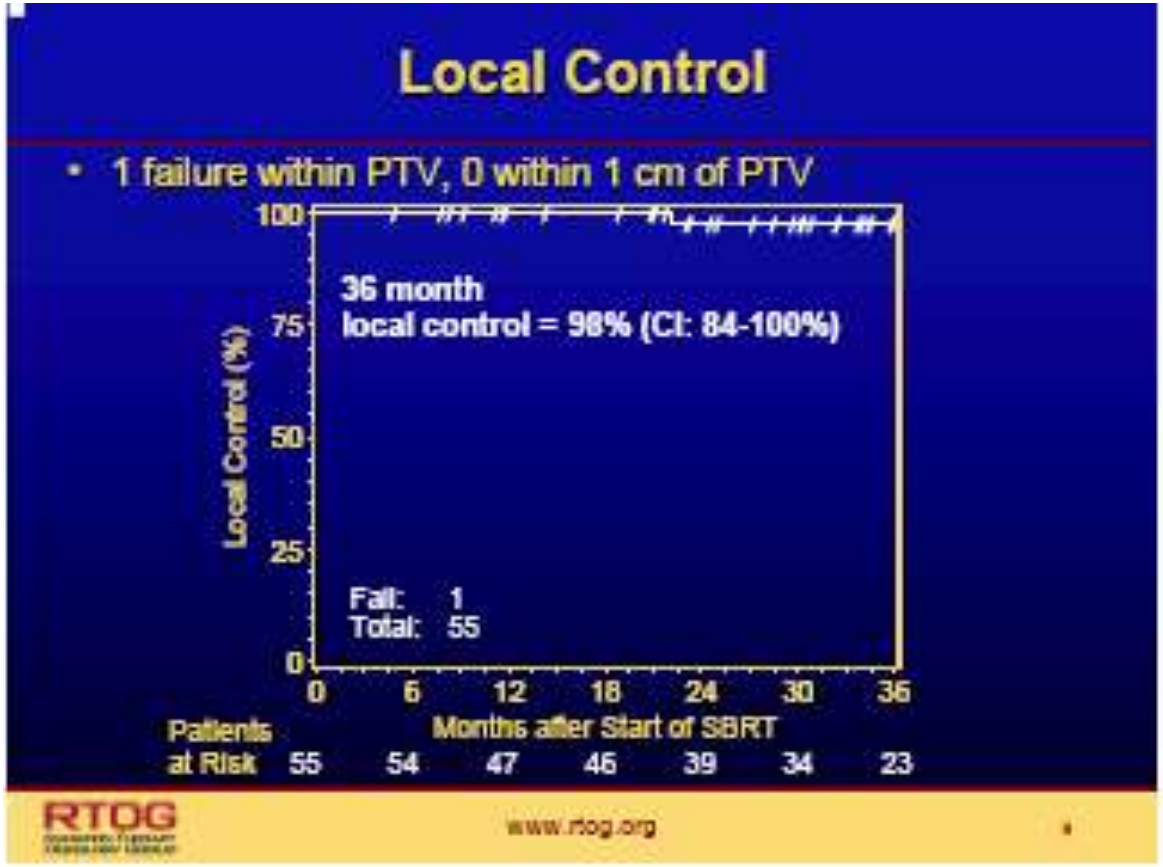


RTOG 9508 (Andrews et al., 2004)

Guckenberger et al., IJROBP, 2007

„With a time interval of approximately 1 week between planning and treatment, the bony anatomy of the skull proved to be an excellent surrogate for the tumor position in image guided SRT. Frameless SRT based on image guidance with registration of the bony anatomy is expected to result in high accuracy.“

Courtesy of R. Timmerman, ASTRO, 2009



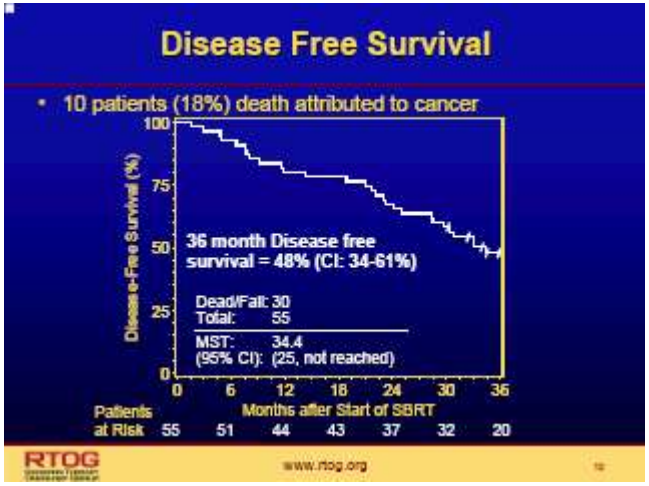


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Table 3.2. Distribution of clinical metastatic neck nodes from head and neck SCC

Tumor site	Patients with N+ (%)	Distribution of metastatic lymph nodes per level (percentage of node-positive patients)					
		I	II	III	IV	V	Other[a]
Oral cavity (n=787)	36	42/3.5[b]	79/8	18/3	5/1	1/0	1.4/0.3
Oropharynx (n=1479)	64	13/2	81/24	23/5	9/2.5	13/3	2/1
Hypopharynx (n=847)	70	2/0	80/13	51/4	20/3	24/2	3/1
Supraglottic larynx (n=428)	55	2/0	71/21	48/10	18/7	15/4	2/0
Nasopharynx (n= 440)	80	9/5	71/56	36/32	22/15	32/26	15/10

[a] Parotid, buccal nodes
[b] Ipsilateral/contralateral nodes
Redrawn from BATAINI et al. (1985); LINDBERG (1972); SHAM et al. (1990)

Table 3.3. Incidence of retropharyngeal lymph nodes in head and neck primary tumors

Authors	Primary site	Incidence of retropharyngeal lymph nodes (percentage of total number of patients)		
		Overall	N0 neck[a]	N+ neck[b]
MCLAUGHLIN et al. (1995)	Oropharynx			
	Pharyngeal wall	18/93 (19%)	6/37 (16%)	12/56 (21%)
	Soft palate	7/53 (13%)	1/21 (5%)	6/32 (19%)
	Tonsillar fossa	16/176 (9%	2/56 (4%)	14/120 (12%)
	Base of tongue	5/121 (4%)	0/31 (0%)	5/90 (6%)
	Hypopharynx (piriform sinus or post-cricoid area)	7/136 (5%)	0/55 (0%)	7/81 (9%)
	Supraglottic larynx	4/196 (2%)	0/87 (0%)	4/109 (4%)
	Nasopharynx	14/19 (74%)	2/5 (40%)	12/14 (86%)
CHUA et al. (1997)	Nasopharynx	106/364 (29%)	21/134 (16%)	85/230 (37%)
CHONG et al. (1995)	Nasopharynx	Not stated	Not stated	59/91 (65%)

[a] Clinically negative nodes in levels I–V
[b] Clinically positive nodes in levels I–V

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Table 3.10. Suggested guidelines for the treatment of patients with head and neck SCC

Location of primary tumor	Appropriate node levels to be treated	
	Stage N0–N1 (AJCC 1997)	Stage N2b (AJCC 1997)
Oral cavity	I, II[a], and III (+IV for anterior tongue tumors)	I, II, III, IV and V[c]
Oropharynx	II, III, and IV (+ retropharyngeal nodes for posterior pharyngeal wall tumors)	I, II, III, IV, V and retropharyngeal nodes
Hypopharynx	II[a], III, and IV (+ VI for esophageal extension)	I, II, III, IV, V and retropharyngeal nodes (+ VI for esophageal extension)
Larynx[b]	II[a], III, and IV (+ VI for transglottic and subglottic tumors)	(I), II, III, IV and V (+ VI for transglottic and subglottic tumors)
Nasopharynx	II, III, IV, V and retropharyngeal nodes	II, III, IV, V and retropharyngeal nodes

[a] Nodes in level IIb could be omitted for N0 patients
[b] T1 glottic cancer excluded
[c] May be omitted if only levels I–III are involved

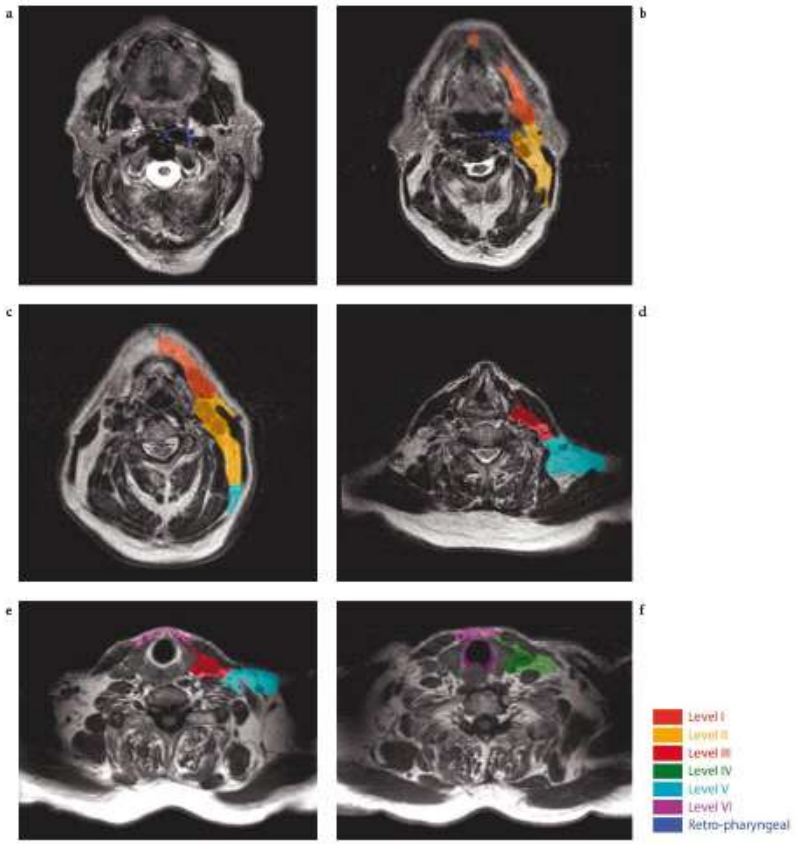

Fig. 3.3. MRI of the same patient with a T1N0M0 glottic SCC (see tumor in *panel d*). The examination was performed on a Gyroscan NT 1.5 T Philips Medical Systems (Eindhoven, the Netherlands) on an axial plane with a slice thickness of 4 mm, a gap of 2 mm, and a field of view of 240 mm. T2-weighted images (TR 7976 ms and TE 90 ms) are displayed in *panels a–d*. *Panels e and f* represent T1-weighted images (TR 500 and TE 12 ms). Sections were taken at the level of the bottom edge of C1 (*panel a*), the upper edge of C3 (*panel b*), mid C4 (*panel c*), the bottom edge of C6 (*panel d*), the bottom edge of C7 (*panel e*), and mid D1 (*panel f*). Neck node levels were drawn on each slice using the radiological boundaries detailed in Table 3.11. The slight difference in the shape of the various levels between Figs. 3.2 and 3.3 is explained by a difference in the positioning of the patient, leading to a slight difference in slice levels. Each node level corresponds to the CTV, and thus does not include a security margin for organ motion or set-up inaccuracy

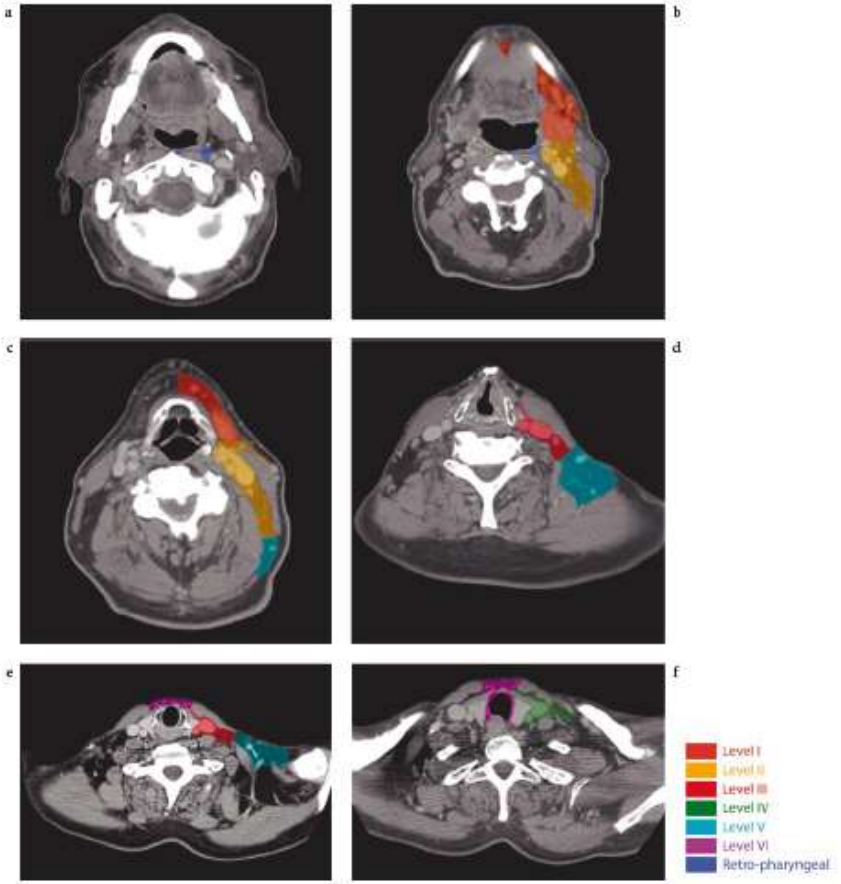

Fig. 3.2. CT imaging of a patient with a T1N0M0 glottic SCC (see tumor in *panel d*). The examination was performed on a dual-detector spiral CT (Elscint Twin, Haifa, Israel) using a slice thickness of 2.7 mm, an interval reconstruction of 2 mm and a pitch of 0.7. Contrast medium was injected intravenously at a rate of 2 ml/s with a total amount of 100 ml. Sections were taken at the level of the bottom edge of C1 (*panel a*), the upper edge of C3 (*panel b*), mid C4 (*panel c*), the bottom edge of C6 (*panel d*), the bottom edge of C7 (*panel e*), and mid D1 (*panel f*). Neck node levels were drawn on each CT slice using the radiological boundaries detailed in Table 3.11. Each node level corresponds to the CTV, and thus does not include a security margin for organ motion or set-up inaccuracy

V. Grégoire · P. Scalliet · K. K. Ang (Eds.)

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A Clinical Guide to Cancer Treatment

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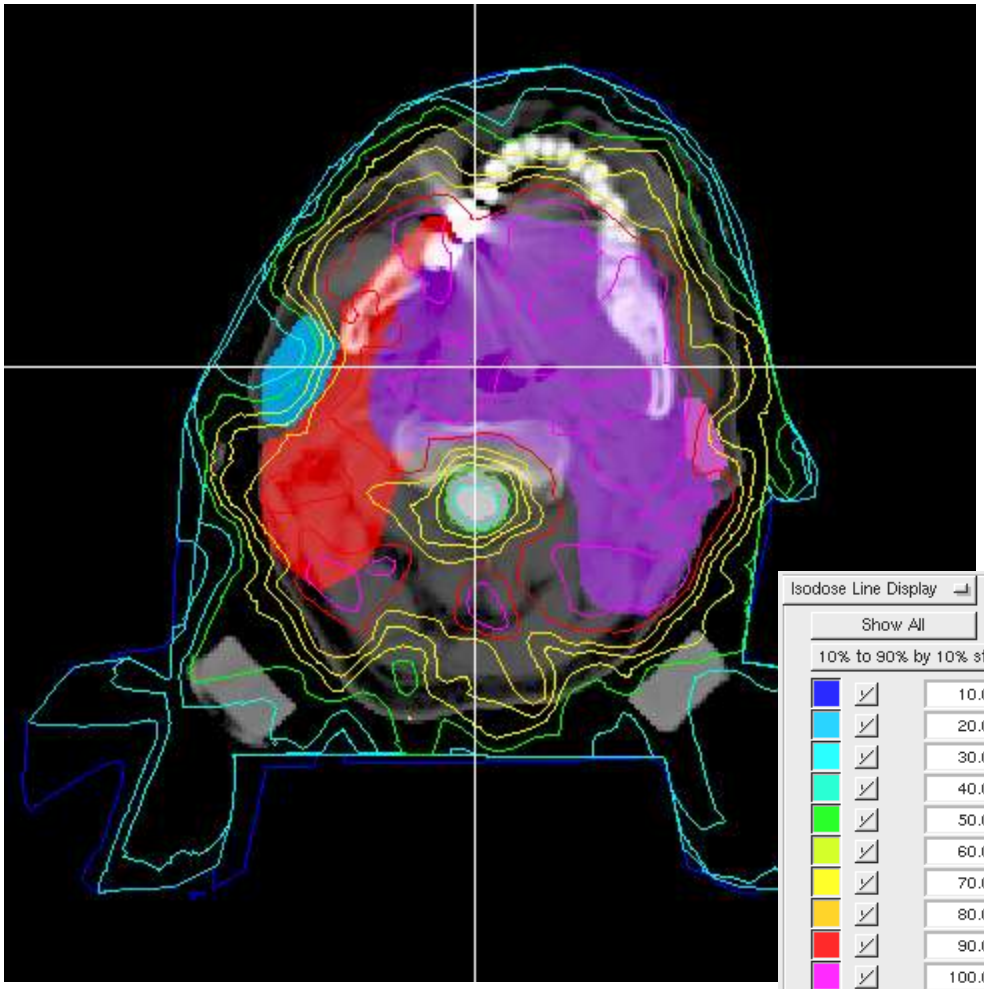

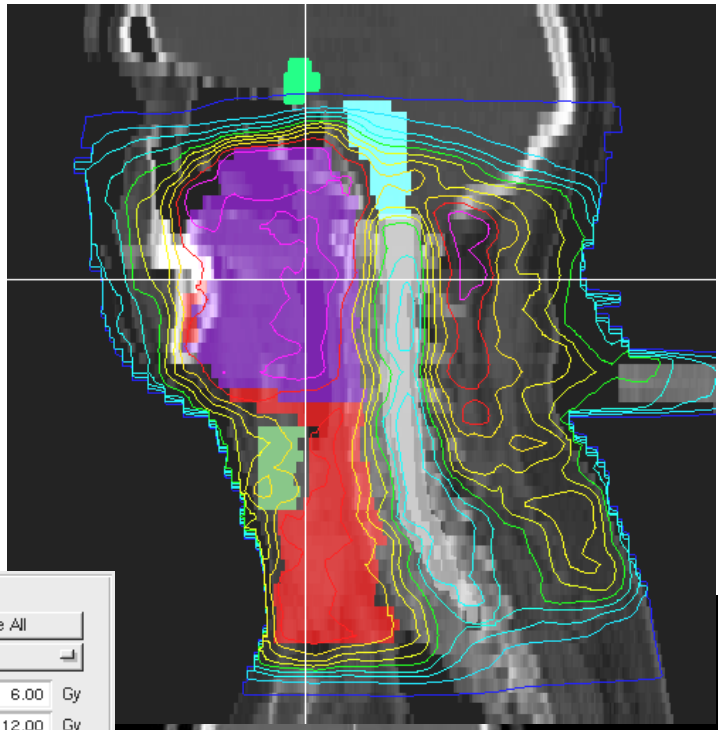

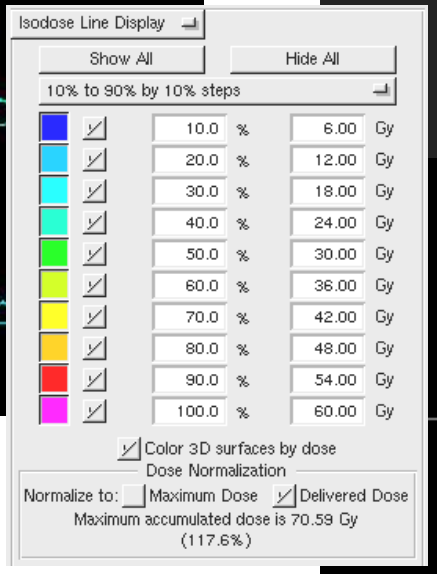

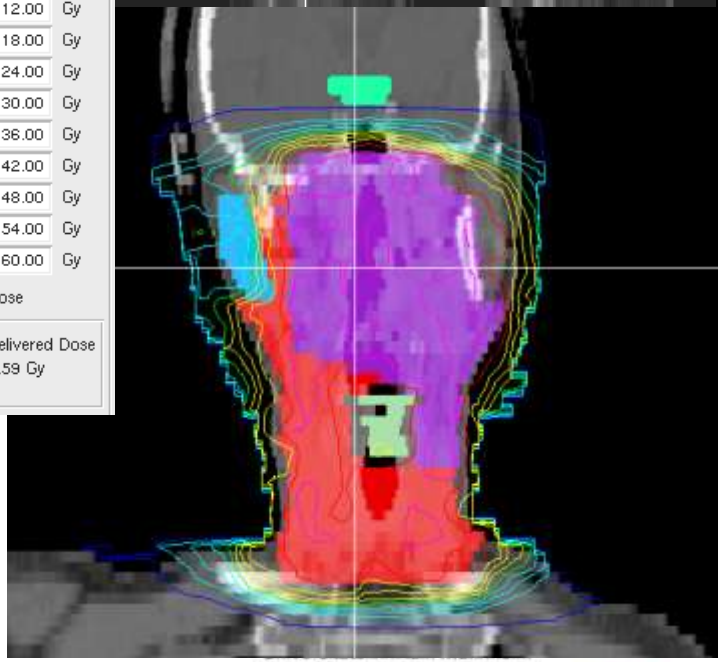

Oropharynx (Tonsil) T2N1 Unilateral Parotid Sparing

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ELSEVIER

Radiotherapy and Oncology 72 (2004) 119–127

www.elsevier.com/locate/radonline

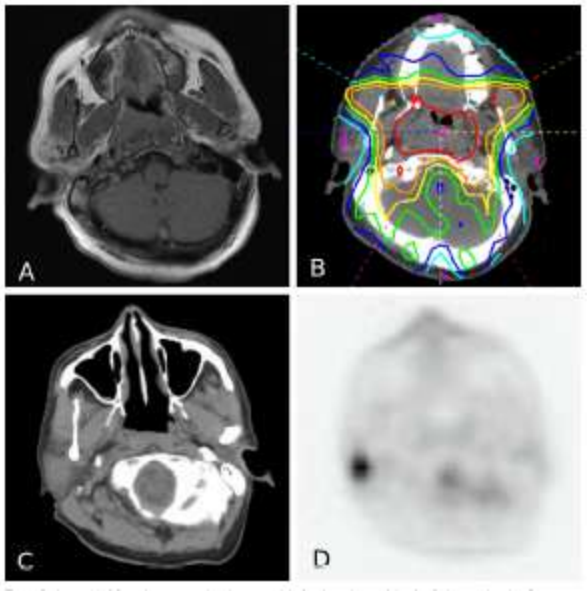
Recurrences after conformal parotid-sparing radiotherapy for head and neck cancer

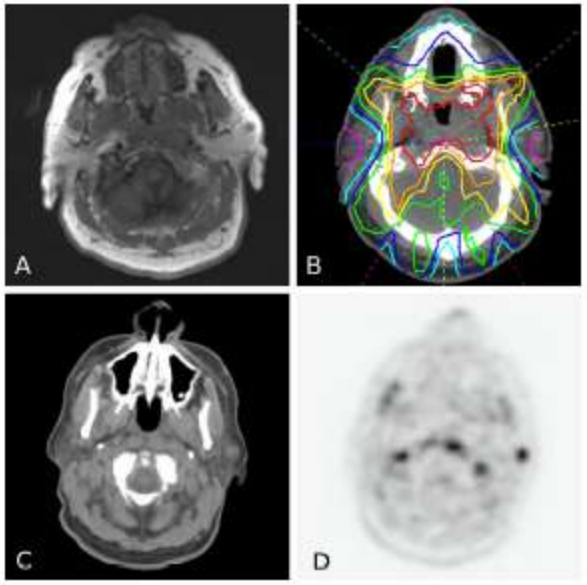
Barbara Bussels[a,*], Annelies Maes[b], Robert Hermans[c], Sandra Nuyts[a], Caroline Weltens[a], Walter Van den Bogaert[a]

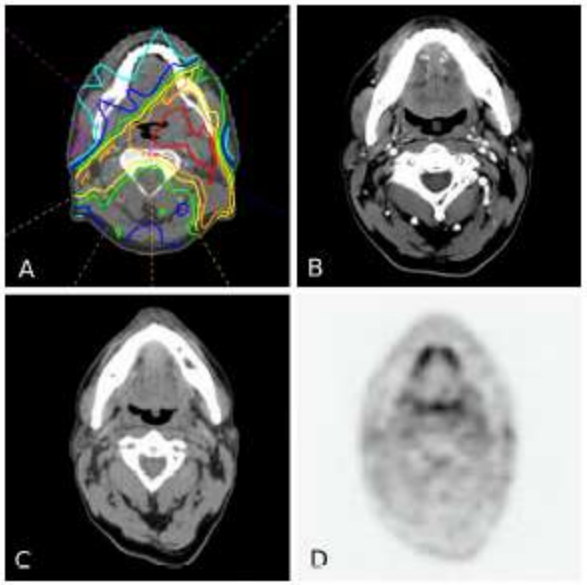
>95% in-field relapse

➢Parotid sparing with correct Patient selection does not seem to increase marginal misses

➢....is it?

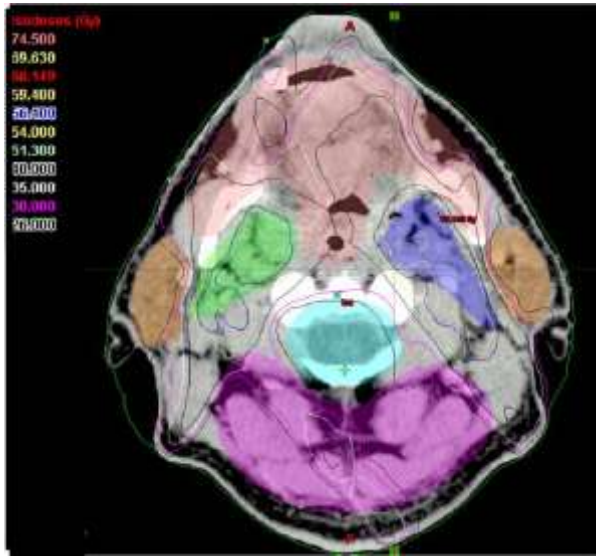


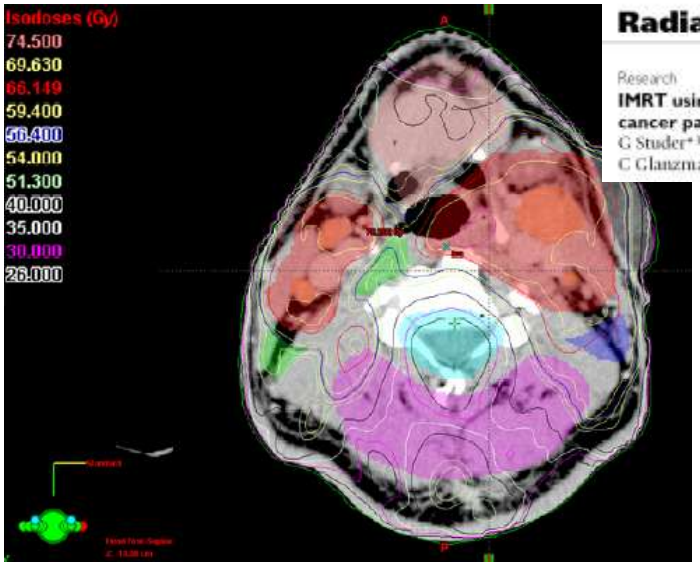




„Our experience with the 2
NPC patients suggests that the presence of multilevel nodal disease and periparotid nodules on pretreatment imaging should raise the index of suspicion for subclinical disease, even if the nodules are not hypermetabolic on PET and do not meet radiographic or clinical criteria for possible gross disease. Additional evaluation such as FNA or CT-guided biopsy might be warranted in such situations before proceeding with definitive IMRT.“

Cannon, IJROBP, 2007





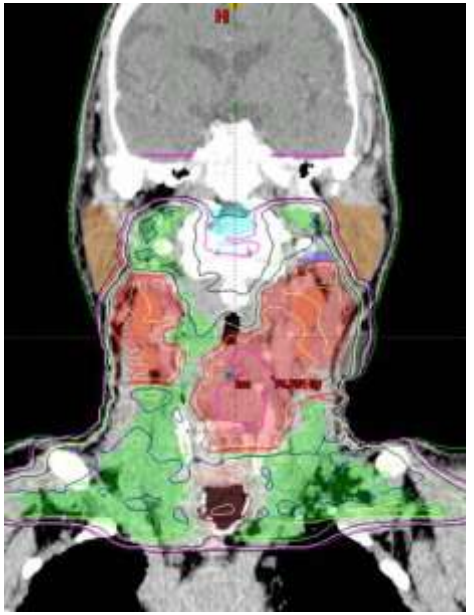
Radiation Oncology

Research

Open Access

IMRT using simultaneously integrated boost (SIB) in head and neck cancer patients

G Studer*[1], PU Huguenin[1], JB Davis[2], G Kunz[2], UM Lütolf[1] and C Glanzmann[1]



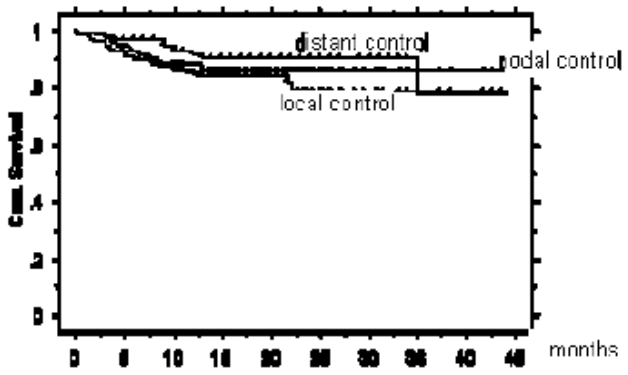


Figure 1
Actuarial 2 year local, nodal, and distant disease free survival: 77 %, 87 %, and 78 %, respectively

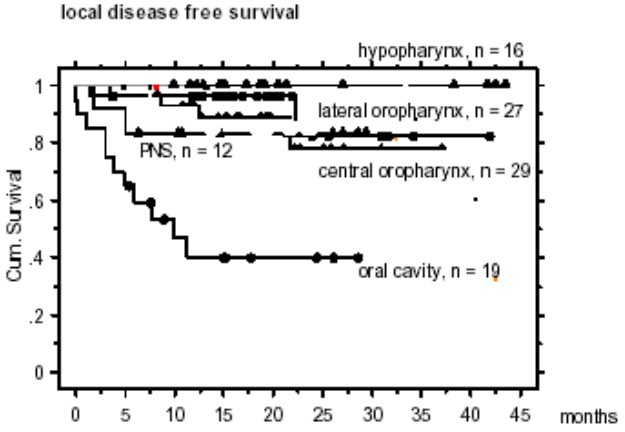


Figure 2
Actuarial 2 year local disease free survival in different HNC entities. Hypopharyngeal tumors revealed the highest local control rates, while oral cavity tumors showed the lowest rate. This fact can not be explained by TN stages or tumor volumes, and is issue of further data anaylses.

Table 3). 5 loco-regionally controlled patients suffered from distant failure.

6% Grade 3/4 late Tox

Medizinische Fakultät Mannheim der Universität Heidelberg

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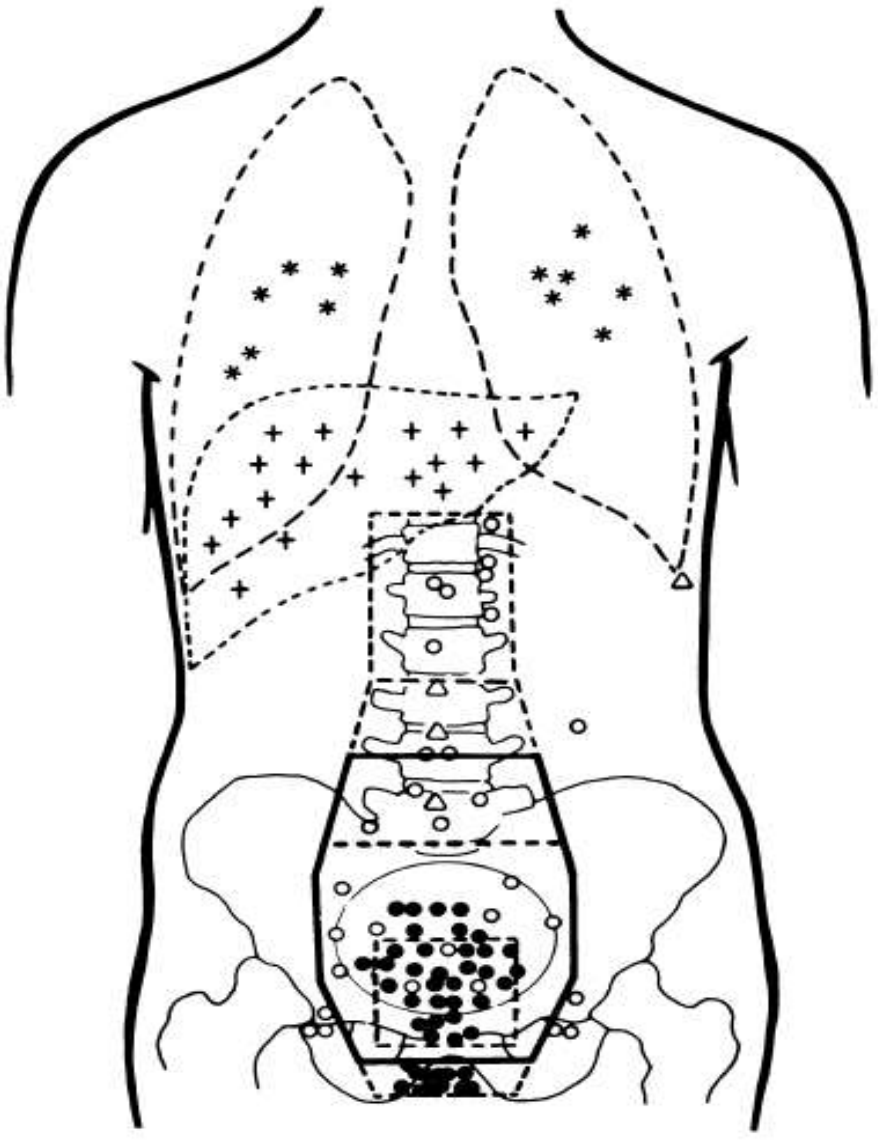
Rektum

Rezidivlokalisation

Minnesota Reoperation-Serie
74 Pat. elektive Re-Lap

rein lokales Rezidiv **46%**
rein distantes Rezidiv **8%**

Gunderson Cancer 1974



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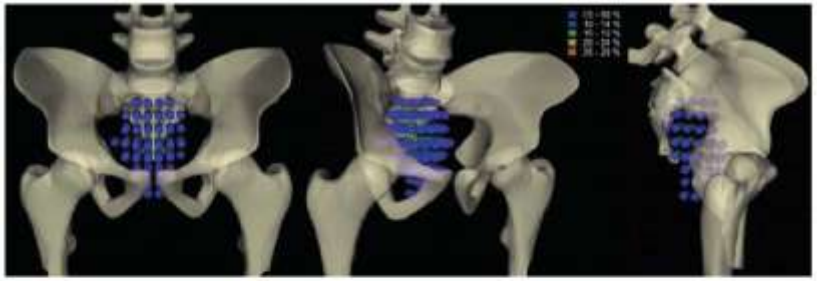

Figure 1. Sites of recurrence in all 123 patients; areas involved in < 5% excluded.

Abbildung 1. Lage der Tumorrezidive bei allen 123 Patienten; < 5% befallene Regionen nicht dargestellt.

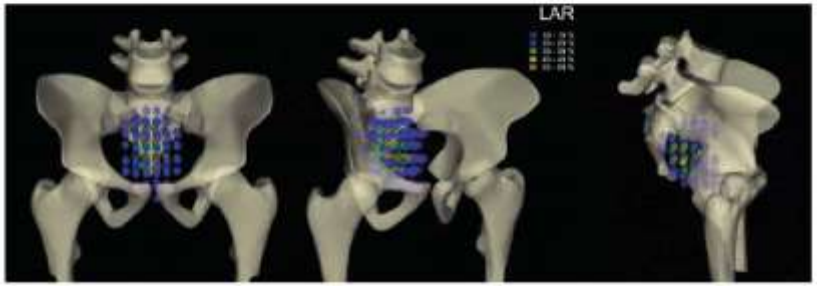

Figure 2. Sites of recurrence after low anterior resection; areas involved in < 10% excluded.

Abbildung 2. Lage der Tumorrezidive nach tiefer anteriorer Resektion; < 10% befallene Regionen nicht dargestellt.

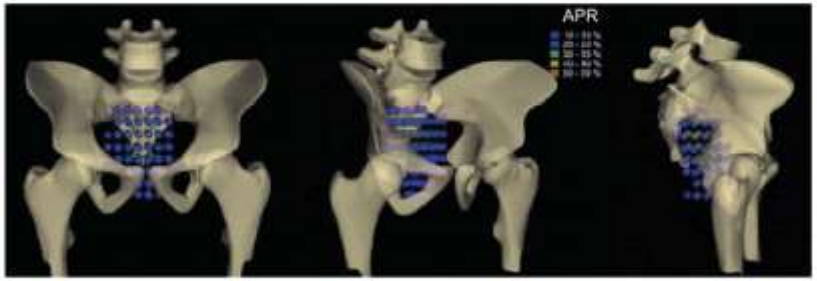

Figure 3. Sites of recurrence after abdominoperineal resection; areas involved in < 10% excluded.

Abbildung 3. Lage der Tumorrezidive nach abdominoperinealer Amputation; < 10% befallene Regionen nicht dargestellt.

Recurrent Rectal Cancer within the Pelvis

A Multicenter Analysis of 123 Patients and Recommendations for Adjuvant Radiotherapy

Stefan Höcht[1], Riad Hammad[1], Hans-Joachim Thiel[2], Thomas Wiegel[1], Alessandra Siegmann[1], Jochen Willner[3], Peter Wust[4], Thomas Herrmann[5], Michael Eble[6], Michael Flentje[1], Detlef Carstens[7], Dirk Bottke[1], Patrick Neumann[8], Wolfgang Hinkelbein[1]

Strahlenther Onkol 2004;180:15–20

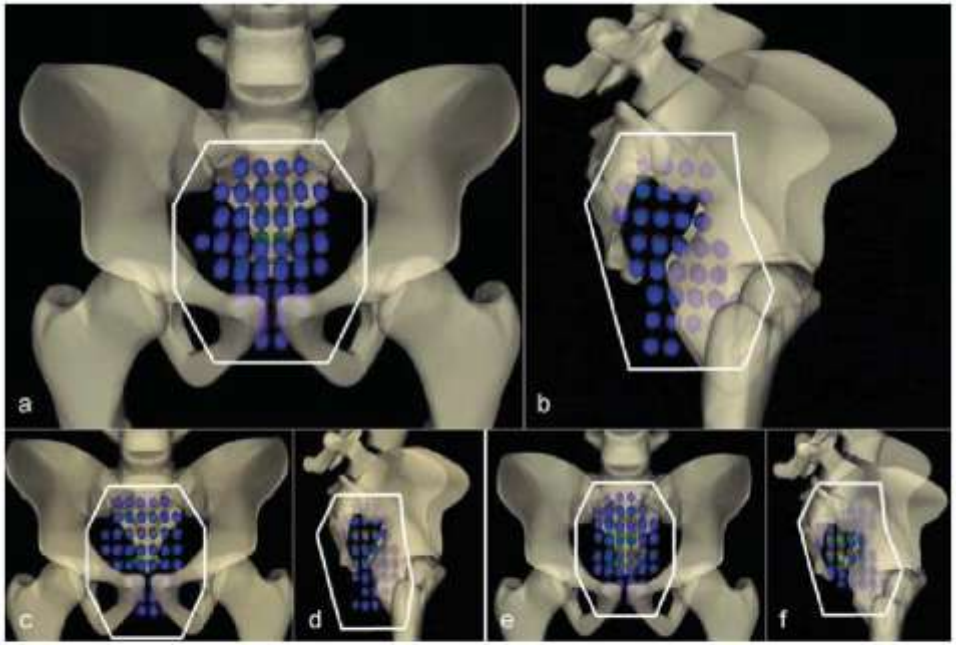

Figure 5. Proposals for radiation ports in adjuvant therapy; in general (a, b), after APR (c, d) and after LAR (e,f).

Abbildung 5. Vorschläge zur Feldwahl bei adjuvanter Behandlung. Allgemein (a, b), nach APR (c, d) und nach LAR (e, f).

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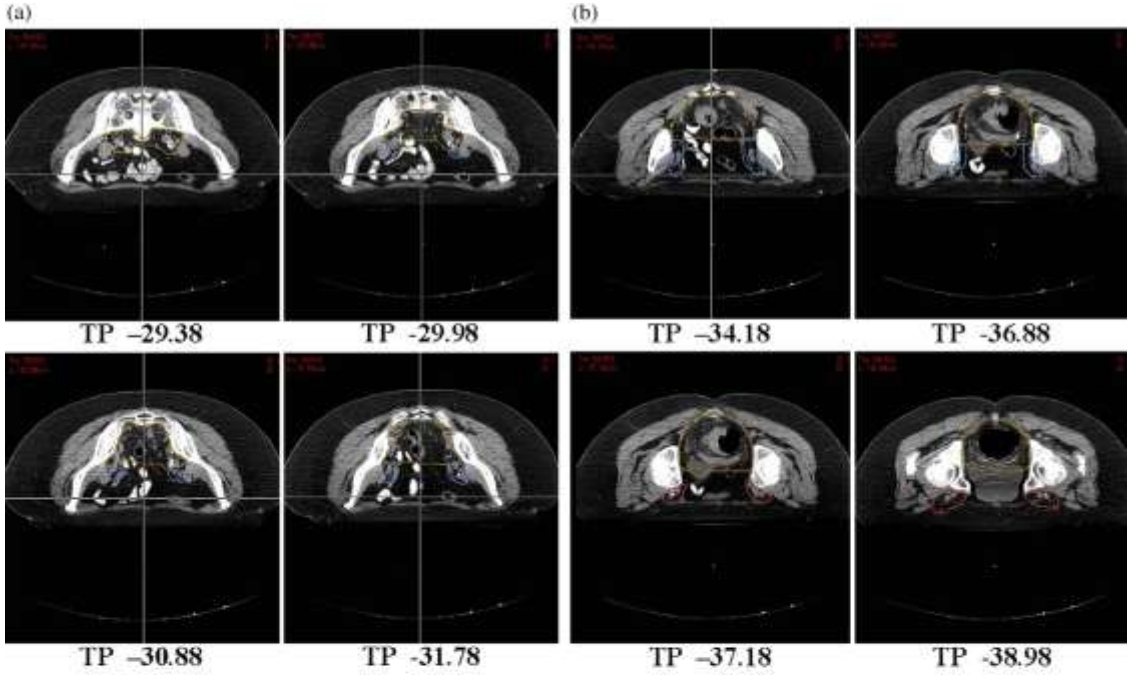

Konsensus

Myerson et al., IJROBP, 2009

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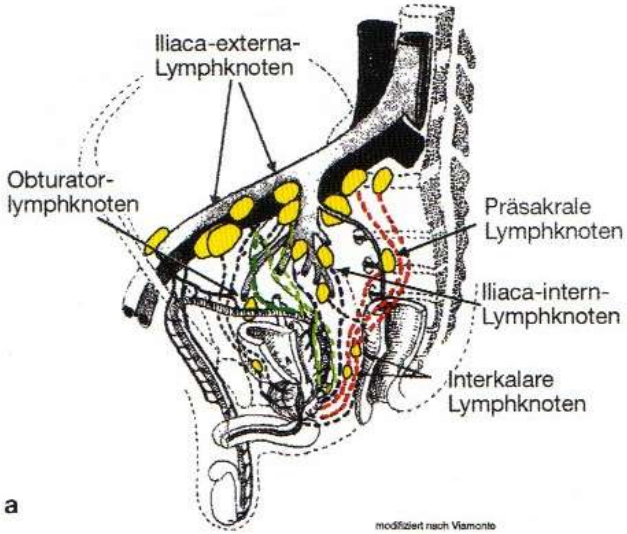
Welche Fragen sind wirklich zu klären?

- Basics Konturierung für IMRT

- Wo wissen wir, was wir tun?

- ***Wo wissen wir‘s noch nicht und was können wir dagegen tun?***

Prostata
Becken



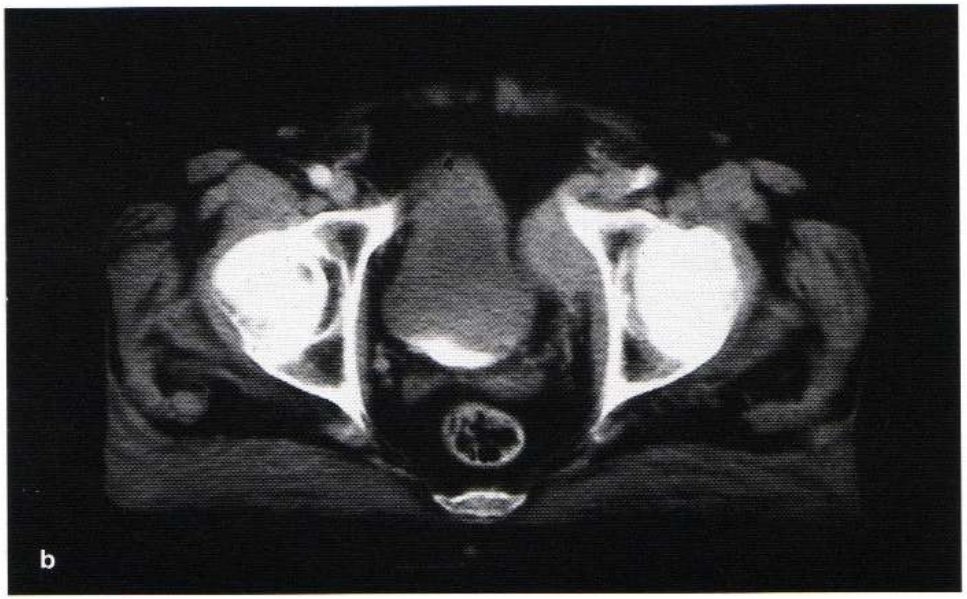
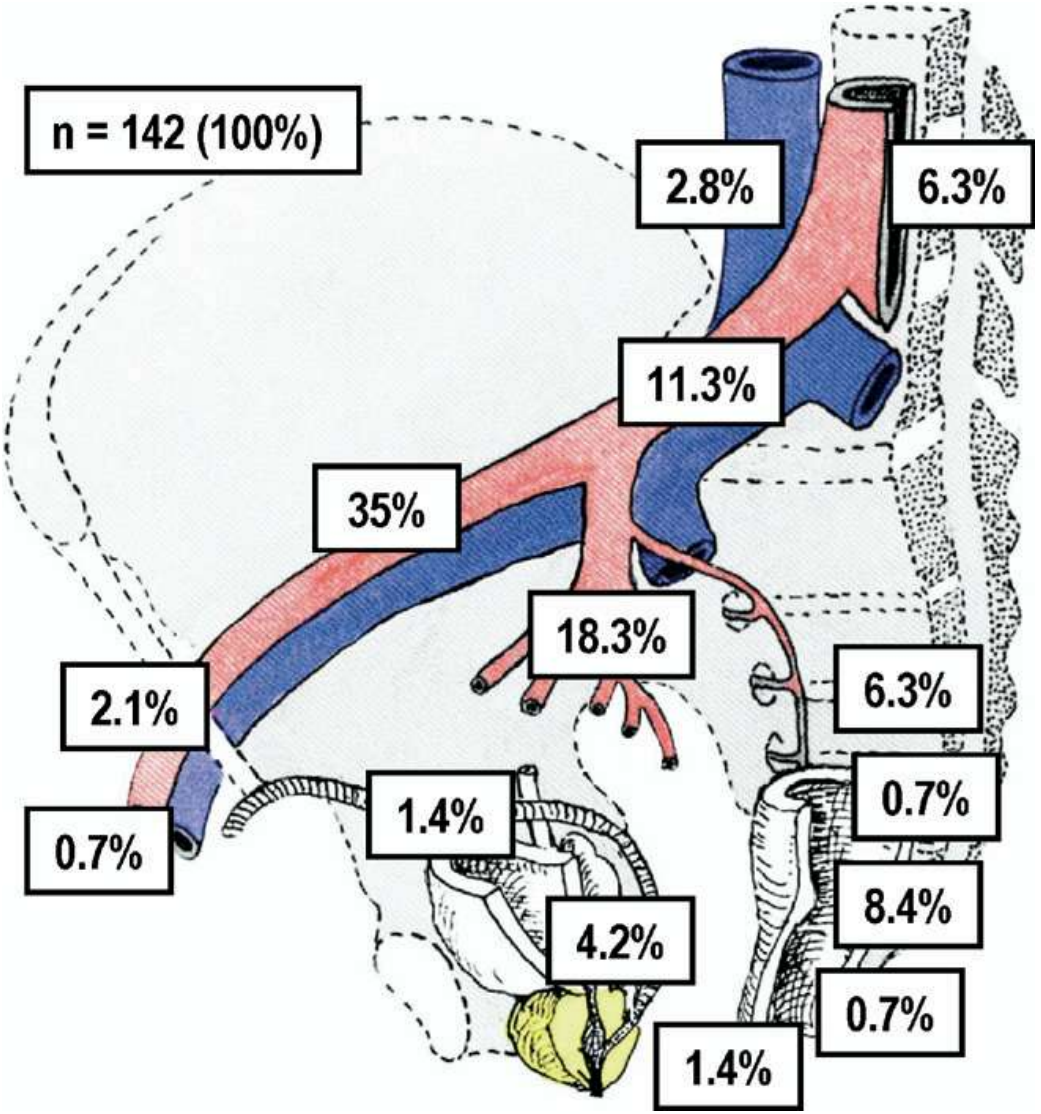


Abb. 4.2a, b. *a* Schematischer Lymphabfluß der Prostata in schräg sagittaler Projektion. *b* Axialer CT-Schnitt mit Lymphknotenmetastase links iliakal (Obturatorlymphknoten)

Ganswindt et al., IJROBP, 2007



Konsensus

Lawton et al.,
IJROB, 2008

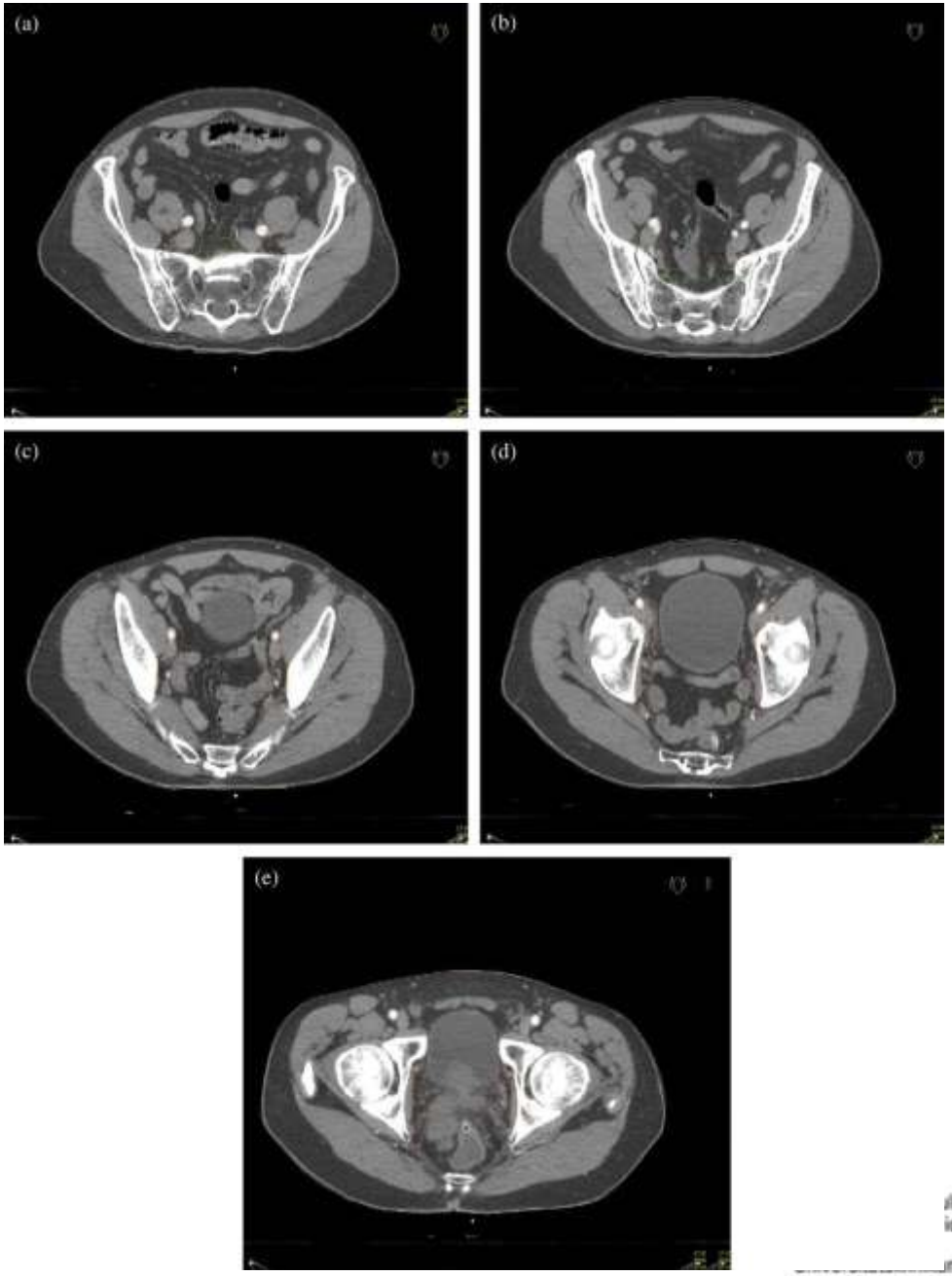


Fig. 2. Representative pelvic lymph node clinical target volume (CTV) contours from consensus computed tomography.
(a) Common iliac and presacral CTV lymph node volumes (L5/S1). (b) External, internal, and presacral CTV lymph node volumes (S1-S3). (c) External and internal Iliac CTV lymph node volumes (below S3). (d) End of external iliac CTV lymph node volumes (at top of femoral head, boney landmark for the inguinal ligament). (e) Obturator CTV lymph node volumes (above the top of the pubic symphysis).

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MRI with a lymph-node-specifi c contrast agent as an alternative to CT scan and lymph-node dissection in patients with prostate cancer: a prospective multicohort study

Roel A M Heesakkers, Anke M Hövels, Gerrit J Jager, Harrie C M van den Bosch, J Alfred Witjes, Hein P J Raat, Johan L Severens, Eddy M M Adang, Christina Hulsbergen van der Kaa, Jurgen J Fütterer, Jelle Barentsz

9/2008

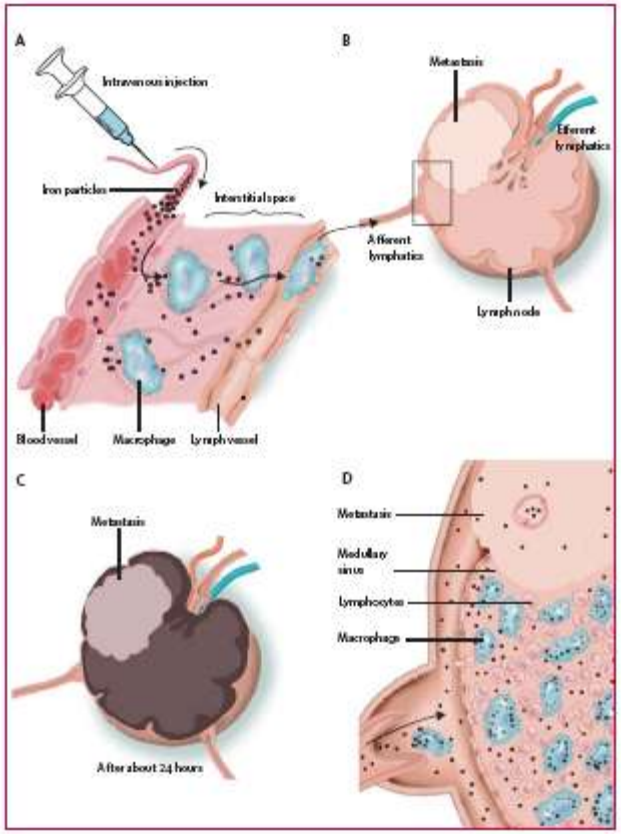
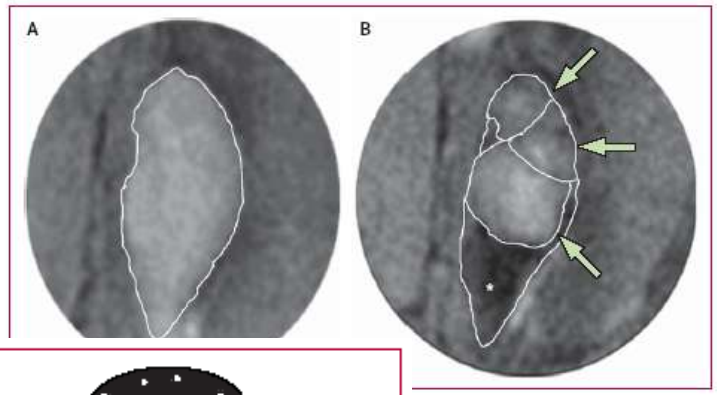


Figure 1: Mechanism of ferumoxtran-10
(A) Infused iron-particles slowly extravasate from the vasculature to the interstitial space and are internalised by macrophages. (B) and (C) Iron-loaded macrophages are transported to lymph nodes via lymphatic vessels and accumulate in normal-sized lymph node tissue. These iron-loaded macrophages cause low signal intensity on T2*-weighted MR image. Box in B shows area depicted in D. (D) Disturbances of lymph flow or nodal architecture by metastases leads to less macrophages, depicted on MR imaging by higher signal intensity.



mage with partial metastatic lymph node before annot be discriminated. (B) MRL image, shows l (arrows). Histopathology showed low signal

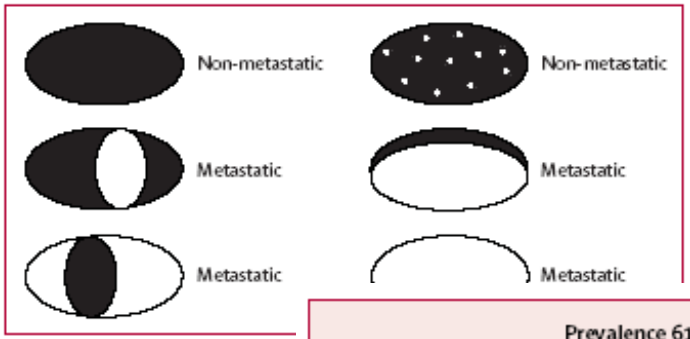


Figure 3: Classification of lymph r
echo images

	Prevalence 61/375 (16%)	
	MDCT	MRL
Sensitivity (%) (95% CI)	21/61 (34) (23–48)	50/61 (82) (70–90)
Specificity (%) (95% CI)	303/314 (97) (94–98)	291/314 (93) (89–95)
PPV (%) (95% CI)	21/32 (66) (47–81)	50/73 (69) (56–79)
NPV (%) (95% CI)	303/343 (88) (84–91)	291/302 (96) (93–98)
Post-test probability of	40/343 (12)	11/302 (4)

	Three experienced hospitals	Seven less experienced hospitals
Patients with MRL results, n	295	80
Sensitivity, n (%) (95% CI)	46/51 (90) (78–96)	4/10 (40) (14–73)
Specificity, n (%) (95% CI)	229/244 (94) (90–96)	62/70 (89) (78–96)
PPV, n (%) (95% CI)	46/61 (75) (62–85)	4/12 (33) (11–65)
NPV, n (%) (95% CI)	229/234 (98) (95–99)	62/68 (91) (81–96)
Post-test probability of false-negative finding (%)	5/234 (2)	6/68 (9)

Table 3: Results of MRL in experienced and less-experienced participating hospitals

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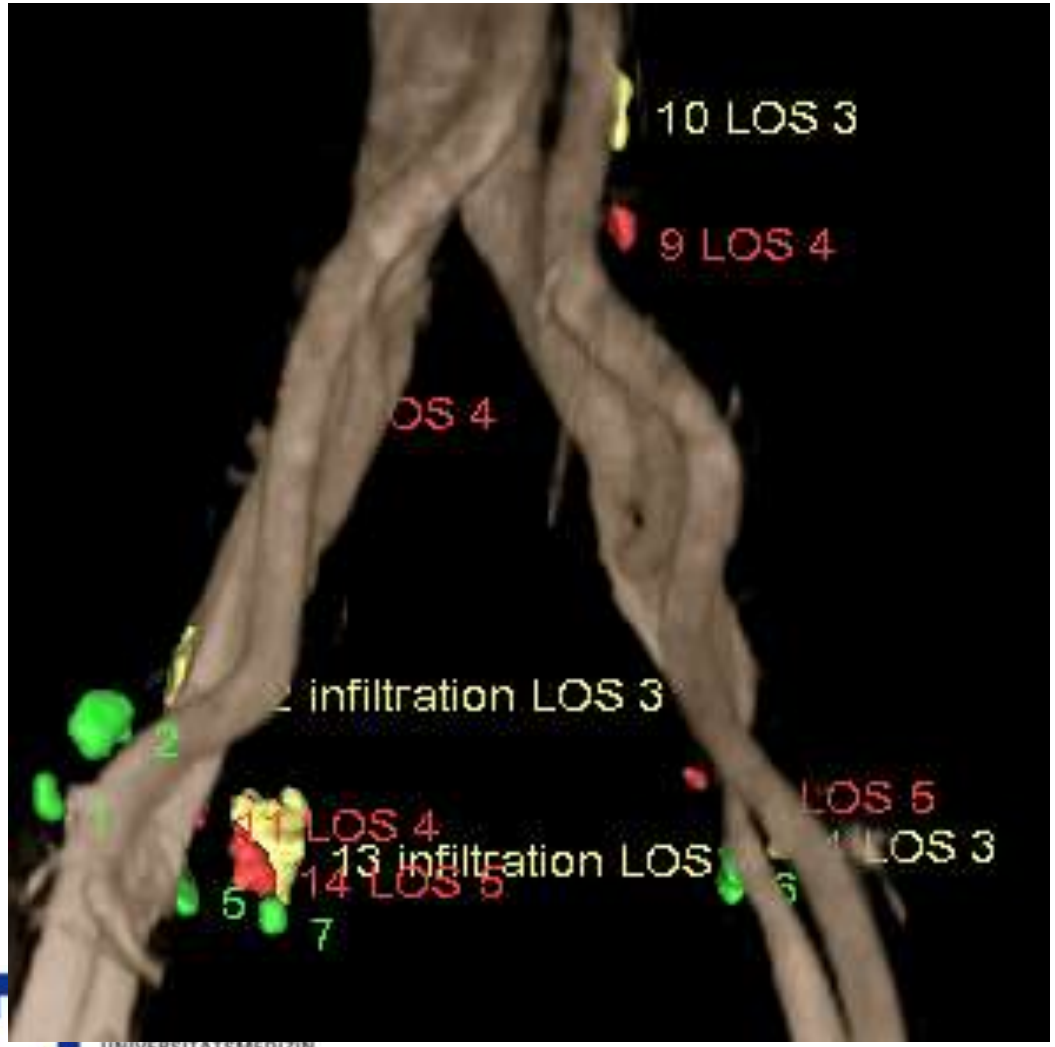
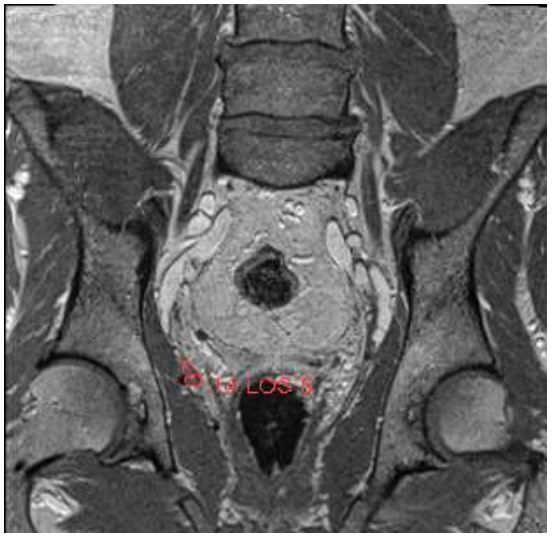
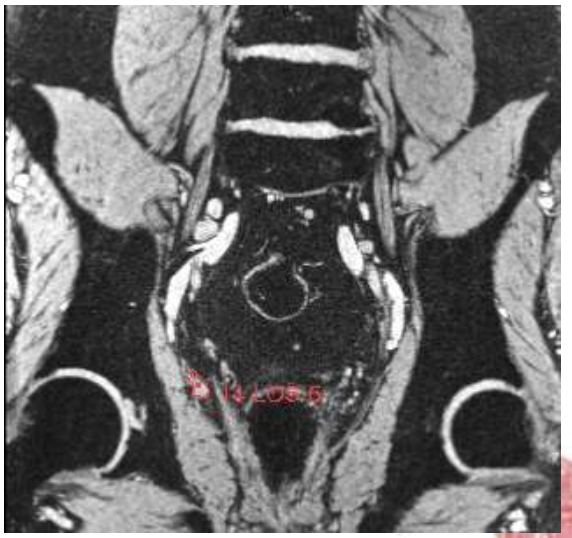
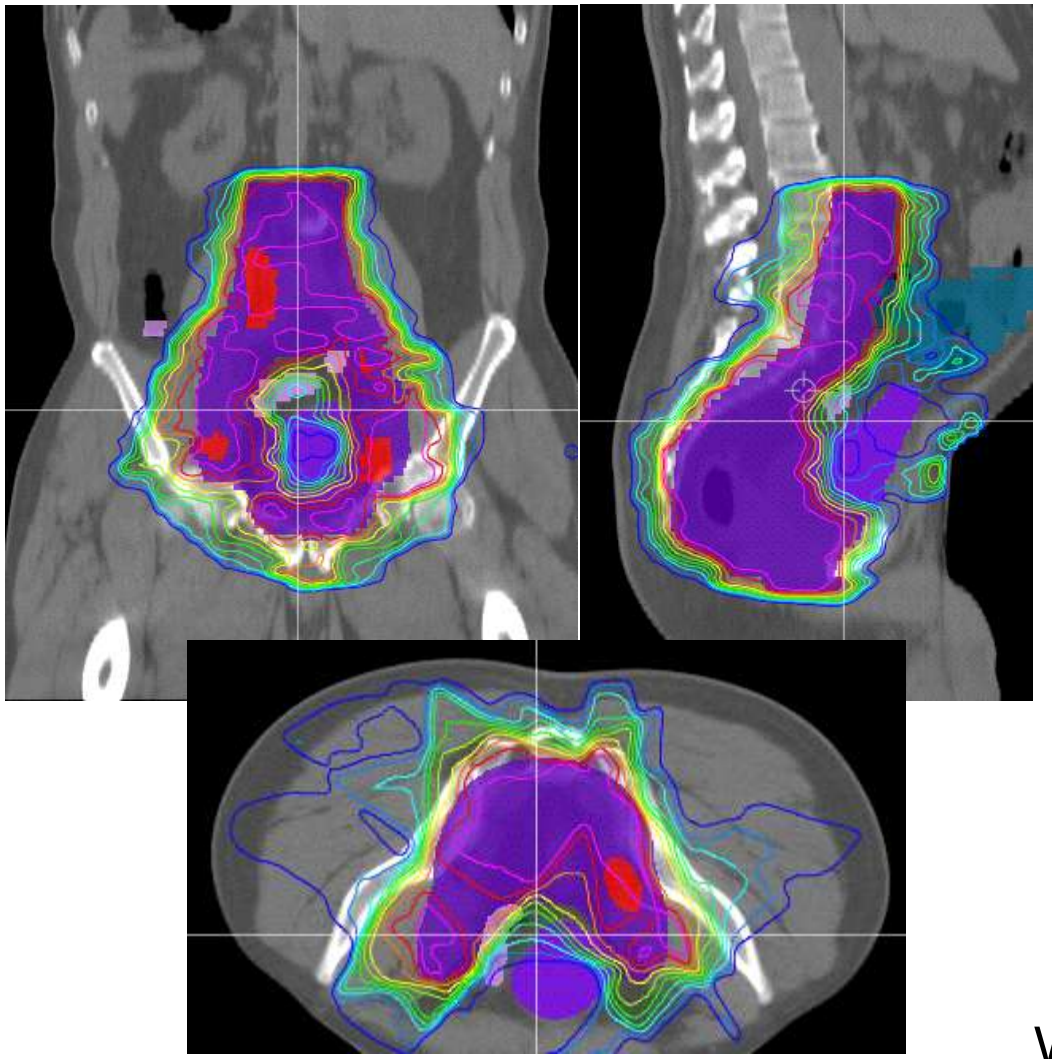
Patient W. before RT

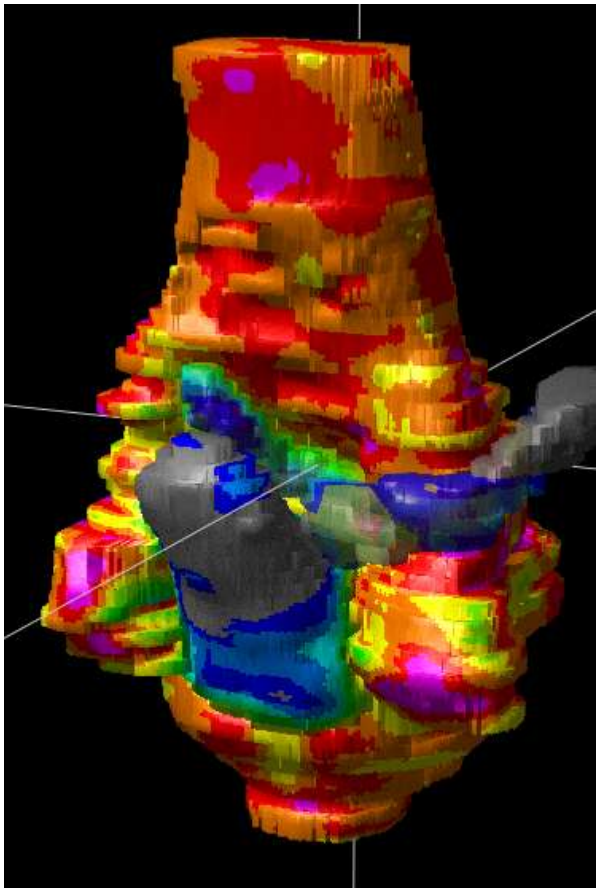






Initial Plan to Pelvic LN and Prostated Bed, 0-44 Gy

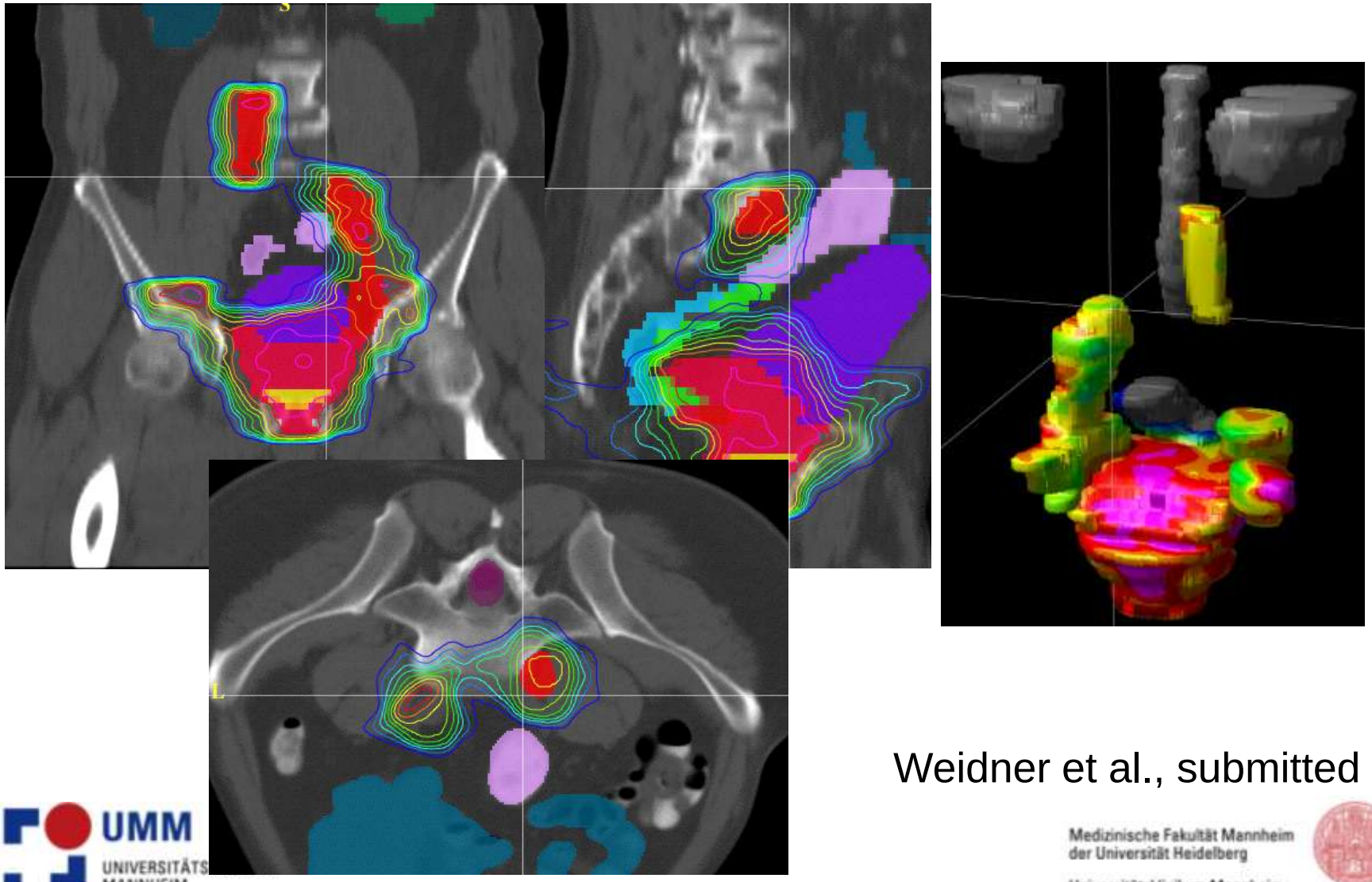




Weidner et al., submitted

Boost to Prostate Bed and LN, 44-60 Gy

(to be followed by further Boost to Prostate Bed (and LN in the Prostate Bed to 71/75 Gy)



Weidner et al., submitted

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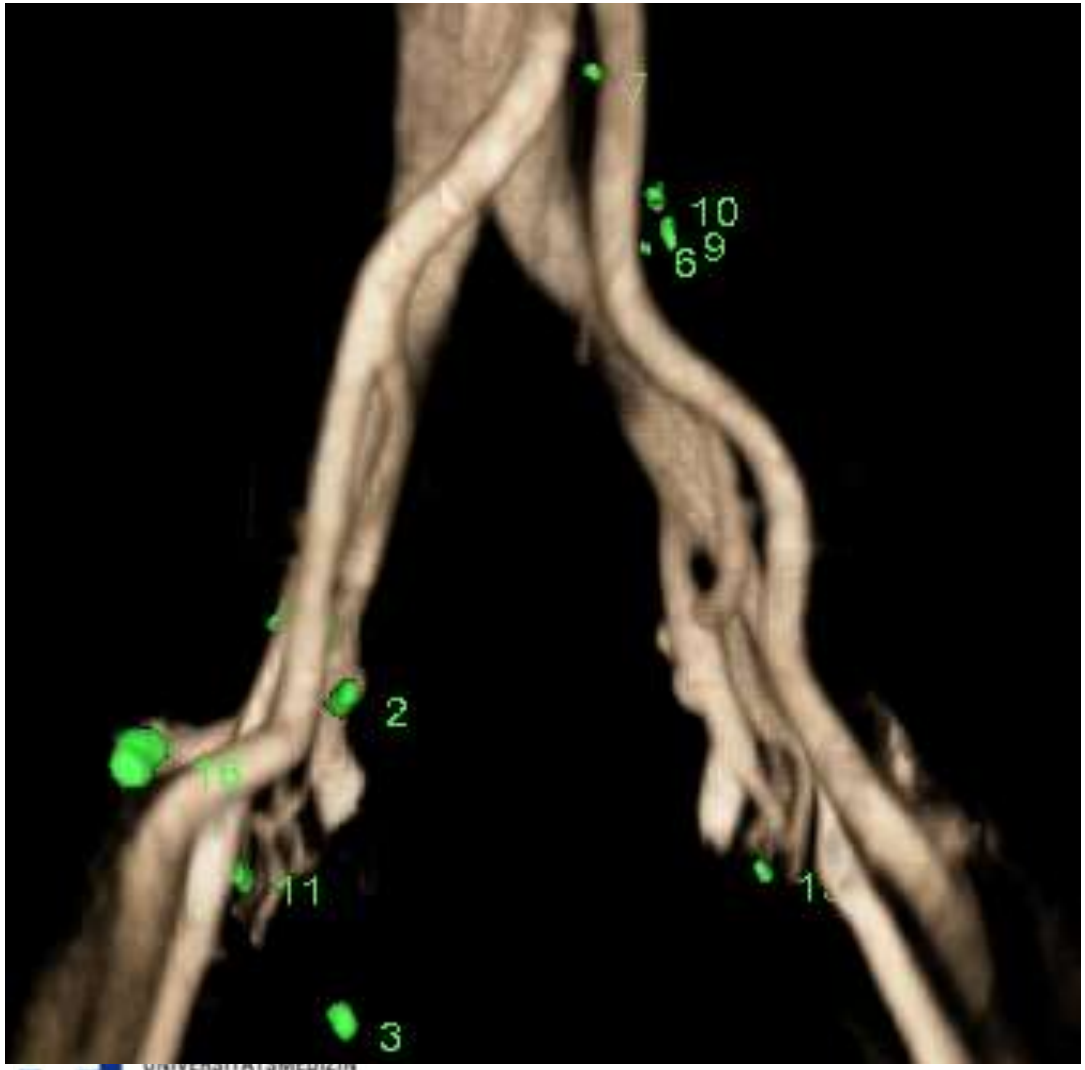
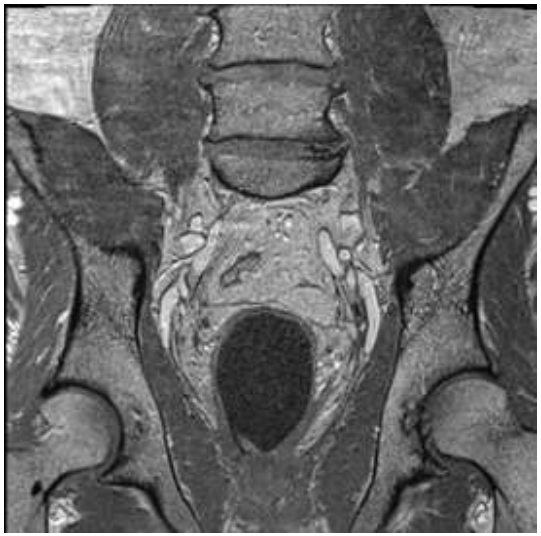
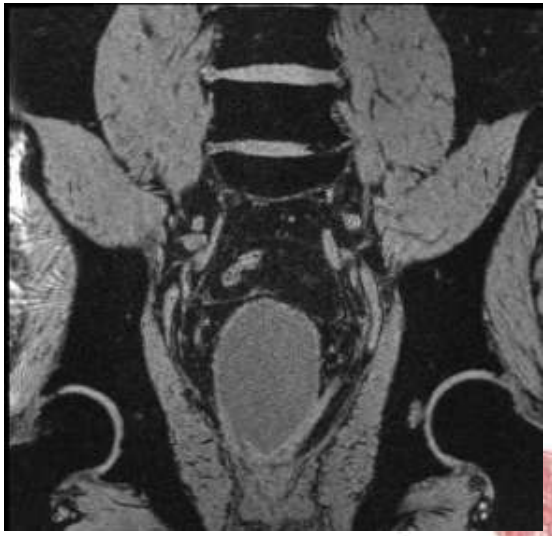
Patient W. after RT



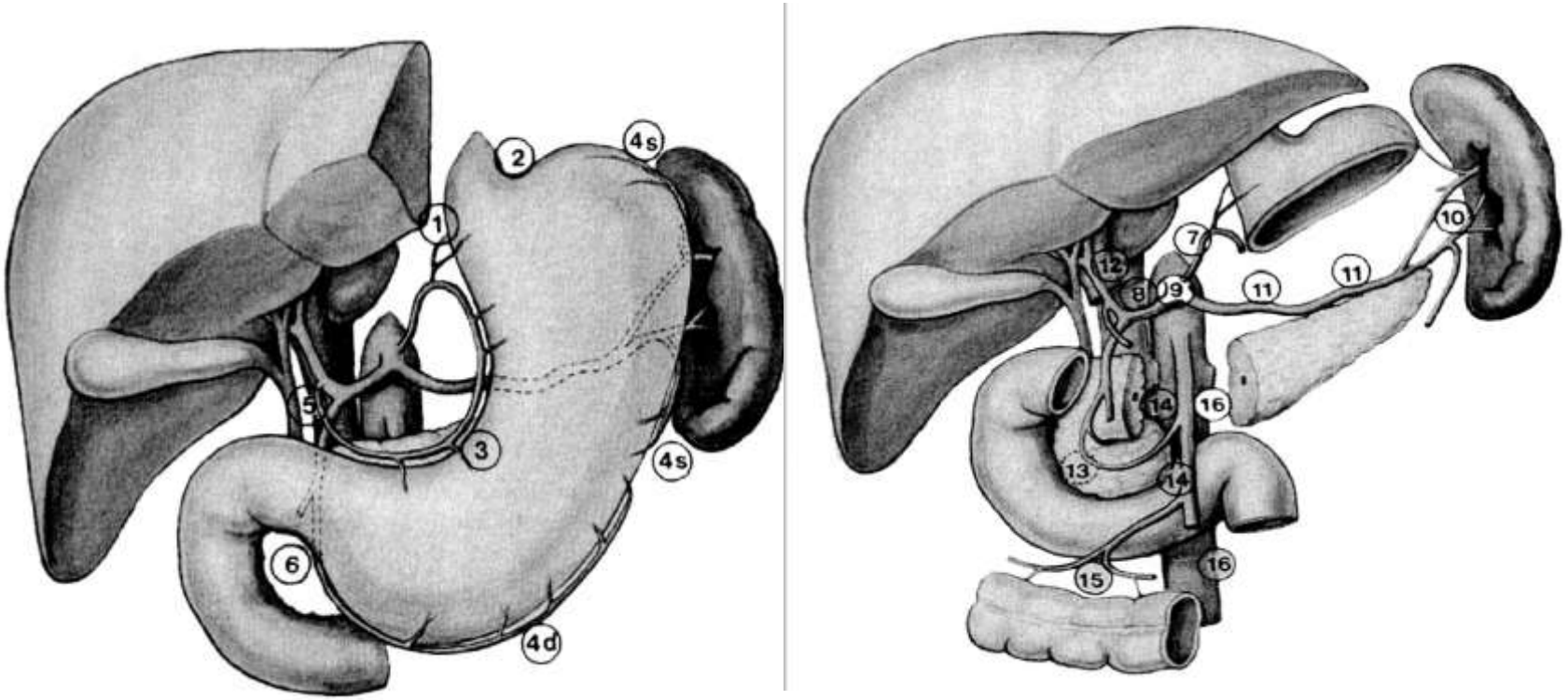




Magen

Anatomie LK

Hartgrink et al



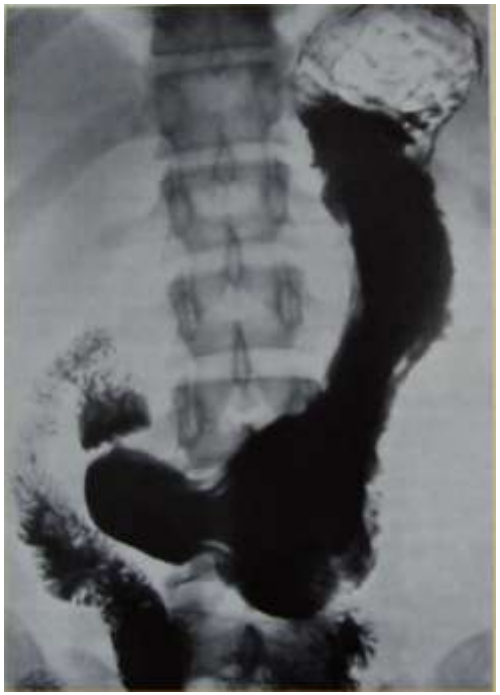
Japanese Research Society for the Study of Gastric Cancer

- N1: Nr. 1 - 6
- N2: Nr. 7 - 11
- N3: Nr. 12 - 16

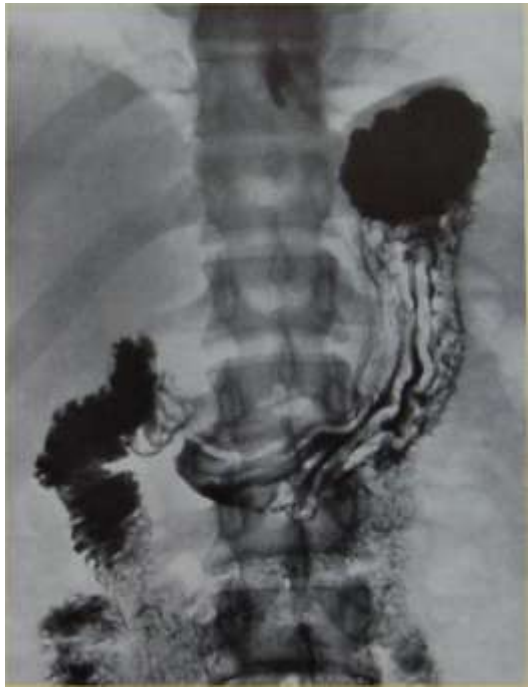
TNM

- N1: 1-6 reg LK
- N2: 7 - 15 reg LK
- N3: >15 reg LK

Röntgenanatomie

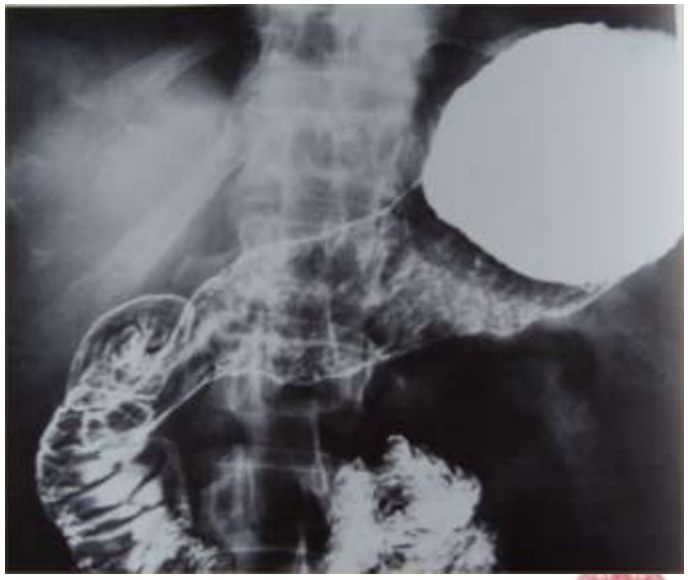


Prallfüllung
im Stehen

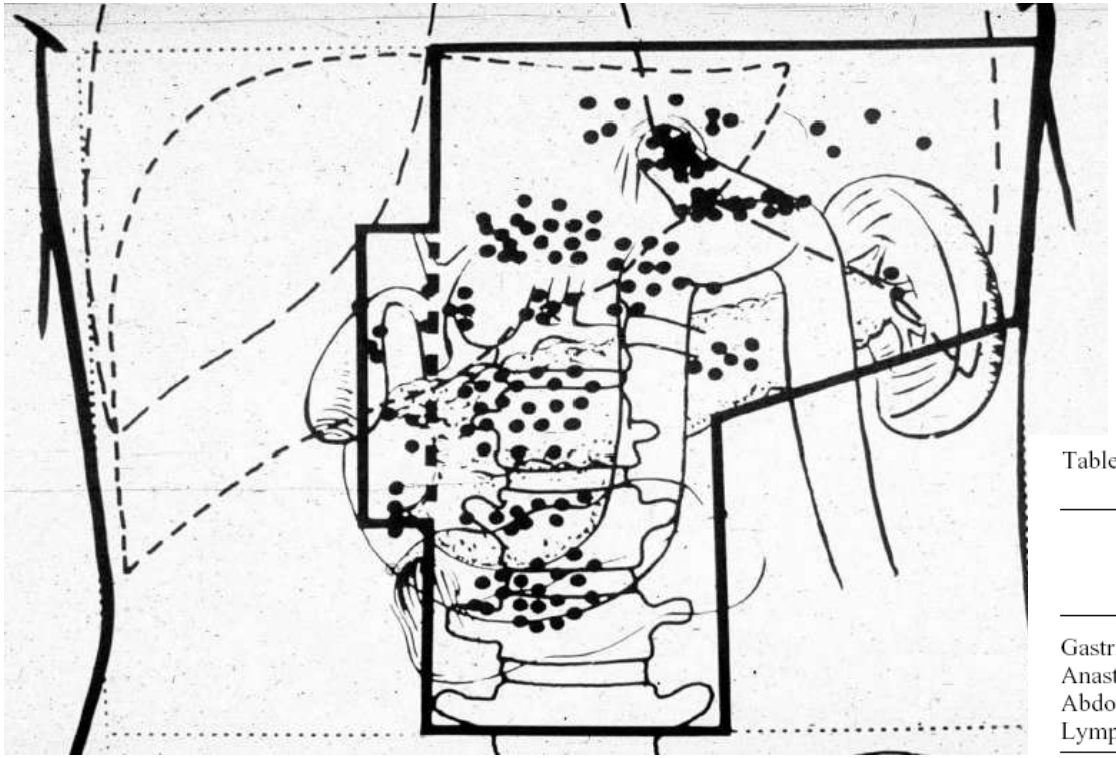


Doppelkontrast
im Liegen

Diffus infiltrierendes Ca
Corpus/Antrum



Rezidivmuster



Gunderson Cartoon of Hypothetical Radiotherapy Field Based on U of Minnesota Reoperative Series POF

Table 2. Pattern of locoregional failure after resection of gastric cancer

Failure area	Incidence (%)		
	Clinical*	Reoperation†	Autopsy‡
Gastric bed	21	54	52–68
Anastomosis or stumps	25	26	54–60
Abdominal or stab wound		5	
Lymph node(s)	8	42	52

* 130 patients at risk (3).
† 105 patients at risk (2).
‡ 92 patients at risk (4) and 28 patients at risk (5)
Modified with permission from Smalley S, Gunderson L Stomach. In: Perez C, Brady W, editors. Principles and practice of radiation oncology. 3rd edition, Philadelphia, PA: Lippincott-Raven Publishers: USA, 1997.

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Medizinische Fakultät Mannheim

Konventionell

ap/pa

Simulationsaufnahmen

- 1. Feldgrenzen festlegen (Anastomose, Clips)
- 2. iv - KM zur Darstellung der Nieren
- 3. orales KM (Anastomose, Magenstumpf

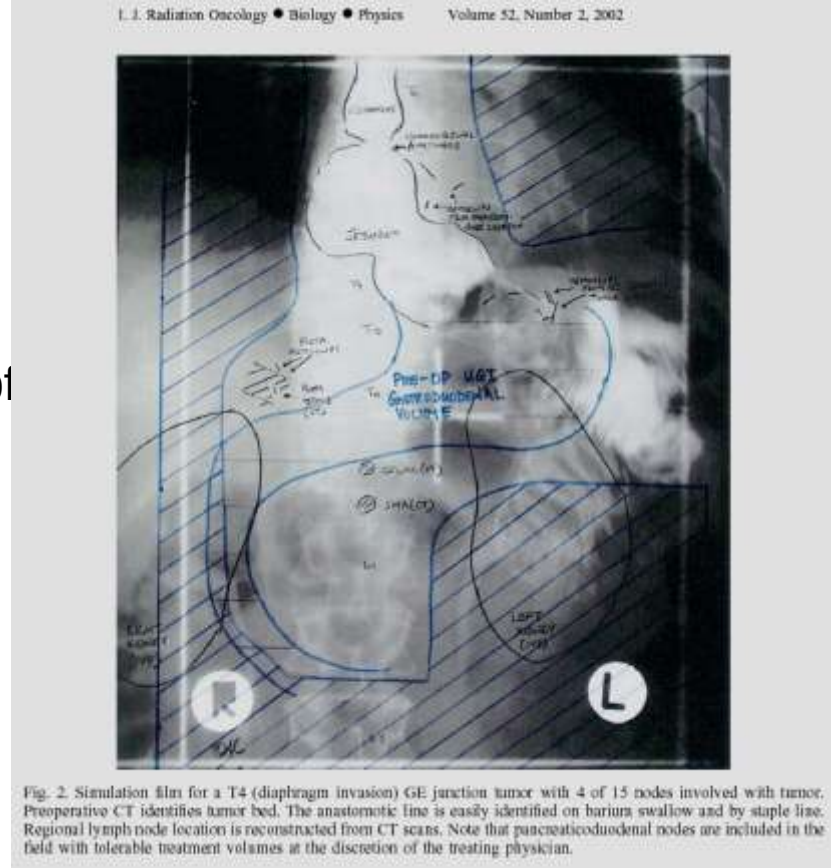
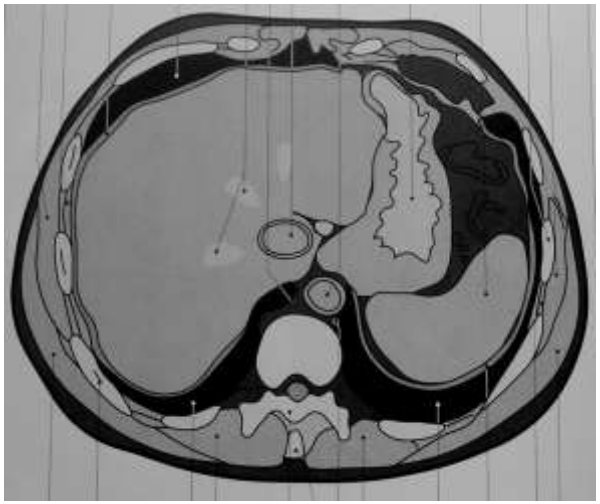
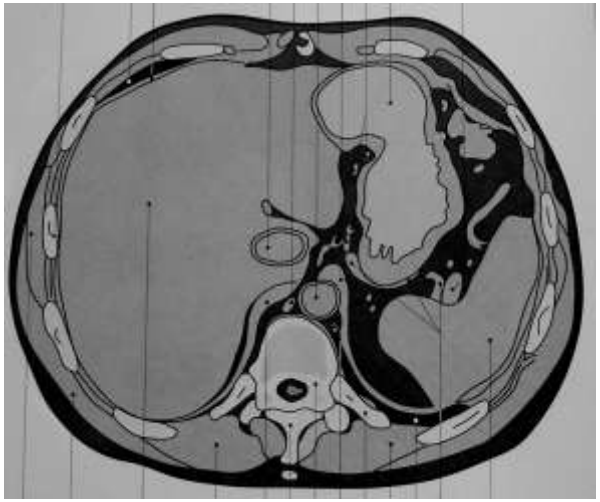
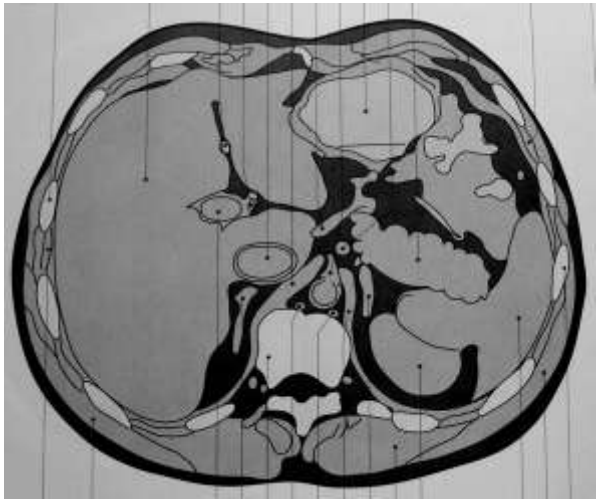
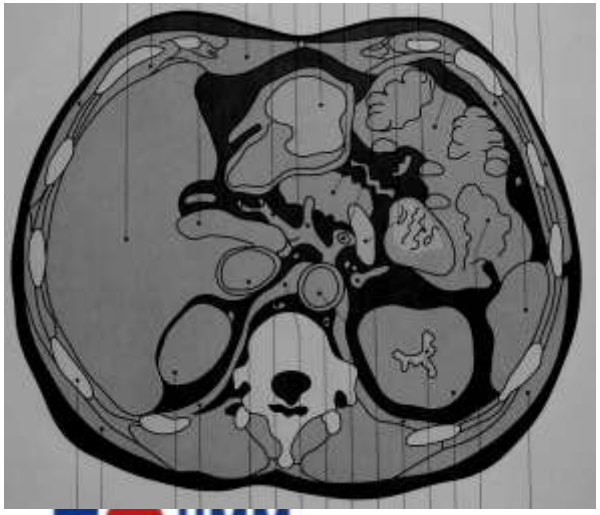
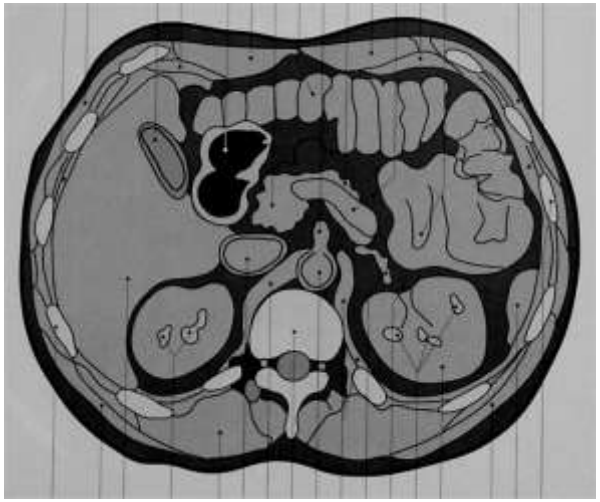
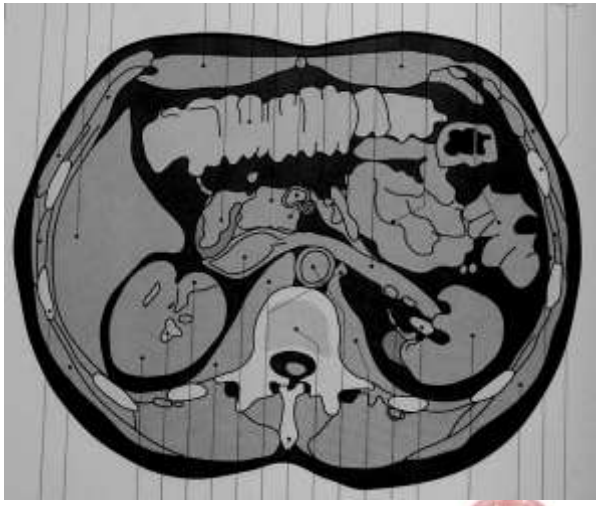


Fig. 2. Simulation film for a T4 (diaphragm invasion) GE junction tumor with 4 of 15 nodes involved with tumor. Preoperative CT identifies tumor bed. The anastomotic line is easily identified on barium swallow and by staple line. Regional lymph node location is reconstructed from CT scans. Note that pancreaticoduodenal nodes are included in the field with tolerable treatment volumes at the discretion of the treating physician.

pT4, N1, Cardia

Anatomie CT

Wegener

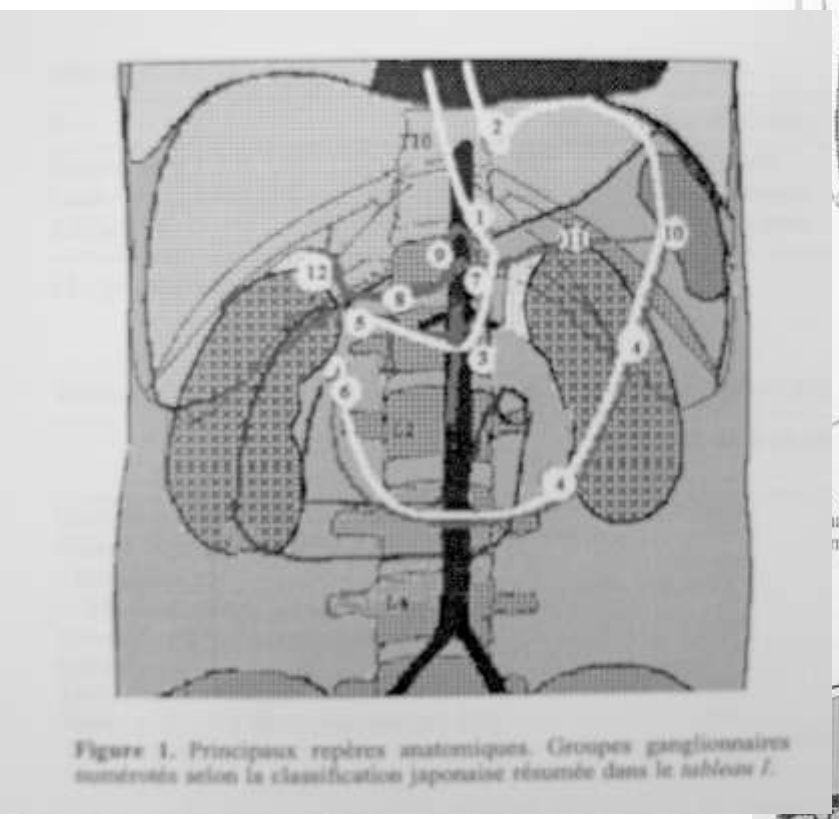
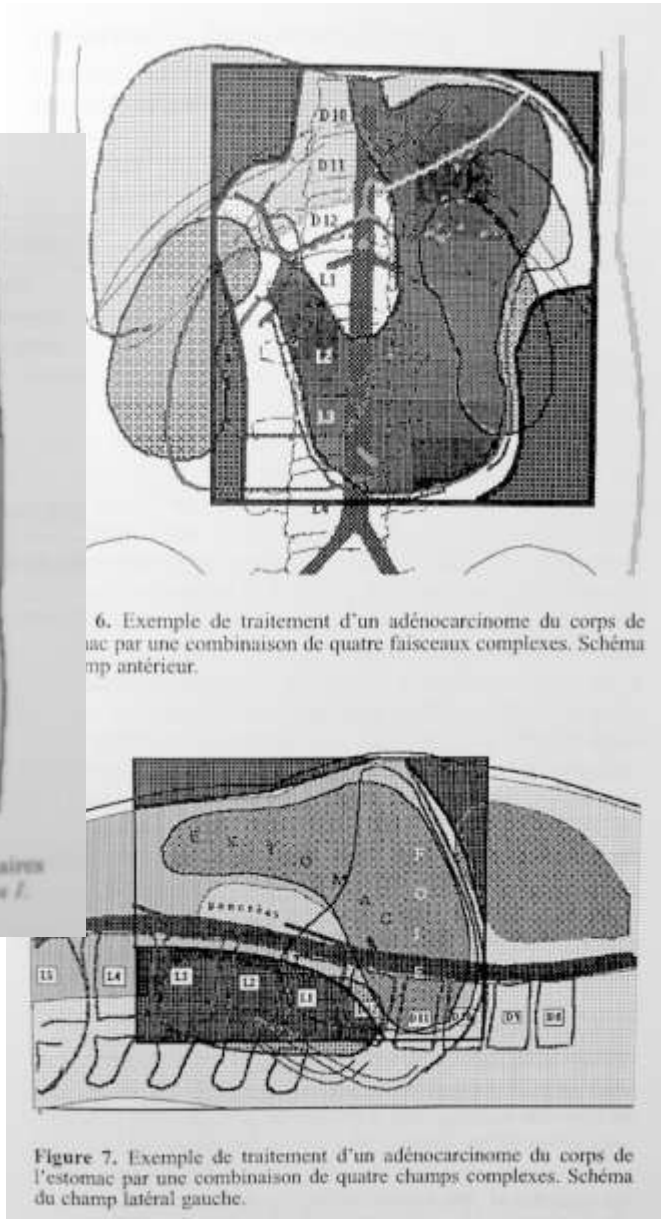
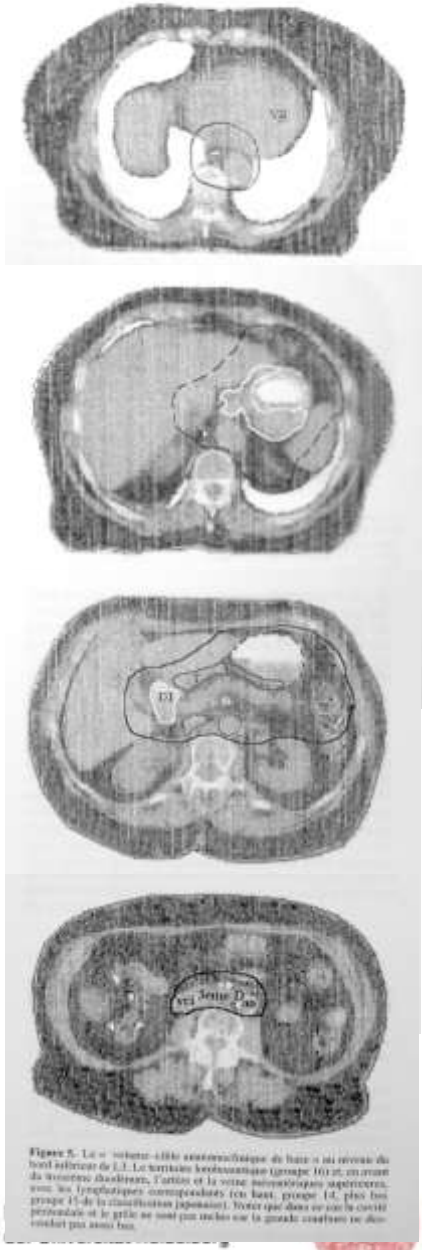


Figure 1. Principaux repères anatomiques. Groupes ganglionnaires numérotés selon la classification japonaise résumée dans le *tableau I*.



6. Exemple de traitement d'un adénocarcinome du corps de ac par une combinaison de quatre faisceaux complexes. Schéma mp antérieur.

Figure 7. Exemple de traitement d'un adénocarcinome du corps de l'estomac par une combinaison de quatre champs complexes. Schéma du champ latéral gauche.



Caudry et al.,
Cancer Radiotherapie
2001

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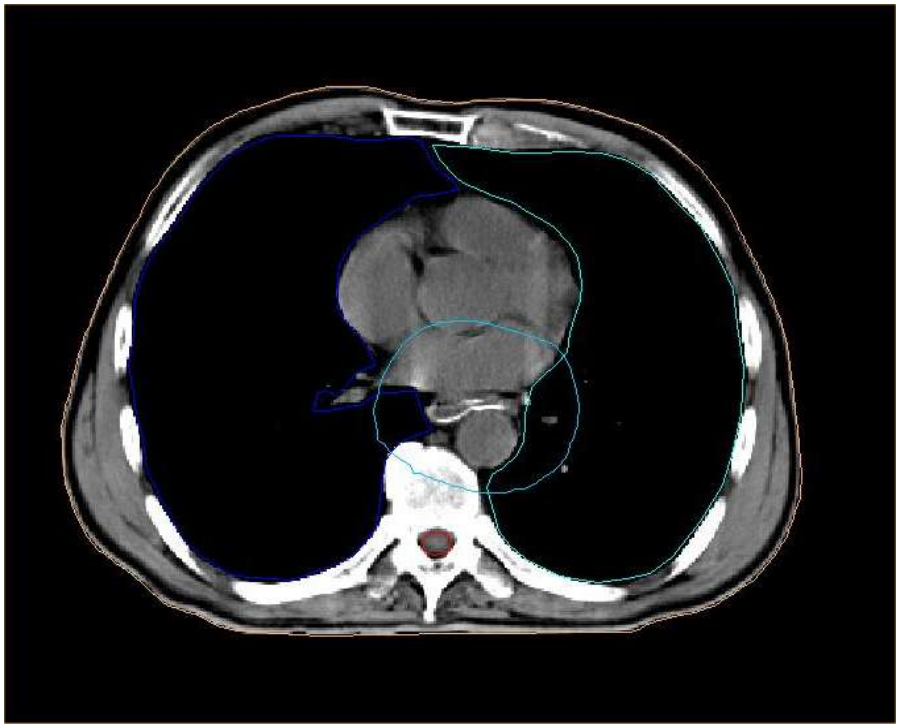
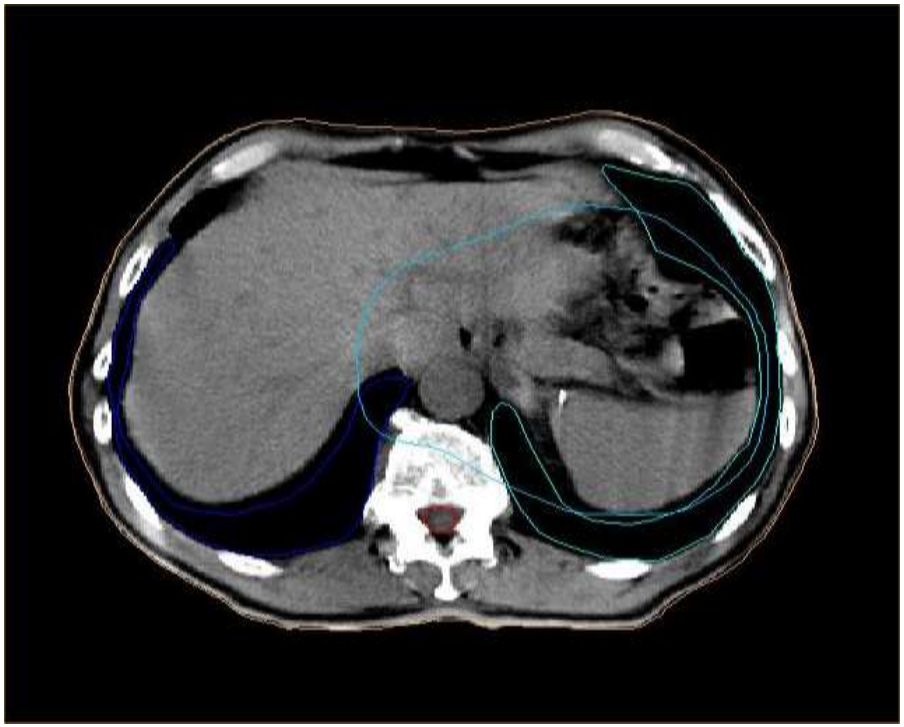
ZV-CT

pT4, N3, M0, Sitz: Cardia
Z.n. Gastrektomie, Oesophagusteilresektion



Proximale Anastomose



Zwerchfell/Milzhilus

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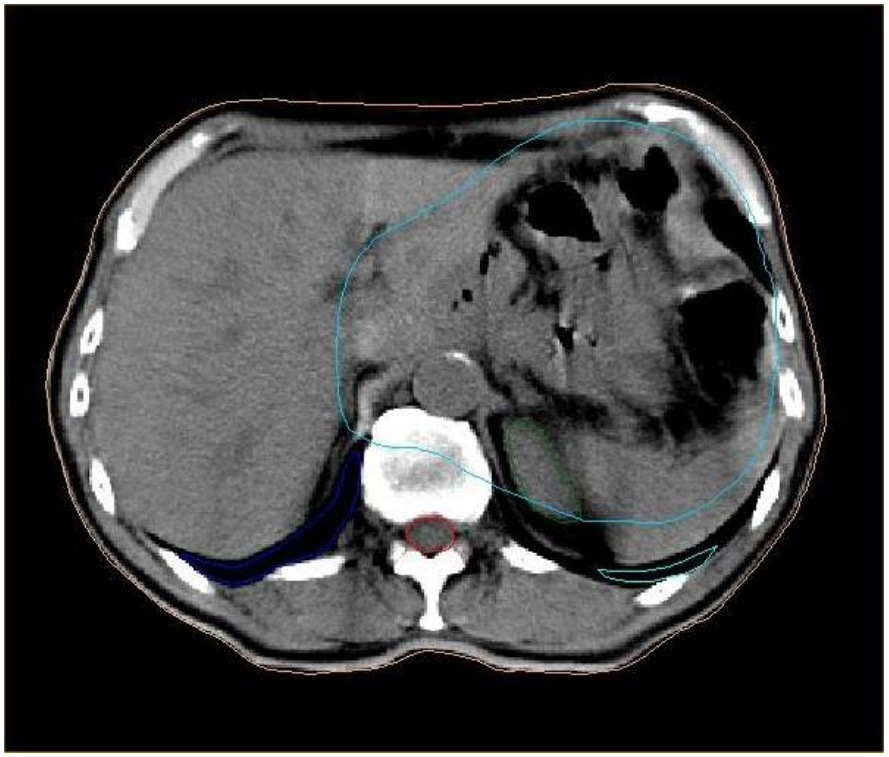
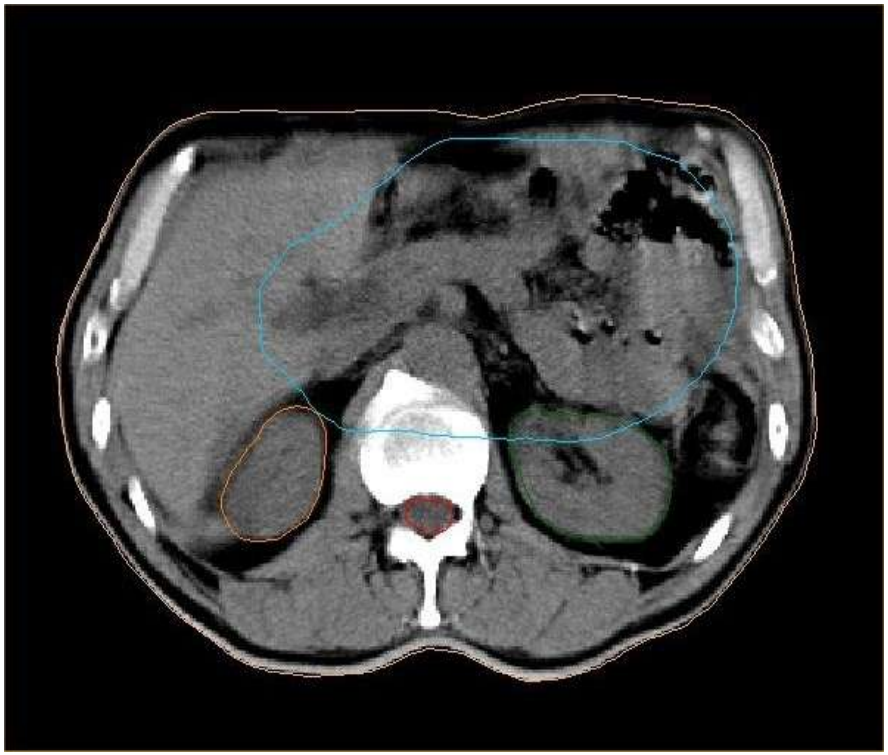
ZV-CT

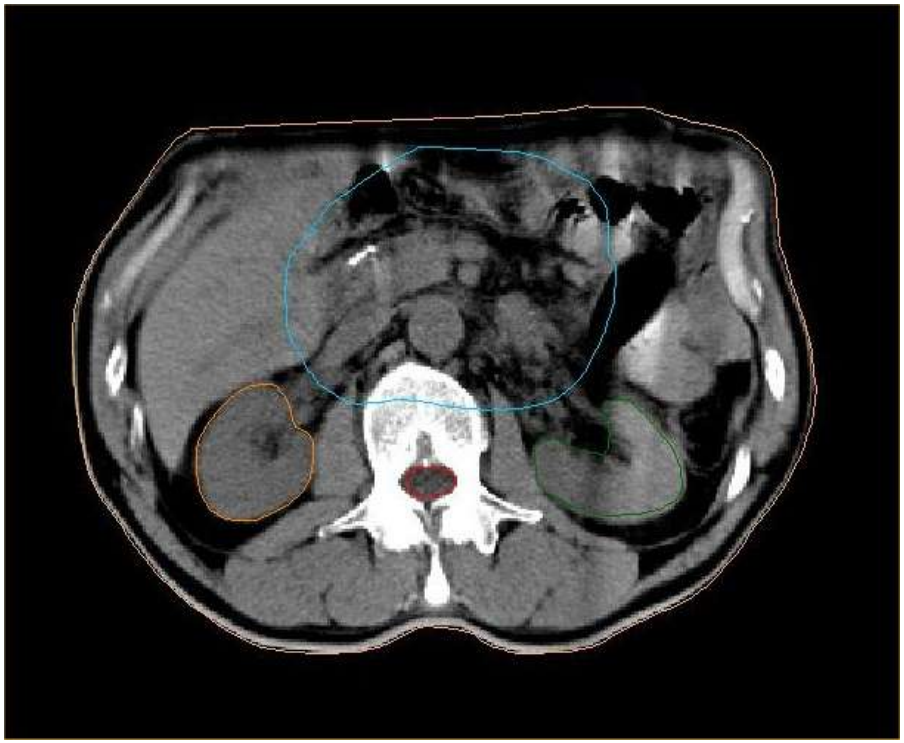


Prox. Magenloge/Milzhilus

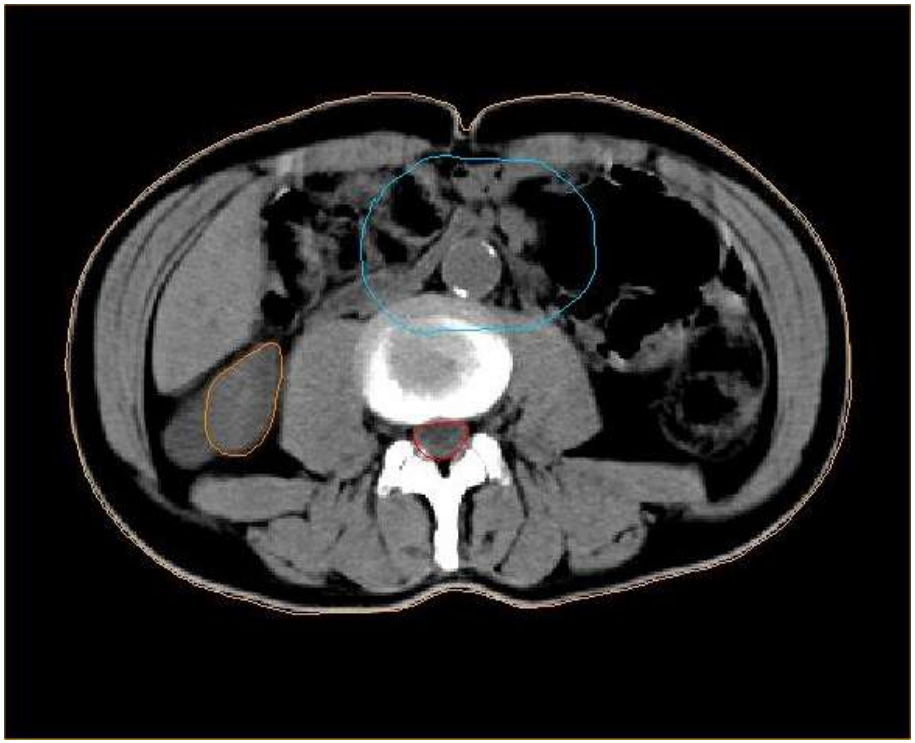


Leberpforte

ZV-CT

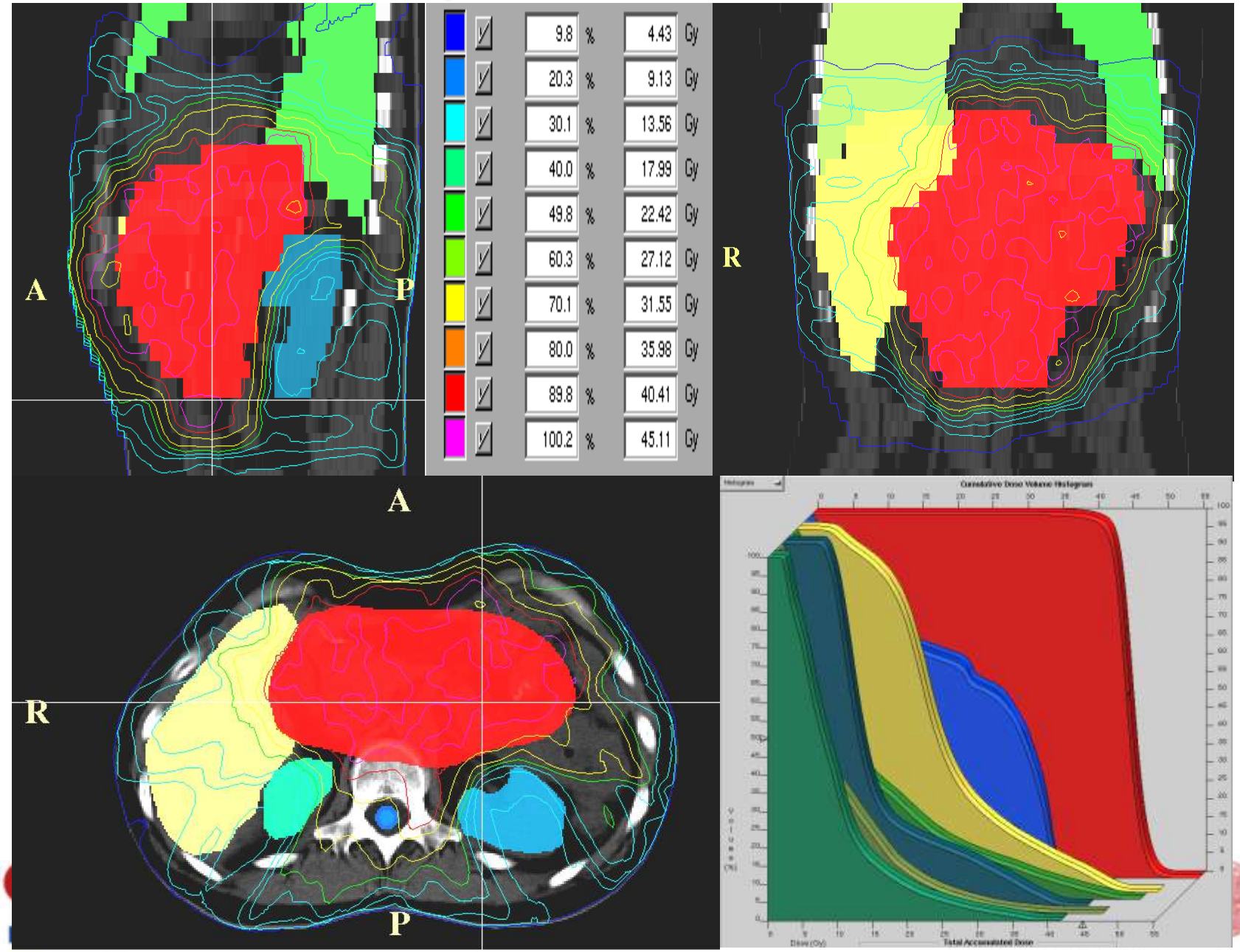


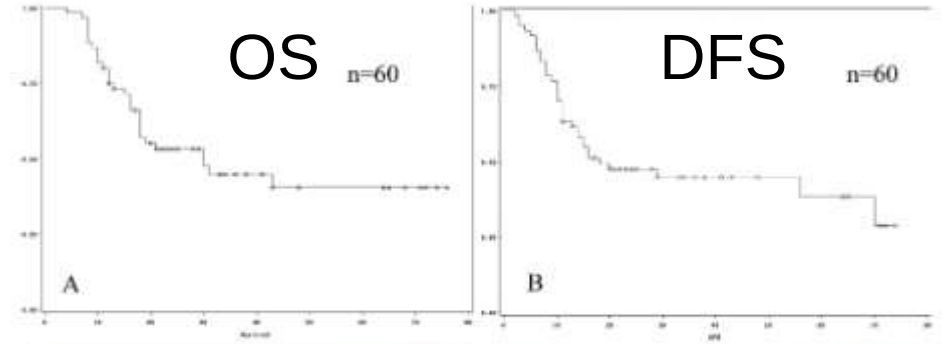
Distale Magenloge

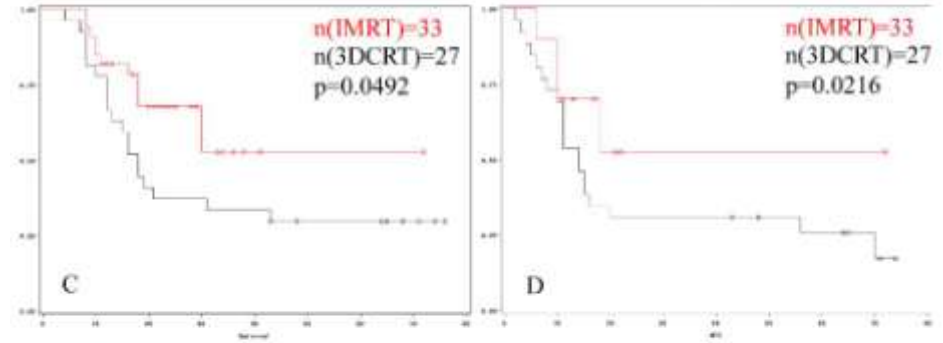


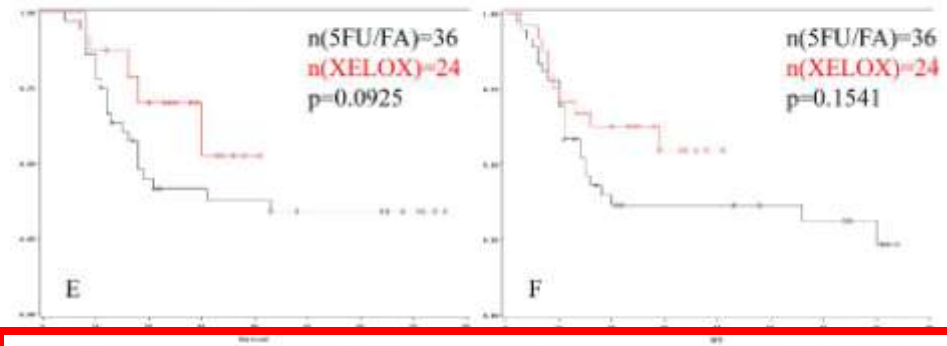
Paraaortal bis L3

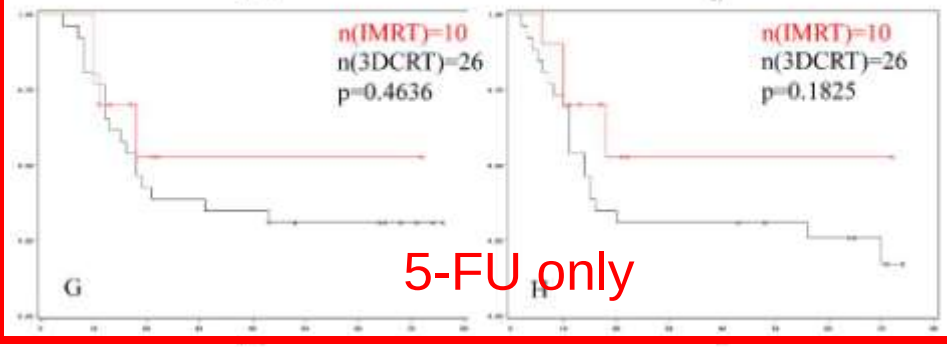
Step-and-shoot IMRT



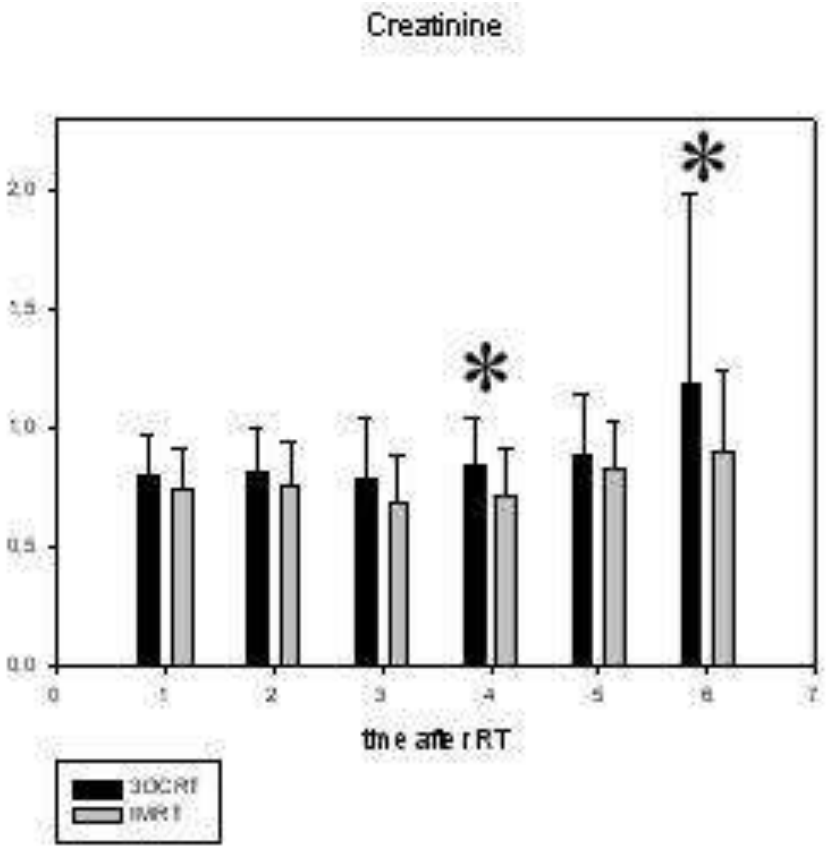








5-FU only



Boda-Heggemann et al., IJROBP, 2009

Lunge

FEMKE O. B. SPOELSTRA, M.D.,* SURESH SENAN, M.R.C.P., F.R.C.R., PH.D.,* CECILE LE PÉCHOUX, M.D.,† SATOSHI ISHIKURA, M.D., PH.D.,‡ FRANCESC CASAS, M.D.,§ DAVID BALL, M.B., B.S., M.D., F.R.A.N.Z.C.R.,¶ ALLAN PRICE, F.R.C.P., F.R.C.R., PH.D.,‖ DIRK DE RUYSSCHER, M.D., PH.D.,** AND JOHN R. VAN SÖRNSEN DE KOSTE, PH.D., * LUNG ADJUVANT RADIOTHERAPY TRIAL INVESTIGATORS GROUP

*Radiation Oncology, VU University Medical Center, Amsterdam, The Netherlands, †Radiation Oncology, Institut Gustave Roussy, Villejuif, France, ‡Clinical Trials and Practice Support Division, National Cancer Center, Tokyo, Japan, §Radiation Oncology, Hospital Clínic, Barcelona, Spain, ¶Radiation Oncology, Peter MacCallum Cancer Centre, Melbourne, Australia, ‖Radiation Oncology, Western General Hospital, Edinburgh, United Kingdom, and **Radiation Oncology (Maastro clinic), Maastricht University Medical Center, Grow, Maastricht, The Netherlands

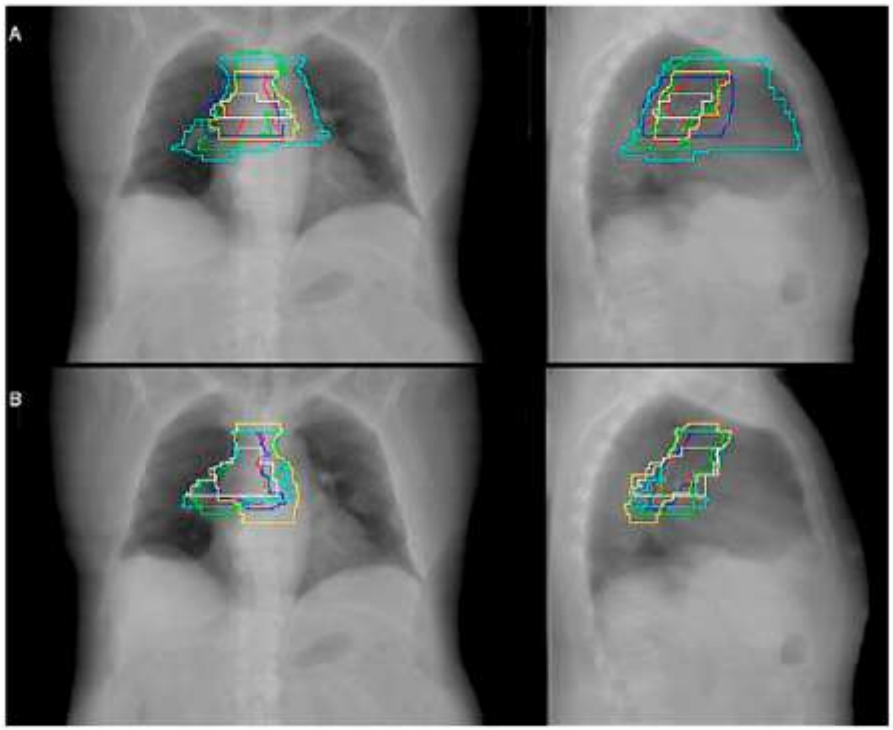


Fig. 1. Routine clinical target volumes (CTVs) (upper panel) and protocol CTVs (lower panel) from six observers projected on a digital reconstruction of a computed tomography dataset from the postlobectomy patient.

Target Volume Definition: Paradigm Shift

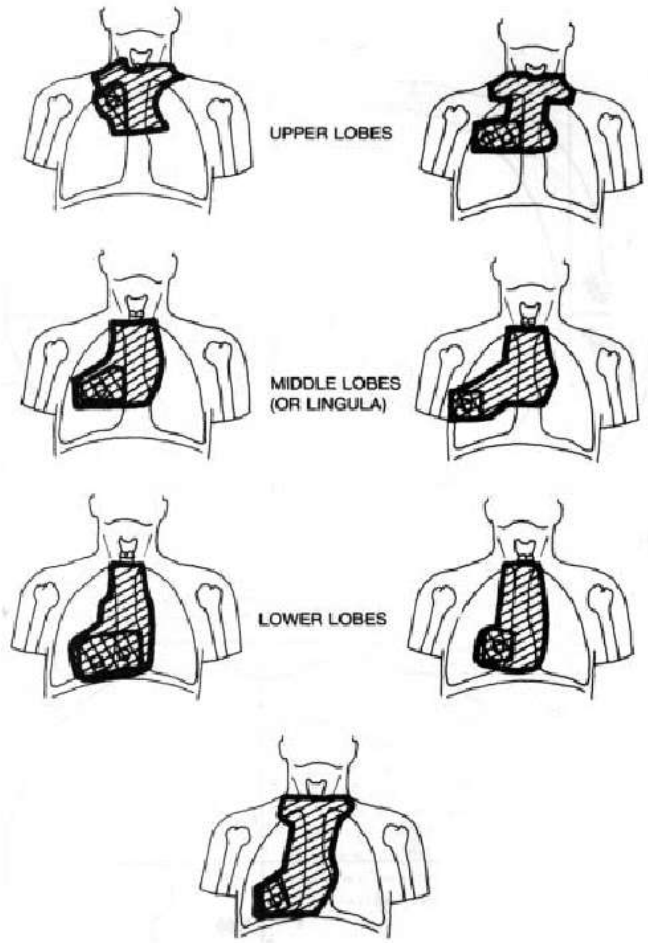


Figure 7. Traditional fields still recommended for different primary localizations for definitive [6].

Selection and Delineation of Lymph Node Target Volume for Lung Cancer Conformal Radiotherapy

Proposal for Standardizing Terminology Based on Surgical Experience

Ion Christian Kiricuta¹

Strahlenther Onkol 2001;177:410–23

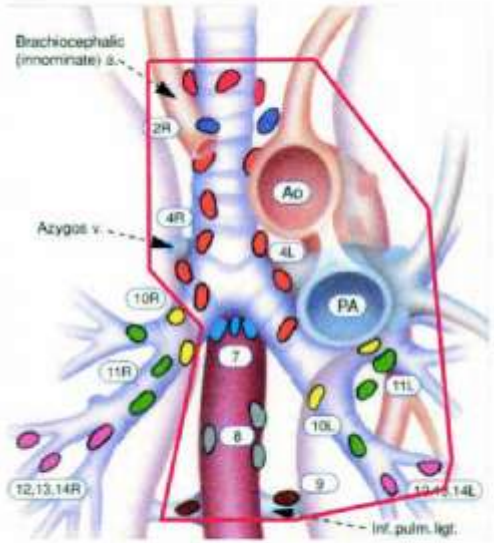


Figure 9a – Abbildung 9a

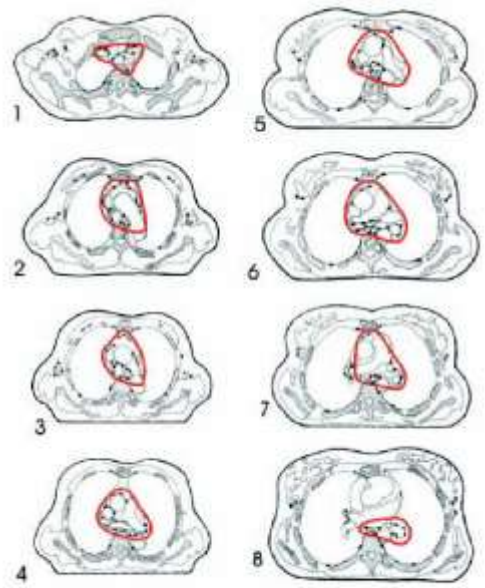
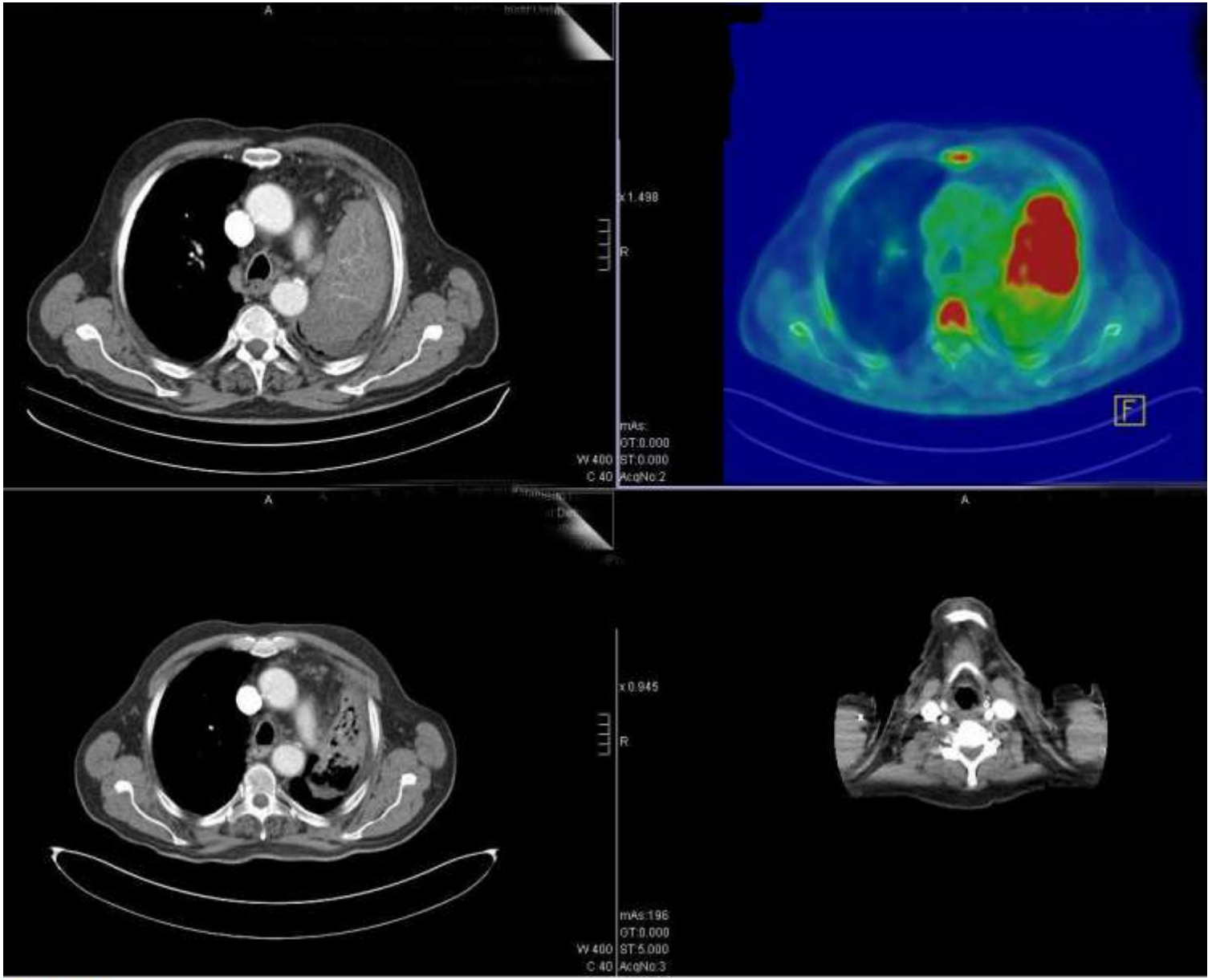


Figure 9b – Abbildung 9b

Figures 9a and 9b. The selection and delineation of the clinical target volume for postoperative radiotherapy for a nodal positive primary located in the lower left lung lobe: a) overview and b) CTV in CT slices (1–8) (included are the bronchial stump, the ipsilateral hilar, the subcarinal and the mediastinal lymph nodes).

Chao, Radiation Oncology, 2002



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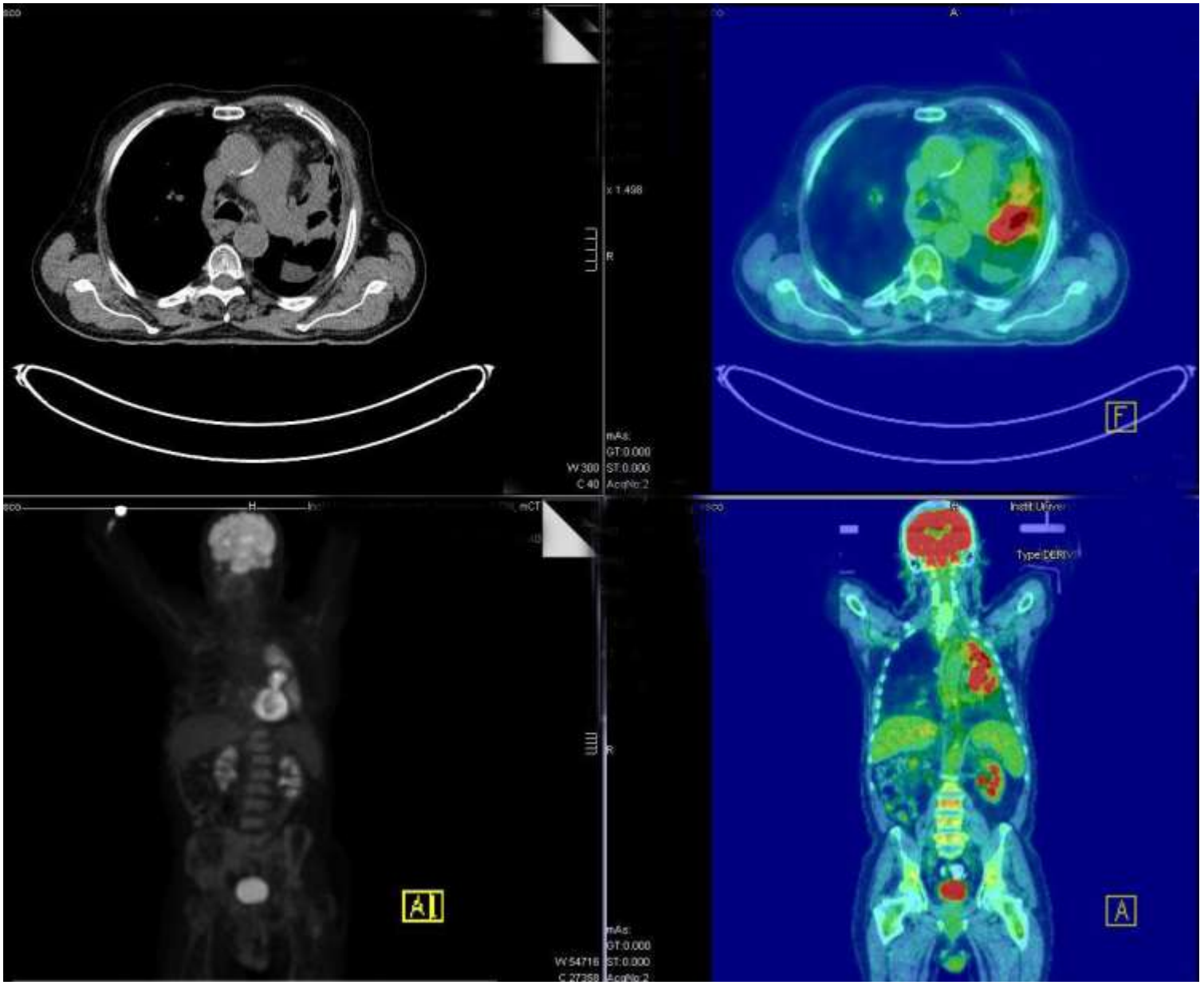

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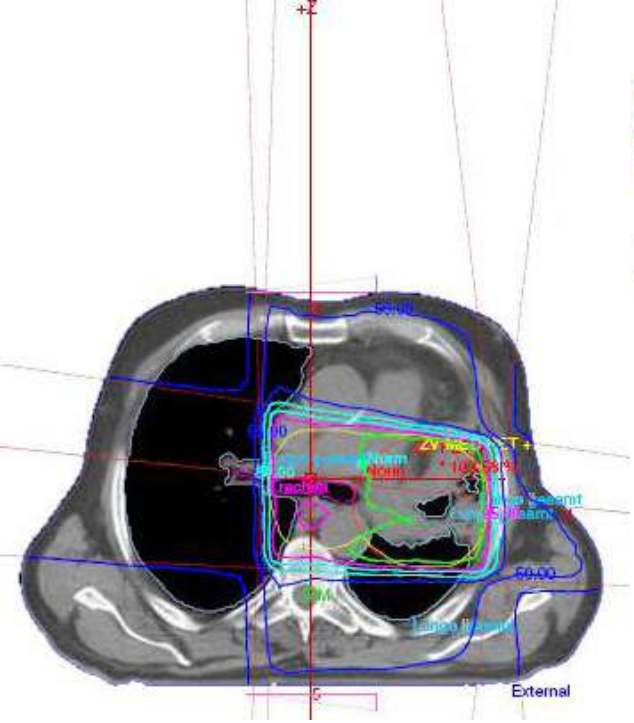

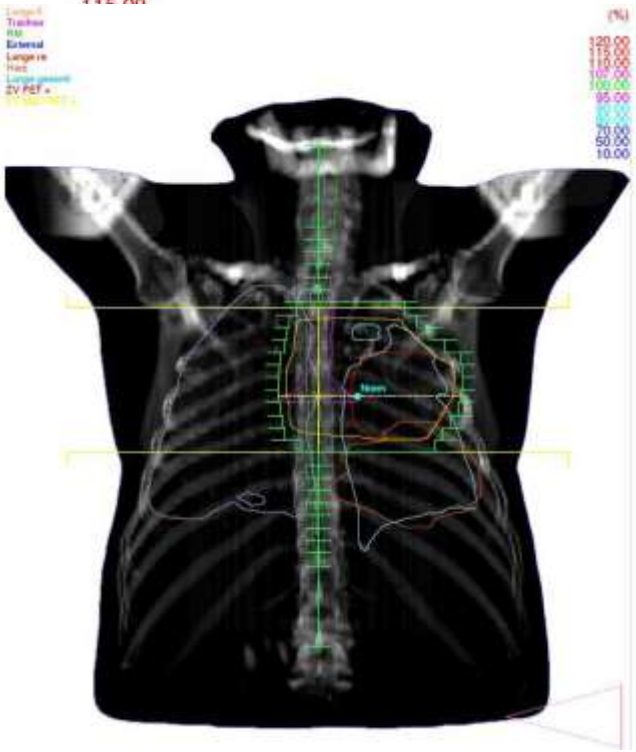

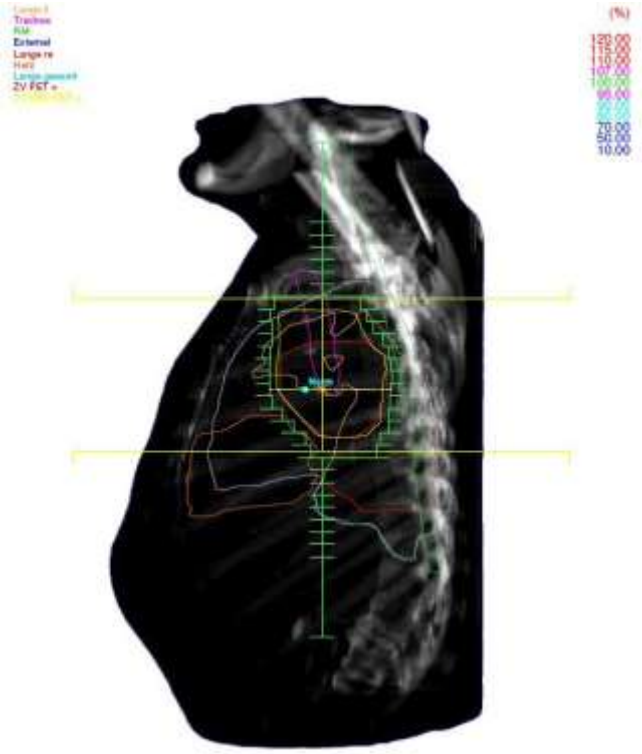

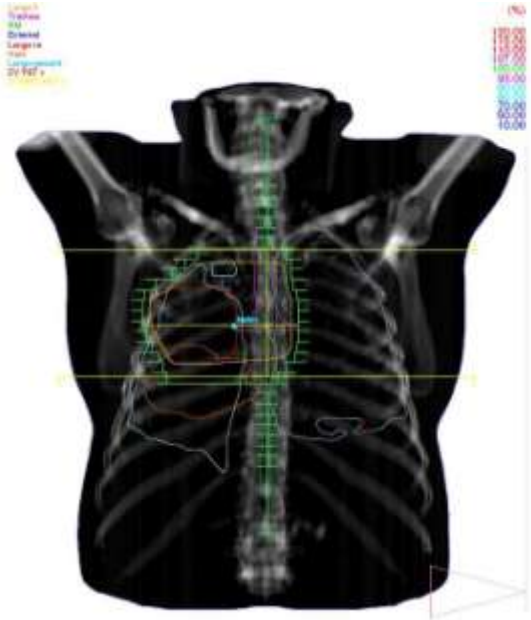

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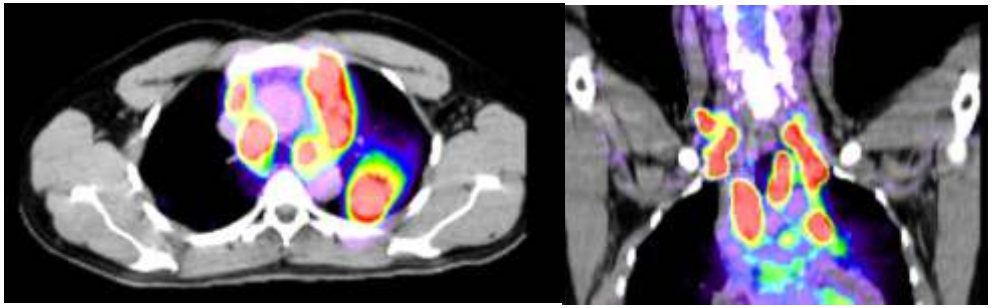
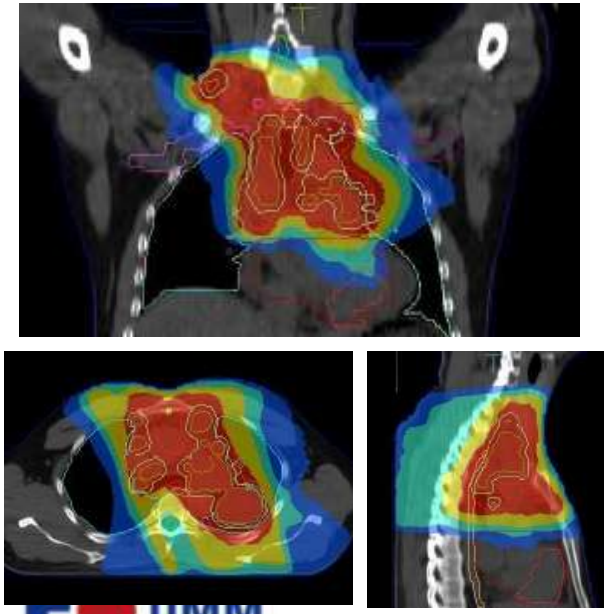
Bildgesteuerte, PET-gestützte Strahlentherapie beim Lungenkarzinom

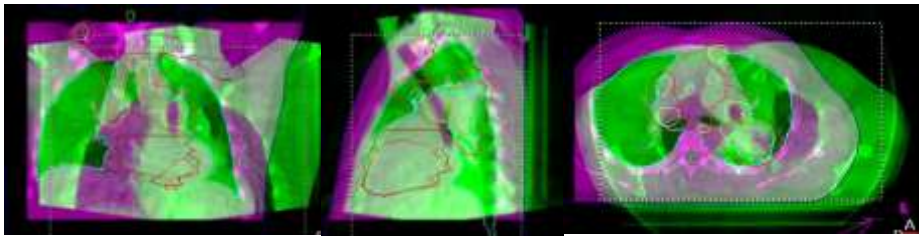
Zielvolumenminimierung und Bestrahlungsoptimierung bei ungünstigem Tumor-zu-Lungenvolumenverhältnis

1. Zielvolumendefinition/Minimierung auf Basis von funktioneller Bildgebung (PET-CT)

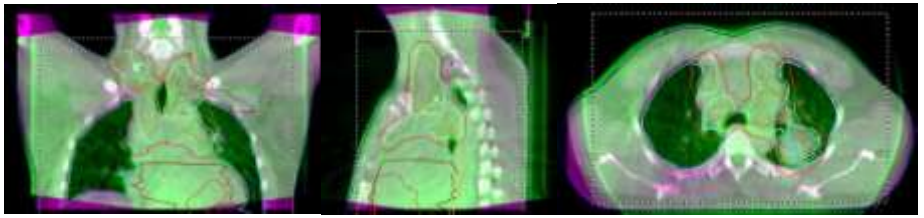




2. Bestrahlungsplanung als IMRT auf Basis einer Monte-Carlo Dosisberechnung

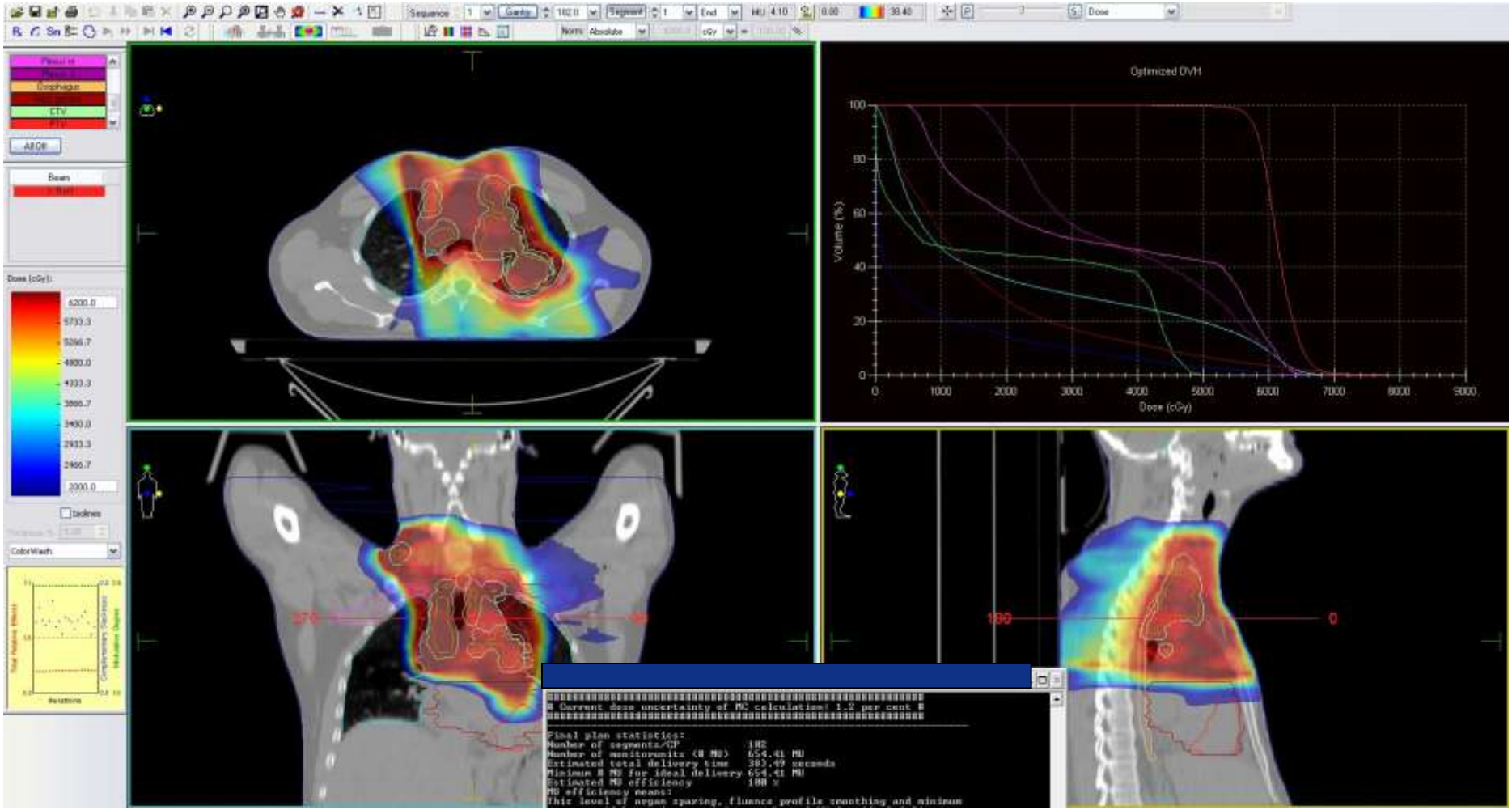


Unzureichende Positionierung



Optimale Positionierung

3. Bildgesteuerte Bestrahlung mittels Cone-Beam-CT am Beschleuniger

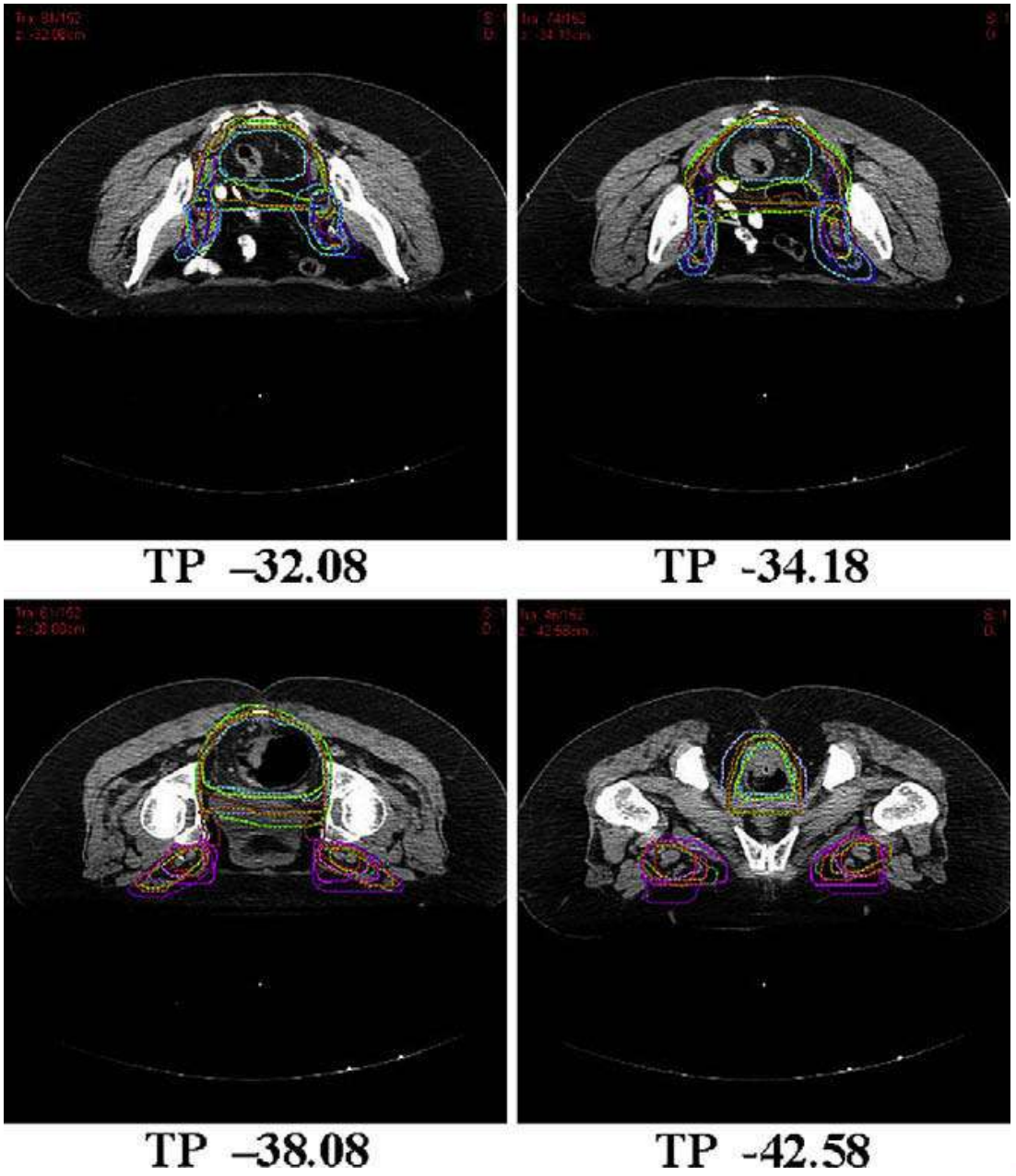

Optimized DVH
Volume (%)
Dose (cGy)
Final plan statistics:
Number of segments/CP 182
Number of monitorunits (8 MU) 654.41 MU
Estimated total delivery time 383.49 seconds
Minimum 8 MU for ideal delivery 654.41 MU
Estimated MU efficiency 100 %
MU efficiency means:
this level of organ sparing, fluence profile smoothing and minimum

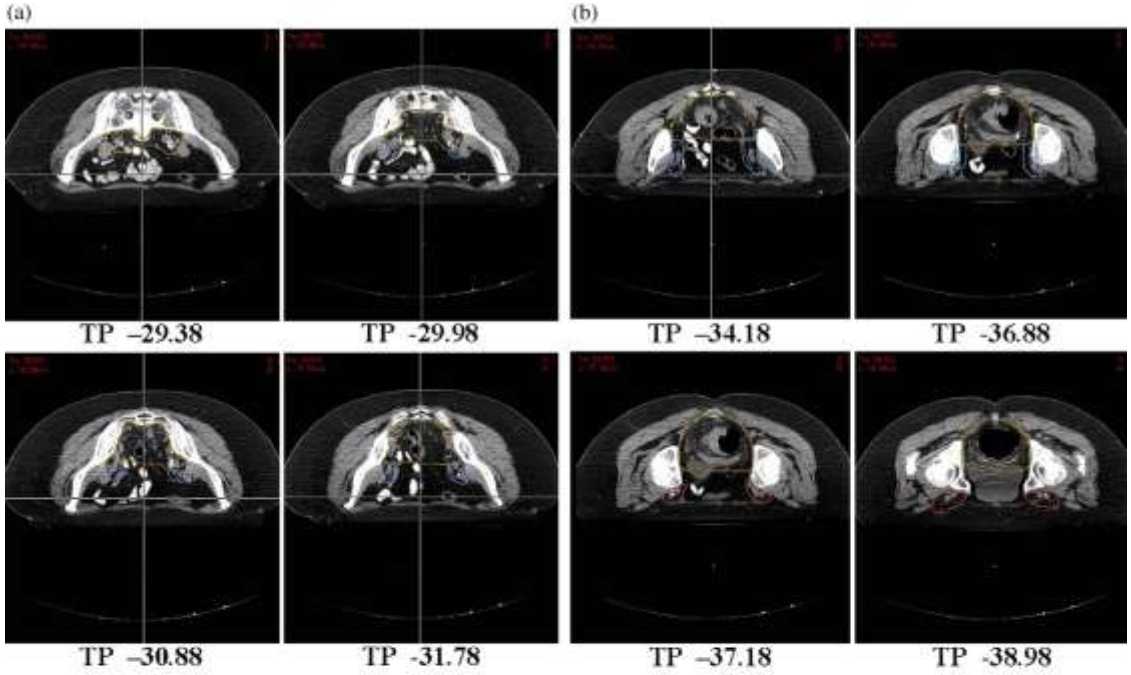
VMAT

Anus

Konsensus

Myerson et al.,
IJROBP, 2009





Konsensus

Myerson et al., IJROBP, 2009

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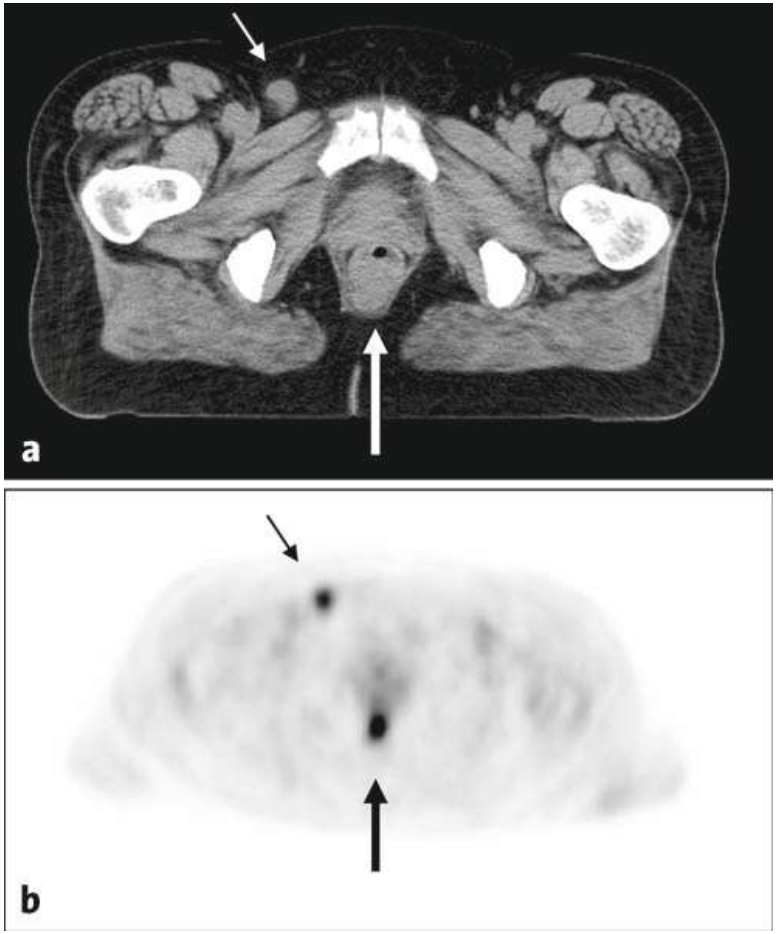

Mai et al.,
Str&Onk,2009

Schlussfolgerung: Eine Reduktion der Bestrahlungsdosis bei im CT vergroserten, aber PET-negativen inguinalen Lymphknoten scheint nicht mit einem erhohten Rezidivrisiko einherzugehen.