# Carcinoma Stomach

## *Radiation Oncology Perspective*

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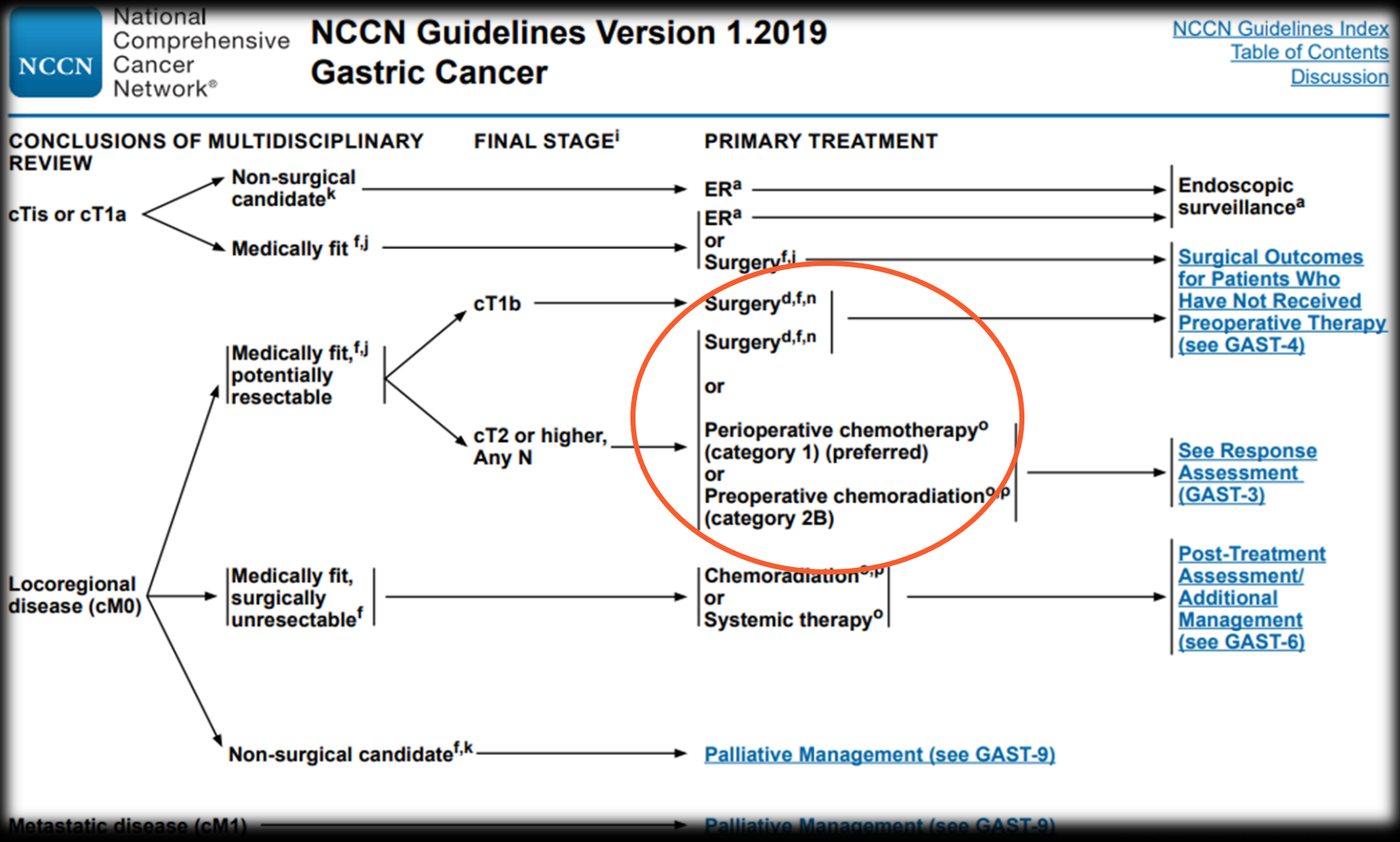
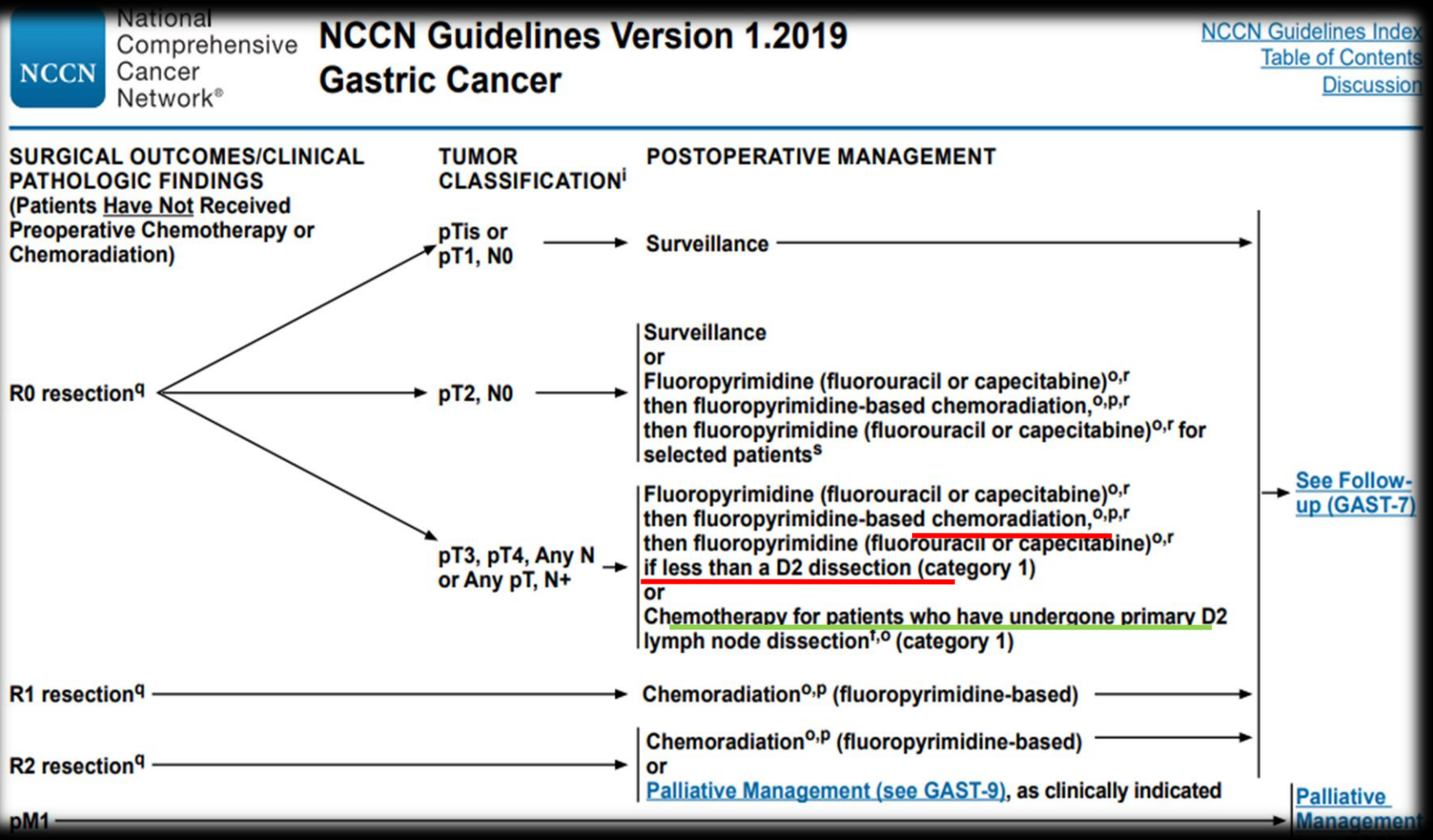
# 31st ICRO-AROI 2019

# Outline

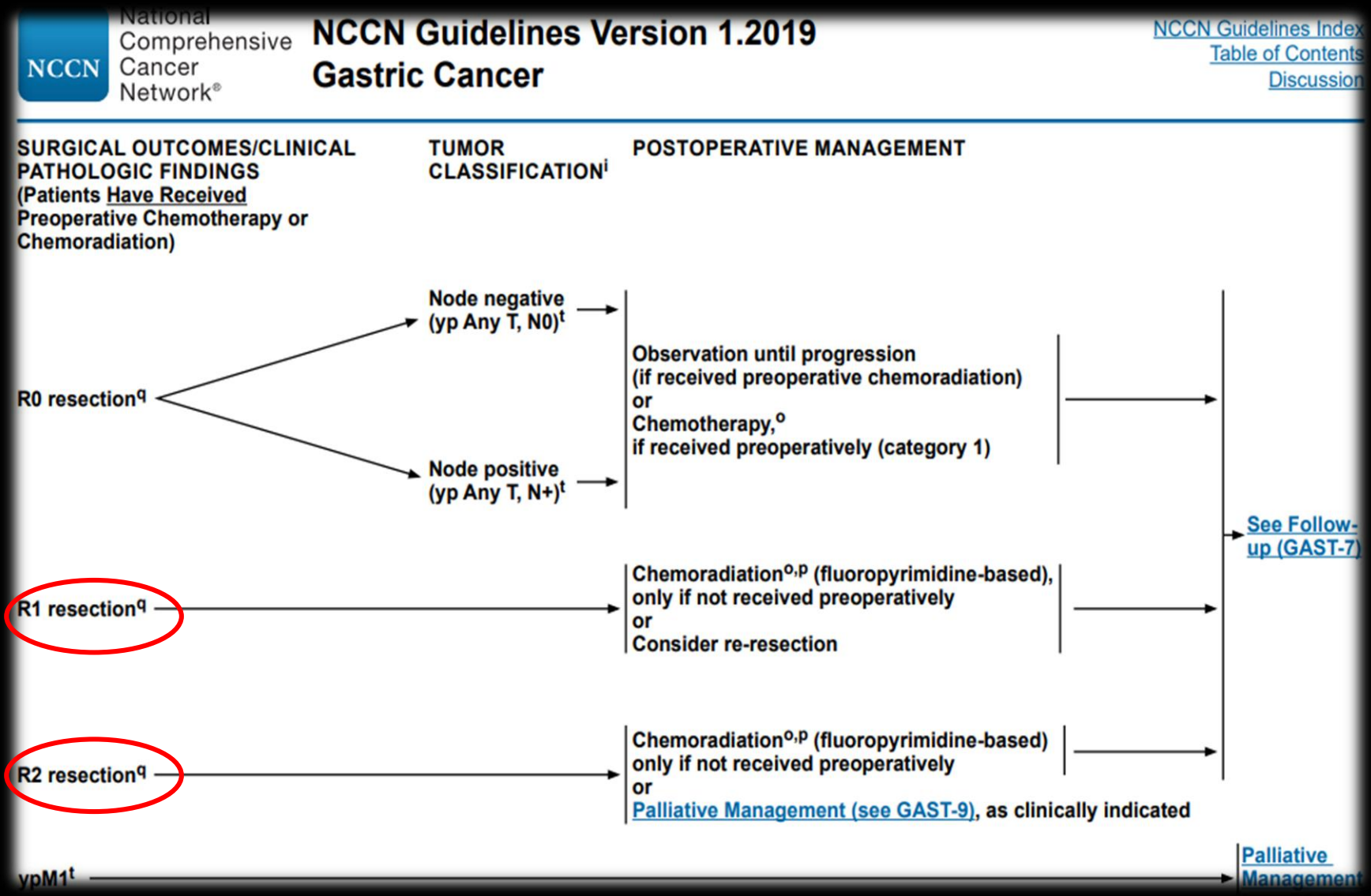
- Indications of Adjuvant Radiation
- CT Anatomy
- Target Delineation
- Plan Evaluation




# Resectable Ca Stomach




## Upfront Surgery




Pre-op Chemo/Chemorad

# D1 vs D2 Resection

*British Journal of Cancer* (1999) 79(9/10), 1522–1530

Article no. bjoc.1998.0243

## Patient survival after $D_1$ and $D_2$ resections for gastric cancer: long-term results of the MRC randomized surgical trial

**No difference in 5yr OS**

**Panc & Spleen removal a/w poor survival**

Joypaul[1], M Sydes[2] and P Fayers[2], for the Surgical

9SY, UK; [2]Cancer Division MRC Clinical Trials Unit, Cambridge, UK;
ospital, Salford, UK; [5]Kingstown General Hospital, St Vincents, Jamaica

**Summary** Controversy still exists on the optimal surgical resection for potentially curable gastric cancer. Much better long-term survival has been reported in retrospective/non-randomized studies with $D_2$ resections that involve a radical extended regional lymphadenectomy than with the standard $D_1$ resections. In this paper we report the long-term survival of patients entered into a randomized study, with follow-up to death or 3 years in 96% of patients and a median follow-up of 6.5 years. In this prospective trial $D_1$ resection (removal of regional perigastric nodes) was compared with $D_2$ resection (extended lymphadenectomy to include level 1 and 2 regional nodes). Central randomization followed a staging laparotomy.

Out of 737 patients with histologically proven gastric adenocarcinoma registered, 337 patients were ineligible by staging laparotomy because of advanced disease and 400 were randomized. The 5-year survival rates were 35% for $D_1$ resection and 33% for $D_2$ resection (difference –2%, 95% CI = –12%–8%). There was no difference in the overall 5-year survival between the two arms (HR = 1.10, 95% CI 0.87–1.39, where HR > 1 implies a survival benefit to $D_1$ surgery). Survival based on death from gastric cancer as the event was similar in the $D_1$ and $D_2$ groups (HR = 1.05, 95% CI 0.79–1.39) as was recurrence-free survival (HR = 1.03, 95% CI 0.82–1.29). In a multivariate analysis, clinical stages II and III, old age, male sex and removal of spleen and pancreas were independently associated with poor survival. These findings indicate that the classical Japanese $D_2$ resection offers no survival advantage over $D_1$ surgery. However, the possibility that $D_2$ resection without pancreatico-splenectomy may be better than standard $D_1$ resection cannot be dismissed by the results of this trial.

# Surgical treatment of gastric cancer: 15-year follow-up results of the randomised nationwide Dutch D1D2 trial

*Ilfet Songun, Hein Putter, Elma Meershoek-Klein Kranenbarg, Mitsuru Sasako, Cornelis J H van de Velde*

**Background** Historical data and recent studies show that standardised extended (D2) lymphadenectomy leads to better results than standardised limited (D1) lymphadenectomy. Based on these findings, the Dutch D1D2 trial, a nationwide prospectively randomised clinical trial, was undertaken to compare D2 with D1 lymphadenectomy in patients with resectable primary adenocarcinoma of the stomach. The aim of the study was to assess the effect of D2 compared with D1 surgery on disease recurrence and survival in patients treated with curative intent.

**Methods** Between August, 1989, and July, 1993, patients were entered and randomised at 80 participating hospitals by means of a telephone call to the central data centre of the trial. The sequence of randomisation was in blocks of six with stratification for the participating centre. Eligibility criteria were a histologically proven adenocarcinoma of the [illegible] physical condition for D1 [illegible] cancer or had undergone [illegible] were implemented and [illegible] trial register, as DUT-KWF-

D2 a/w:

- Lower LRR & gastric cancer related death
- Higher post-op mortality/morbidity/re-op rates

[illegible]. 711 patients underwent the [illegible] the D2 group) and 285 had palliative treatment. Data were collected prospectively and all patients were followed up for a median time of 15·2 years (range 6·9–17·9 years). Analyses were done for the 711 patients treated with curative intent and were according to the allocated treatment group. Of the 711 patients, 174 (25%) were alive, all but one without recurrence. Overall 15-year survival was 21% (82 patients) for the D1 group and 29% (92 patients) for the D2 group (p=0·34). Gastric-cancer-related death rate was significantly higher in the D1 group (48%, 182 patients) compared with the D2 group (37%, 123 patients), whereas death due to other diseases was similar in both groups. Local recurrence was 22% (82 patients) in the D1 group versus 12% (40 patients) in D2, and regional recurrence was 19% (73 patients) in D1 versus 13% (43 patients) in D2. Patients who had the D2 procedure had a significantly higher operative mortality rate than those who had D1 (n=32 [10%] *vs* n=15 [4%]; 95% CI for the difference 2–9; p=0·004), higher complication rate (n=142 [43%] *vs* n=94 [25%]; 11–25; p<0·0001), and higher reoperation rate (n=59 [18%] *vs* n=30 [8%]; 5–15; p=0·00016).

**Interpretation** After a median follow-up of 15 years, D2 lymphadenectomy is associated with lower locoregional recurrence and gastric-cancer-related death rates than D1 surgery. The D2 procedure was also associated with significantly higher postoperative mortality, morbidity, and reoperation rates. Because a safer, spleen-preserving D2 resection technique is currently available in high-volume centres, D2 lymphadenectomy is the recommended surgical approach for patients with resectable (curable) gastric cancer.

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See **Reflection and Reaction** page 404

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# CHEMORADIOTHERAPY AFTER SURGERY COMPARED WITH SURGERY ALONE FOR ADENOCARCINOMA OF THE STOMACH OR GASTROESOPHAGEAL JUNCTION

JOHN S. MACDONALD, M.D., STEPHEN R. SMALLEY, M.D., JACQUELINE BENEDETTI, PH.D., SCOTT A. HUNDAHL, M.D., NORMAN C. ESTES, M.D., GRANT N. STEMMERMANN, M.D., DANIEL G. HALLER, M.D., JAFFER A. AJANI, M.D., LEONARD L. GUNDERSON, M.D., J. MILBURN JESSUP, M.D., AND JAMES A. MARTENSON, M.D.

## ABSTRACT

***Background*** Surgical resection of adenocarcinoma of the stomach is curative in less than 40 percent of cases. We investigated the effect of surgery plus postoperative (adjuvant) chemoradiotherapy on the survival of patients with resectable adenocarcinoma of the stomach or gastroesophageal junction.

***Methods*** A total of 556 patients with resected adenocarcinoma of the stomach or gastroesophageal junction were randomly assigned to surgery plus postoperative chemoradiotherapy or surgery alone. The adjuvant treatment consisted of 425 mg of fluor-

**Significant improvement in OS and RFS**

**41% grade 3 toxicities**

per square meter per day) plus leucovorin (20 mg per square meter per day) were given one month apart.

***Results*** The median overall survival in the surgery-only group was 27 months, as compared with 36 months in the chemoradiotherapy group; the hazard ratio for death was 1.35 (95 percent confidence interval, 1.09 to 1.66; P=0.005). The hazard ratio for relapse was 1.52 (95 percent confidence interval, 1.23 to 1.86; P<0.001). Three patients (1 percent) died from toxic effects of the chemoradiotherapy; grade 3 toxic effects occurred in 41 percent of the patients in the chemoradiotherapy group, and grade 4 toxic effects occurred in 32 percent.

***Conclusions*** Postoperative chemoradiotherapy should be considered for all patients at high risk for recurrence of adenocarcinoma of the stomach or gastroesophageal junction who have undergone curative resection. (N Engl J Med 2001;345:725-30.)



with more advanced disease ranged from 3 percent to 42 percent, depending on the extent of disease.[2]

The high rate of relapse after resection makes it important to consider adjuvant treatment for patients with stomach cancer. However, adjuvant chemotherapy has not resulted in higher survival rates than surgery alone.[3-5]

Local or regional recurrence in the gastric or tumor bed, the anastomosis, or regional lymph nodes occurs in 40 to 65 percent of patients after gastric resection with curative intent.[6-9] The frequency of such relapses makes regional radiation an attractive possibility for adjuvant therapy. A phase 3 trial[10] found clinically limited but statistically significant improvement (P=0.009) in survival after preoperative regional radiotherapy in patients with cancer of the gastric cardia. Small phase 3 trials have suggested that survival is improved after postoperative radiation, with or without fluorouracil,[11] and after intraoperative radiation.[12]

Phase 3 trials have found that 12 to 20 percent of patients with residual or locally unresectable gastric cancer are long-term survivors after treatment with radiation plus fluorouracil.[13,14] We undertook a study to determine the efficacy of chemoradiotherapy in patients with resected gastric cancer. The trial was initiated in 1991 to compare surgery followed by fluorouracil plus irradiation of the gastric bed and regional lymph nodes with surgery alone.

## METHODS

### Eligibility

The eligibility criteria included histologically confirmed adenocarcinoma of the stomach or gastroesophageal junction; complete resection of the neoplasm, defined as resection performed with curative intent and resulting in resection of all tumor with the margins of the resection testing negative for carcinoma; a classification of the resected adenocarcinoma of the stomach or gastro-

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JOURNAL OF CLINICAL ONCOLOGY

ORIGINAL REPORT

# Updated Analysis of SWOG-Directed Intergroup Study 0116: A Phase III Trial of Adjuvant Radiochemotherapy Versus Observation After Curative Gastric Cancer Resection

*Stephen R. Smalley, Jacqueline K. Benedetti, Daniel G. Haller, Scott A. Hundahl, Norman C. Estes, Jaffer A. Ajani, Leonard L. Gunderson, Bryan Goldman, James A. Martenson, J. Milburn Jessup, Grant N. Stemmermann,† Charles D. Blanke, and John S. Macdonald*

See accompanying editorial on page 2297

Stephen R. Smalley, Radiation Oncology

**>10 yr median f/u –**

- **Sig.improvement in RFS&OS**
- **Similar distant relapse rates**
- **9.6% D2 dissection, 36% D1**
- **Lower OS rates in diffuse histology (40% pts)**

ABSTRACT

ed suboptimal survival despite multiple randomized
or more aggressive surgical procedures. We
operative radiochemotherapy in those at moderate
rgery. We originally reported results with 4-year
than 10-year median follow-up, presents data on
explores selected subset analyses.

d/or node-positive gastric cancer were randomly
rapy after R0 resection. Fluorouracil and leucovorin
diotherapy. Radiotherapy was given to all LRF sites

(RFS) data demonstrate continued strong benefit
hazard ratio (HR) for OS is 1.32 (95% CI, 1.10 to
(95% CI, 1.25 to 1.83; $P < .001$). Adjuvant
duction in both overall relapse and locoregional
d in 21 patients with radiotherapy versus eight
show robust treatment benefit in most subsets,
histology who exhibited minimal nonsignificant

**Conclusion**

Intergroup 0116 (INT-0116) demonstrates strong persistent benefit from adjuvant radiochemotherapy. Toxicities, including second malignancies, appear acceptable, given the magnitude of RFS and OS improvement. LRF reduction may account for the majority of overall relapse reduction. Adjuvant radiochemotherapy remains a rational standard therapy for curatively resected gastric cancer with primaries T3 or greater and/or positive nodes.

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of interest and author contributions are found at the end of this article.

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JOURNAL OF CLINICAL ONCOLOGY

ORIGINAL REPORT

# Phase III Trial Comparing Capecitabine Plus Cisplatin Versus Capecitabine Plus Cisplatin With Concurrent Capecitabine Radiotherapy in Completely Resected Gastric Cancer With D2 Lymph Node Dissection: The ARTIST Trial

*Jeeyun Lee, Do Hoon Lim, Sung Kim, Se Hoon Park, Joon Oh Park, Young Suk Park, Ho Yeong Lim, Min Gew Choi, Tae Sung Sohn, Jae Hyung Noh, Jae Moon Bae, Yong Chan Ahn, Insuk Sohn, Sin Ho Jung, Cheol Keun Park, Kyoung-Mee Kim, and Won Ki Kang*

- **D2 dissection**
- **XP arm vs XP/XPRT/XP arm**
- **Remnant stomach not routinely included in fields**
- **No 3DCRT or IMRT**

**Results:**

**No sig difference in DFS**

**Sig better DFS in pN+**

A C T

mach Cancer) trial was the first study to our hemoradiotherapy therapy in patients with ode dissection. This trial was designed to us cisplatin (XP) versus XP plus radiotherapy

2,000 mg/m$^2$ per day on days 1 to 14 and eeks) chemotherapy. The XP/XRT/XP arm ecitabine 1,650 mg/m$^2$ per day for 5 weeks)

e XP arm and 230 to the XP/XRT/XP arm. tients (172 of 228) in the XP arm and 81.7% dition of XRT to XP chemotherapy did not 0862). However, in the subgroup of patients of surgery (n = 396), patients randomly ior DFS when compared with those who ficance was retained at multivariate analysis .9952; *P* = .0471).

The addition of XRT to XP chemotherapy did not significantly reduce recurrence after curative resection and D2 lymph node dissection in gastric cancer. A subsequent trial (ARTIST-II) in patients with lymph node–positive gastric cancer is planned.

Corresponding author: Won Ki Kang, MD, PhD, Division of Hematology-Oncology, Department of Medicine, Samsung Medical Center, Sungkyunkwan University School of Medicine, 50

*J Clin Oncol 30:268-273.* 

VOLUME 33 · NUMBER 28 · OCTOBER 1 2015

JOURNAL OF CLINICAL ONCOLOGY

ORIGINAL REPORT

# Phase III Trial to Compare Adjuvant Chemotherapy With Capecitabine and Cisplatin Versus Concurrent Chemoradiotherapy in Gastric Cancer: Final Report of the Adjuvant Chemoradiotherapy in Stomach Tumors Trial, Including Survival and Subset Analyses

*...o Hoon Lim, Min Eui Hong, Kyoung-Mee Kim, Insuk Sohn, ...e Moon Bae, Sung Kim, Seung Tae Kim, Joon Oh Park, ...i Kang*

...082 and article on page 3085

- **7 yrs f/u, similar OS & DFS**
- **Similar distant relapse rates**
- **LRR more in XP arm, 13% vs 7%, p=0.003**

A B S T R A C T

...omach Tumors (ARTIST) trial tested whether the addition of ...y improved disease-free survival (DFS) in patients with

**Patients and Methods**

Between November 2004 and April 2008, 458 patients with GC who received gastrectomy with D2 lymph node dissection were randomly assigned to either six cycles of adjuvant chemotherapy with capecitabine and cisplatin (XP) or to two cycles of XP followed by chemoradiotherapy and then two additional cycles of XP (XPRT). This final update contains the first publication of overall survival (OS), together with updated DFS and subset analyses.

**Results**

With 7 years of follow-up, DFS remained similar between treatment arms (hazard ratio [HR], 0.740; 95% CI, 0.520 to 1.050; $P = .0922$). OS also was similar (HR, 1.130; 95% CI, 0.775 to 1.647; $P = .5272$). The effect of the addition of radiotherapy on DFS and OS differed by Lauren classification (interaction $P = .04$ for DFS; interaction $P = .03$ for OS) and lymph node ratio (interaction $P < .01$ for DFS; interaction $P < .01$ for OS). Subgroup analyses also showed that chemoradiotherapy significantly improved DFS in patients with node-positive disease and with intestinal-type GC. There was a similar trend for DFS and OS by stage of disease.

**Conclusion**

In D2-resected GC, both adjuvant chemotherapy and chemoradiotherapy are tolerated and equally beneficial in preventing relapse. Because results suggest a significant DFS effect of chemoradiotherapy in subsets of patients, the ARTIST 2 trial evaluating adjuvant chemotherapy and chemoradiotherapy in patients with node-positive, D2-resected GC is under way.

SMO-1131311.

Both S.H.P. and T.S.S. contributed equally to this work.

Presented in part at the 50th Annual Meeting of the American Society of Clinical Oncology, May 30-June 3, 2014, Chicago, IL.

Clinical trial information: NCT00323830

Authors' disclosures of potential conflicts of interest are found in the article online at www.jco.org. Author contributions are found at the end of this article.

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No RT

ARTIST TRIAL

No RT

# ARTIST Trial
# Critical Analysis!!

# ARTIST Trial

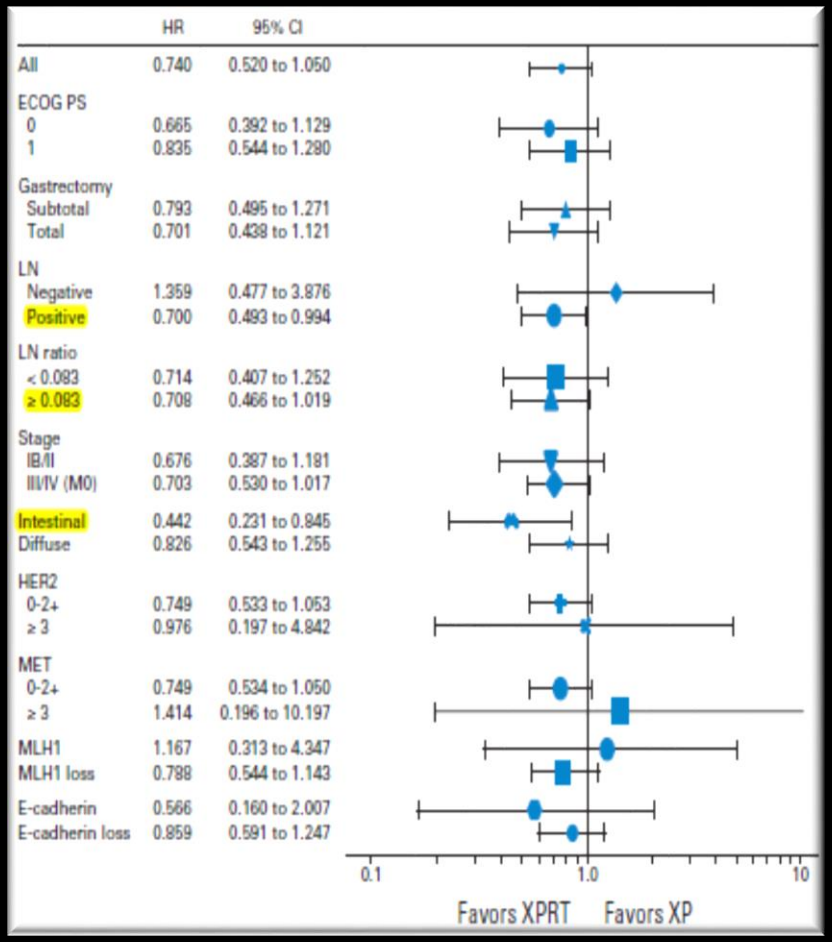
## High proportion of early stage & diffuse type gastric cancer

- 60% in stage Ib/II (15% node negative)
- 60% diffuse type

## Subgroup Analysis

**Chemoradiotherapy beneficial in –**

- Node positive disease
- Intestinal type GC
- Higher lymph node ratio




**HRs for DFS**

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Original article

Effects of adjuvant radiotherapy on completely resected gastric cancer: A radiation oncologist's view of the ARTIST randomized phase III trial

Jeong Il Yu [a], Do Hoon Lim [a,*], Yong Chan Ahn [a], Jeeyun Lee [b], Won Ki Kang [b], Se Hoon Park [b], Joon Oh Park [b], Young Suk Park [b], Ho Yeong Lim [b], Seung Tae Kim [b], Sung Kim [c], Tae Sung Sohn [c], Min Gew Choi [c], Jae Moon Bae [c], Heerim Nam [d]

[a] Department of Radiation Oncology; [b] Department of Medicine; [c] Department of Surgery, Samsung Medical Center; and [d] Department of Radiation Oncology, Kangbuk Samsung Hospital, Sungkyunkwan University School of Medicine, Seoul, Republic of Korea

- **Regional nodes and/or Tumor Bed within RT fields**
- **Remnant stomach not routinely encompassed**
- **Duodenal stump/Anastomotic site included if margins<3cm**
- **Group 2 LNs - common hepatic, celiac, splenic, hepatoduodenal**
  **Group 3 LNs – Posterior panc head, sup.mesentric, paraaortic**
- **Dose – 45Gy/5 weeks**
- **No 3DCRT or IMRT**

- 22 pts, 11 in each arm
- Common in
  >pT1
  PNI +
  Signet ring/P.D. adeno
- 9.7% vs 2.3% LR in pts. with all 3 factors

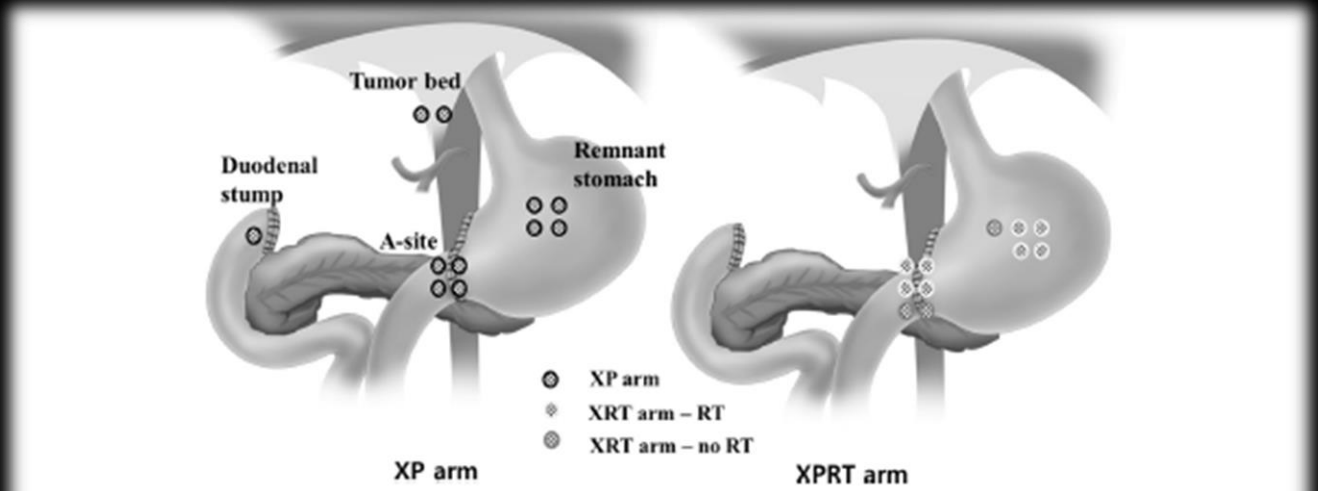



Fig. 1. Patterns of local recurrence. Tumor recurrence at the anastomosis site (10, 2.2%), remnant stomach (9, 2.0%), tumor bed (2, 0.4%), and duodenal stump (1, 0.2%).

- 25/28 rec.in XP arm
- Most rec.in group 3 LNs

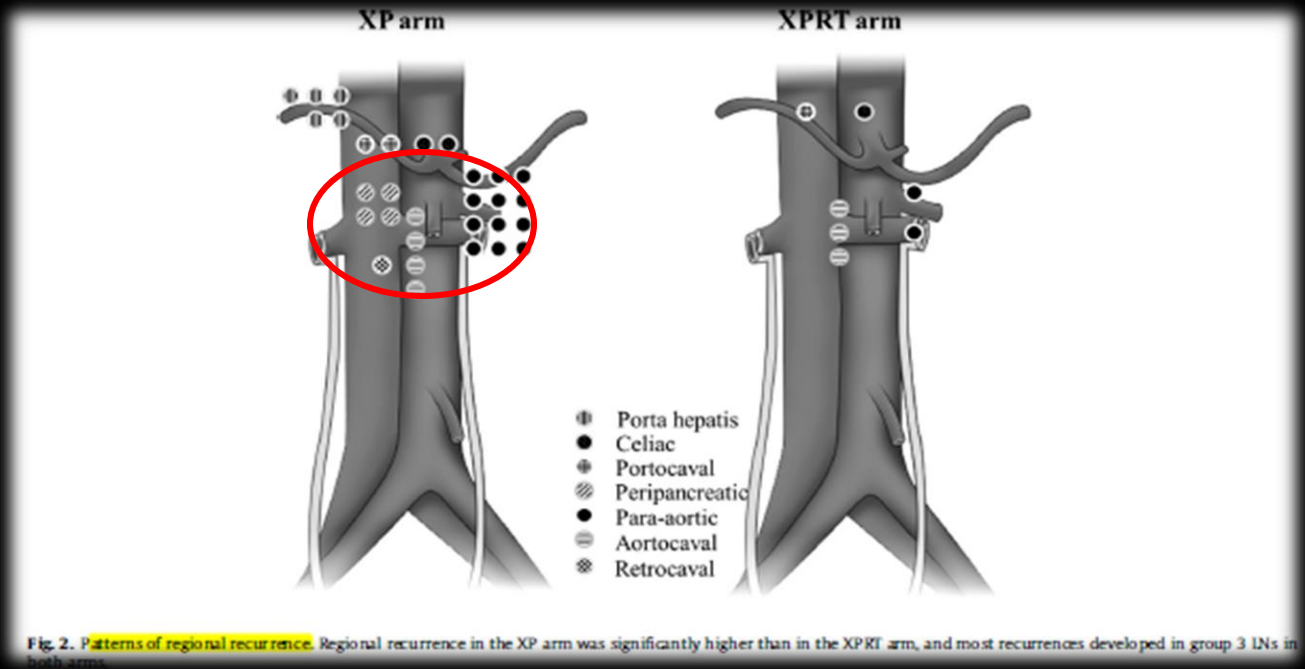
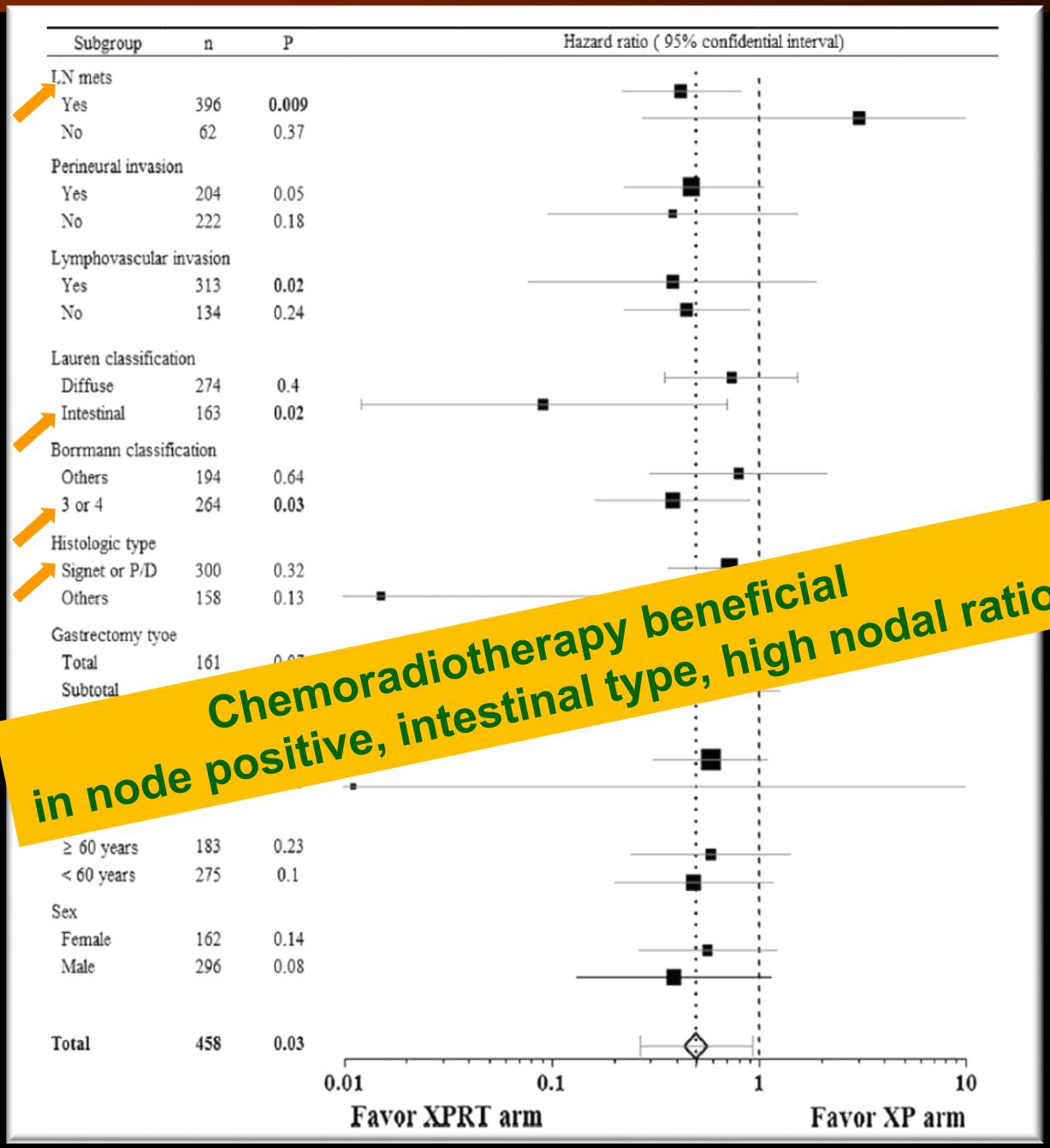



Fig. 2. Patterns of regional recurrence. Regional recurrence in the XP arm was significantly higher than in the XPRT arm, and most recurrences developed in group 3 LNs in both arms.




**Chemoradiotherapy beneficial in node positive, intestinal type, high nodal ratio**

Radiotherapy and Oncology xxx (2015) xxx–xxx

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Original article

# Effects of adjuvant radiotherapy on completely resected gastric cancer: A radiation oncologist's view of the ARTIST randomized phase III trial

Jeong Il Yu [a], Do Hoon Lim [a,*], Yong Chan Ahn [a], Jeeyun Lee [b], Won Ki Kang [b], Se Hoon Park [b], Joon Oh Park [b], Young Suk Park [b], Ho Yeong Lim [b], Seung Tae Kim [b], Sung Kim [c], Tae Sung Sohn [c], Min Gew Choi [c], Jae Moon Bae [c], Heerim Nam [d]

[a] Department of Radiation Oncology; [b] Department of Medicine; [c] Department of Surgery, Samsung Medical Center; and [d] Department of Radiation Oncology, Kangbuk Samsung Hospital, Sungkyunkwan University School of Medicine, Seoul, Republic of Korea

In conclusion, adjuvant XPRT significantly prolonged LRRFS in completely D2 resected gastric cancer patients, and adjuvant XPRT had a large effect on LRRFS in patients with LN metastasis. The regional area (LNs in groups 2 and 3 including the para-aortic, retropancreatic, aortocaval, retrocaval region) might be the most important RT target, and local area could be considered when determining RT targets in strictly limited patients. The combination of RT and chemotherapy was well tolerated without an increased risk of complications. The ARTIST-II trial is ongoing.

Gastrectomy with D2 lymph node dissection is the standard treatment for curable gastric cancer in eastern Asia. In Western countries, extended dissection of distant lymph nodes contributes to accurate staging of the disease; however, its contribution to the prolongation of survival is unclear.[71,110,113] Initial results from two large randomized trials performed in

For patients with localized resectable gastric cancer, the NCCN Guidelines recommend gastrectomy with a D1 or a modified D2 lymph node dissection, with a goal of examining ≥15 lymph nodes.[110,116,120,121] The guidelines emphasize that D2 lymph node dissection should be performed by experienced surgeons in high-volume centers. Routine or prophylactic pancreatectomy is not recommended with D2 lymph node dissection,[106,125] and splenectomy is acceptable only when the spleen or hilum is involved.

## Patients who have not received pre-op chemotherapy

The benefit of postoperative chemoradiation for patients who have not received preoperative therapy has been established in randomized studies.[191,192,194,195] Therefore, postoperative chemoradiation is recommended for all patients following an R1 or R2 resection, patients with pT3-pT4, any N or any pT, N+ tumors who received less than a D2 dissection (category 1), and select high-risk patients with pT2, N0 tumors following an R0 resection. High-risk features include poorly differentiated or higher grade cancer, LVI, neural invasion, age <50 years, and not undergoing D2 lymph node dissection.[281] Palliative management, as clinically indicated, is an alternate option for patients with R2 resection.

fluorouracil or capecitabine before and after fluoropyrimidine-based chemoradiation. Patients with pT3-pT4, any N or any pT, N+ tumors who have undergone primary D2 lymph node dissection may alternatively receive chemotherapy (category 1).[204,205]

## Perioperative Chemotherapy

Patients who have received preoperative chemoradiation should be observed until disease progression following R0 resection, regardless of tumor stage or nodal status. However, patients who have received preoperative chemotherapy could receive postoperative chemotherapy following R0 resection (category 1). In the absence of distant metastases, chemoradiation is recommended for patients with R1 or R2 resection, only

# Adjuvant Radiotherapy in D2 Dissections??

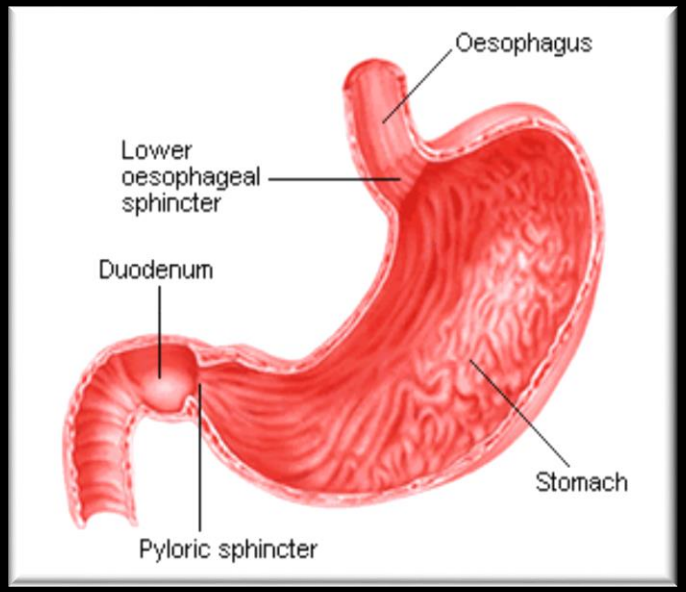
***Risk stratification is the key***
***ARTIST II Trial ongoing***

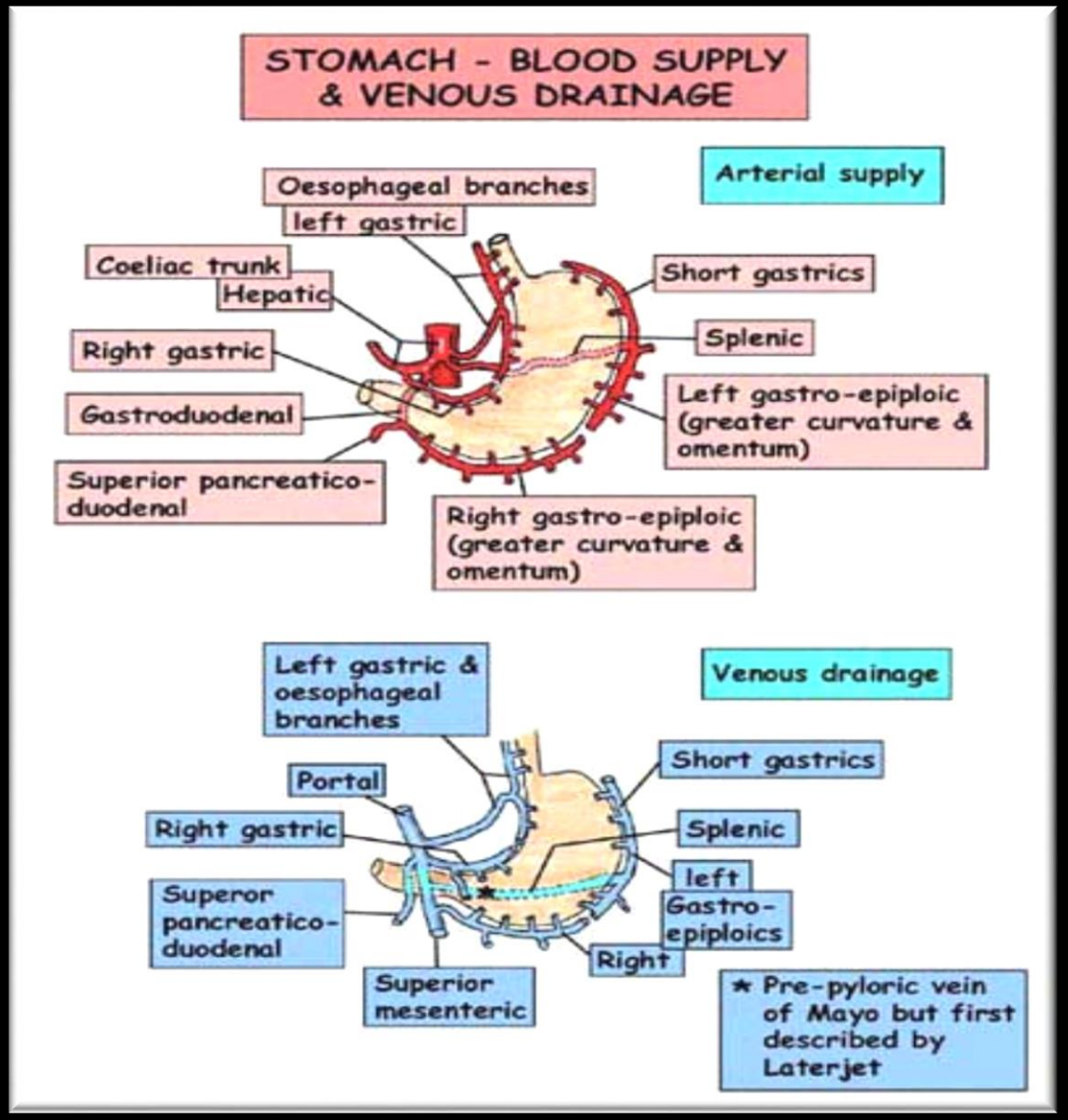
# RADIOTHERAPY PLANNING IN CARCINOMA STOMACH

# Relevant Anatomy

**Gross**

- **Relations**
- **Arterial/Lymphatic supply**



# Lymphatic Drainage

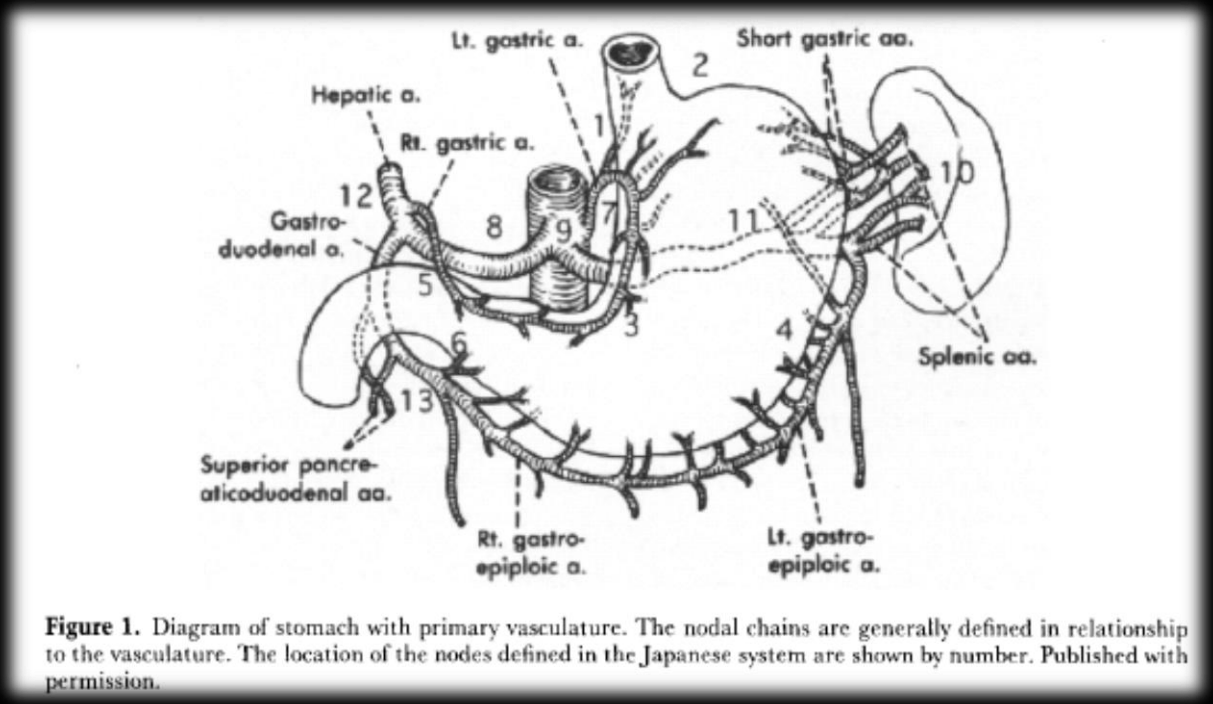



**Figure 1.** Diagram of stomach with primary vasculature. The nodal chains are generally defined in relationship to the vasculature. The location of the nodes defined in the Japanese system are shown by number. Published with permission.

**1/2- Paracardia**

**3/4 – Lesser and Greater curvature**

**5 – Rt Gastric A**

**6 – Infrapyloric**

**7 – Lt Gastric A**

**8 – Common Hepatic A**

**9 – Celiac axis**

**10/11 – Splenic A/Hilum**

**12 – Hepatoduodenal ligament**

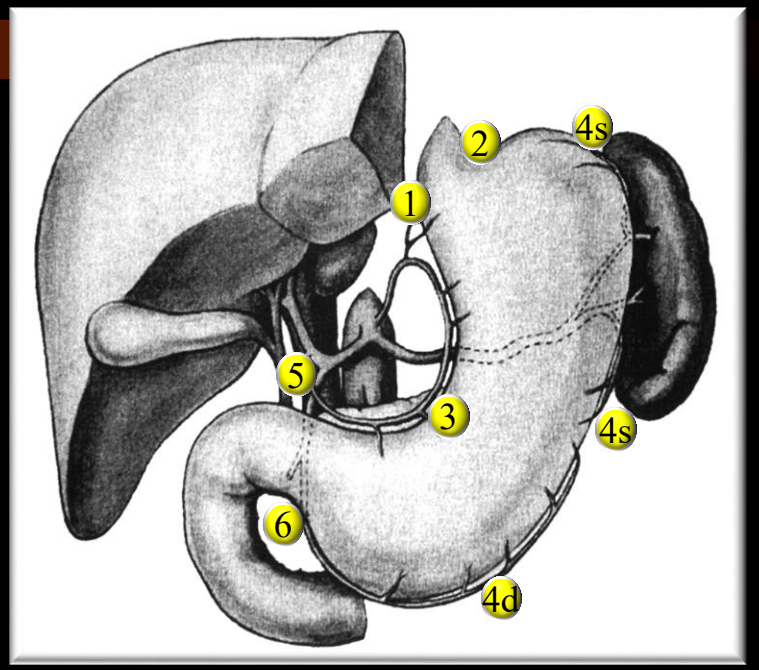
**13-20 & 110-112 – others(distant nodes)**

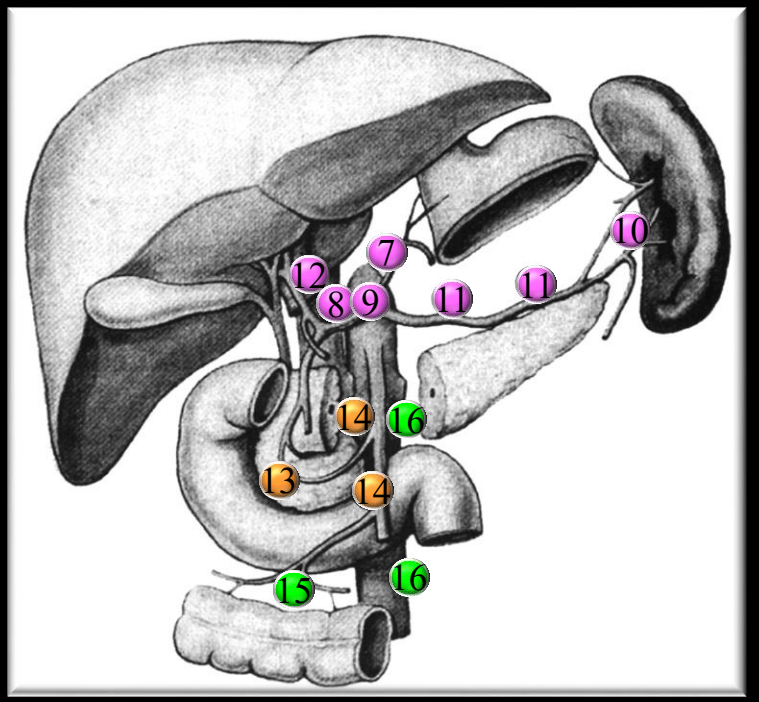
***Japanese Classification of Gastric Carcinoma, 3rd Edn: Gastric Cancer 2011***

- **N1 lymph nodes:**
  perigastric, along lesser and greater curvatures
- **N2 lymph nodes:**
  along celiac and its three branches (left gastric, common hepatic, and splenic)

- **More distal nodes:**
  N3 (hepatoduodenal, peripancreatic, root of mesentery) and N4 (periaortic, middle colic)

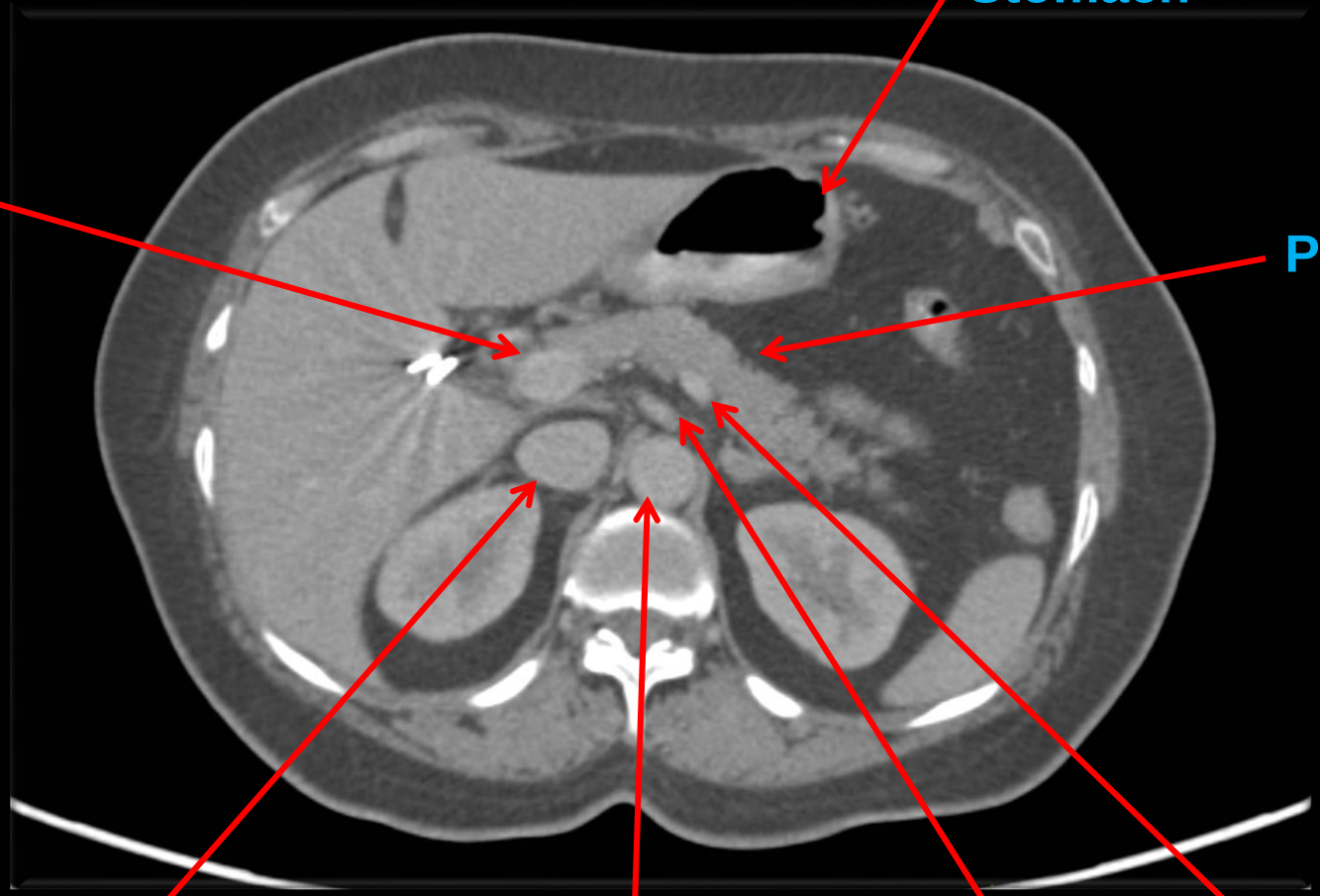
*Splenic & Lt Cardia – N3 for antral lesions
*Infra/Supra Pyloric – N3 for cardial lesions



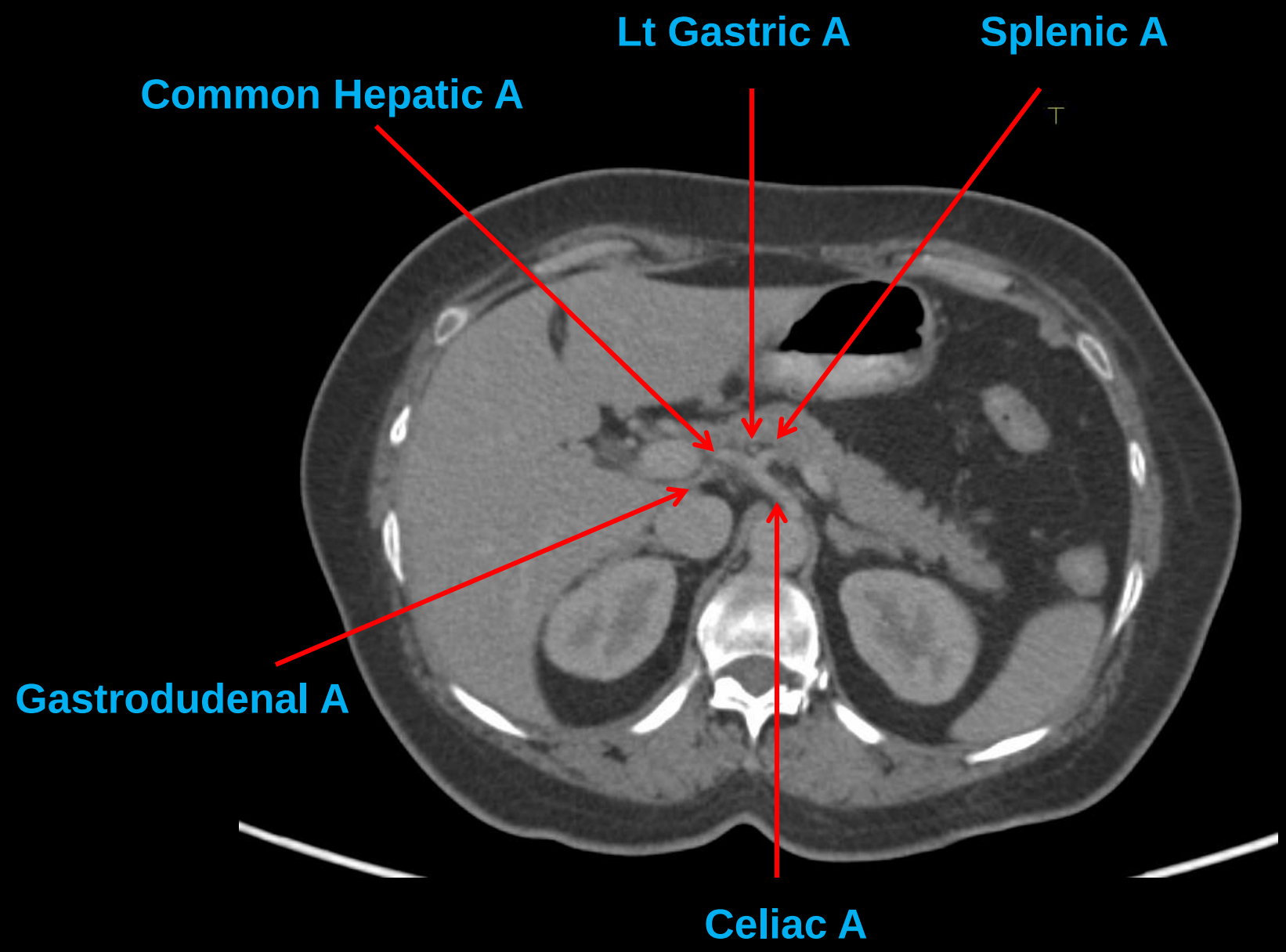



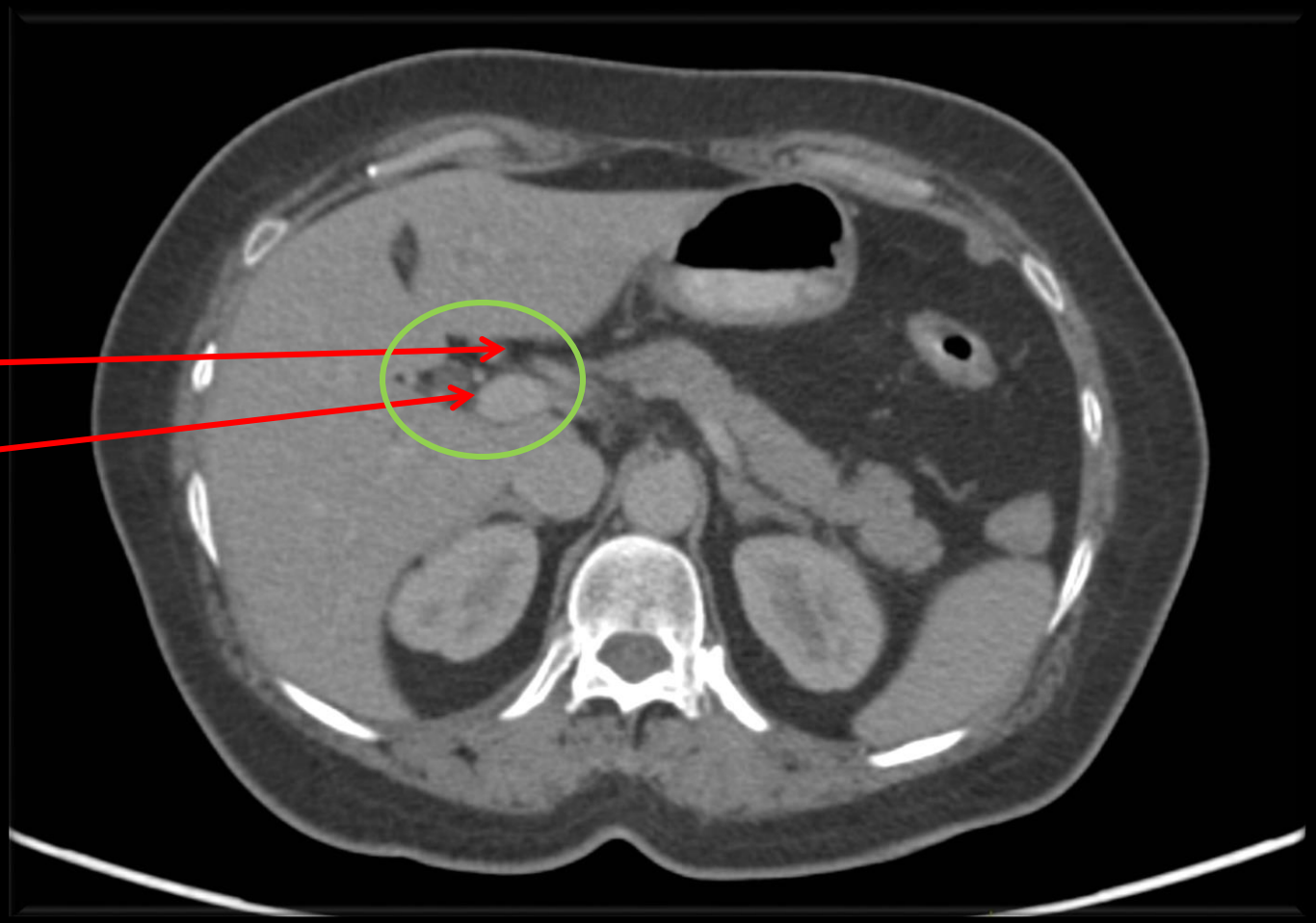

*Japanese Research Society for Gastric Cancer. Jpn J Surg 1981*

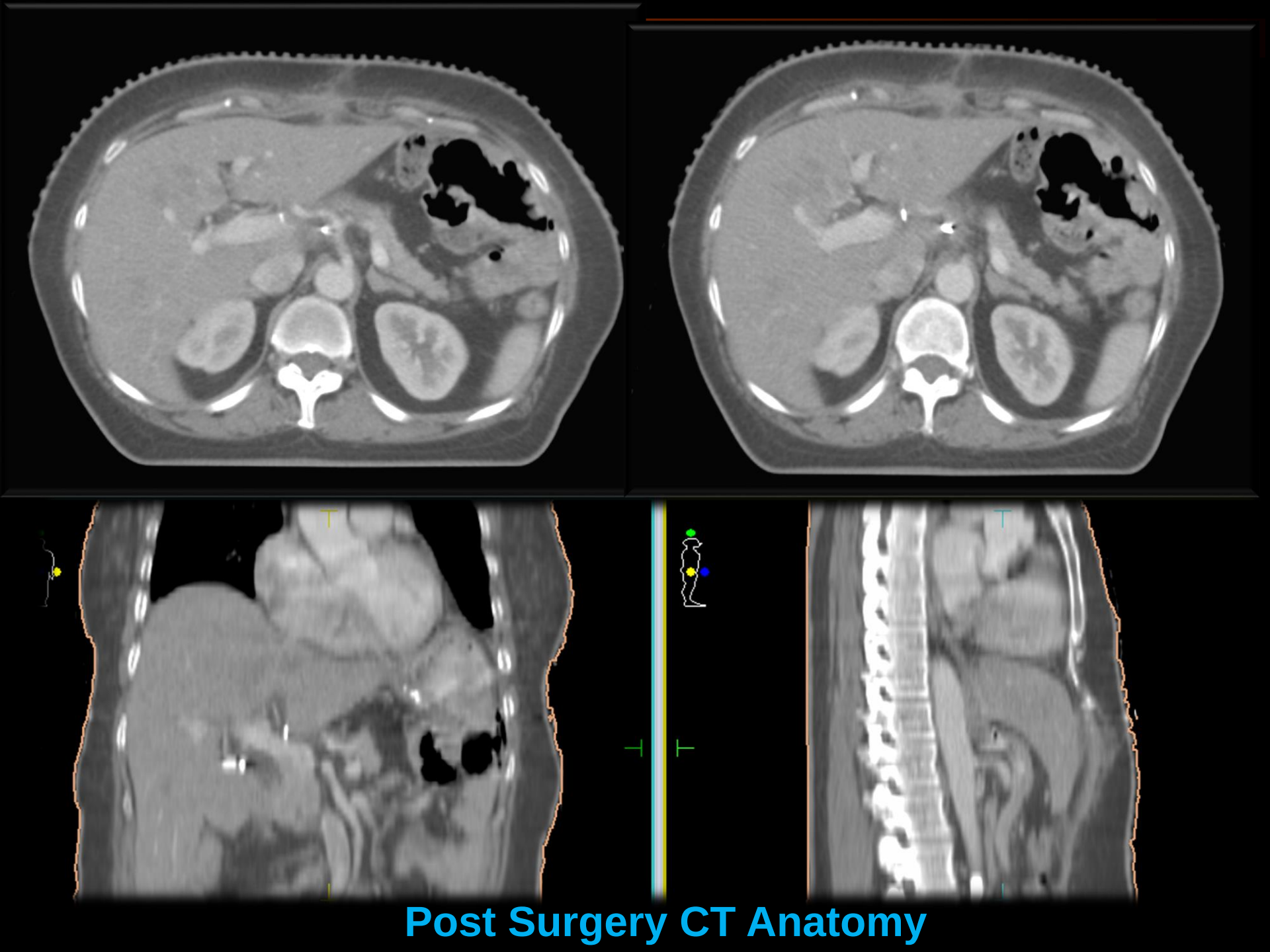
# Radiological Anatomy




T10-L1 level


Lt Gastric A
Splenic A
Common Hepatic A
Gastrodudenal A
Celiac A


Proper Hepatic A
Portal V


Post Surgery CT Anatomy

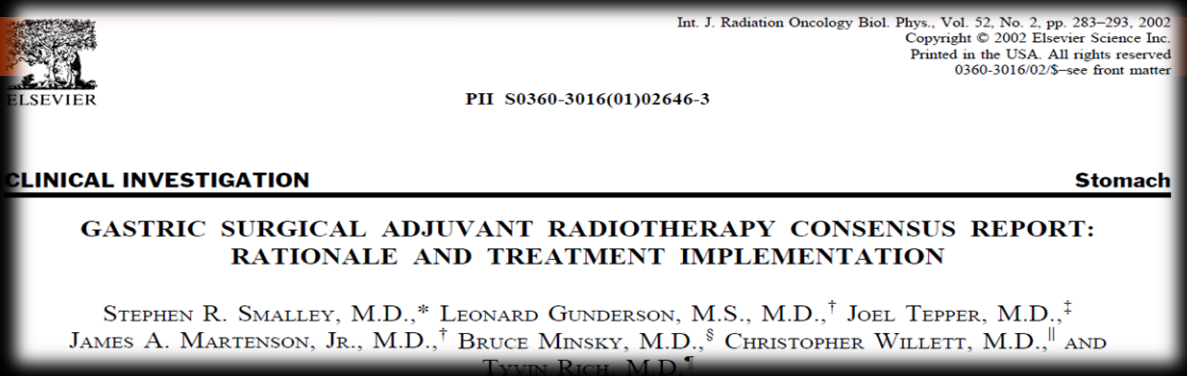
# Patterns of Spread

- **Direct through wall –**
  **All adhesions regarded as malignant**

- **Lymphatic –**
  **Submucosal and subserosal**
  **At least 5cm cut margins**
  **All LN groups are at some risk irrespective of site of tumor**

- **Hematogenous – portal vein , liver in 30%**

- **Peritoneum**



Int. J. Radiation Oncology Biol. Phys., Vol. 52, No. 2, pp. 283–293, 2002

0360-3016/02/$–see front matter

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PII S0360-3016(01)02646-3

CLINICAL INVESTIGATION Stomach

GASTRIC SURGICAL ADJUVANT RADIOTHERAPY CONSENSUS REPORT: RATIONALE AND TREATMENT IMPLEMENTATION

Stephen R. Smalley, M.D.,* Leonard Gunderson, M.S., M.D.,† Joel Tepper, M.D.,‡ James A. Martenson, Jr., M.D.,† Bruce Minsky, M.D.,§ Christopher Willett, M.D.,‖ and Tyvin Rich, M.D.¶

| | LN at risk | Low risk | Direct Spread |
|---|---|---|---|
| Proximal/ Cardia | Mediastinal Paracardial | Gastric antrum, Periduodenal, Porta hepatic | Esophageal anastamosis, Tumor bed |
| Body | ALL nodal sites esp perigastric | | Pancreas, Gastric resection margin |
| Distal 1/3rd/ Antrum | Periduodenal, Peripancreatic, Porta hepatis | Cardia, Periesophageal, Mediastinal, Splenic hilum | Duodenum |

*Smalley SR et al, IJROBP 2002*

# Preplanning

- Pre-op CT scan
- Operative notes
- Histopathology
- Determine treatment volume
- Planning -  2D/3DCRT/IMRT

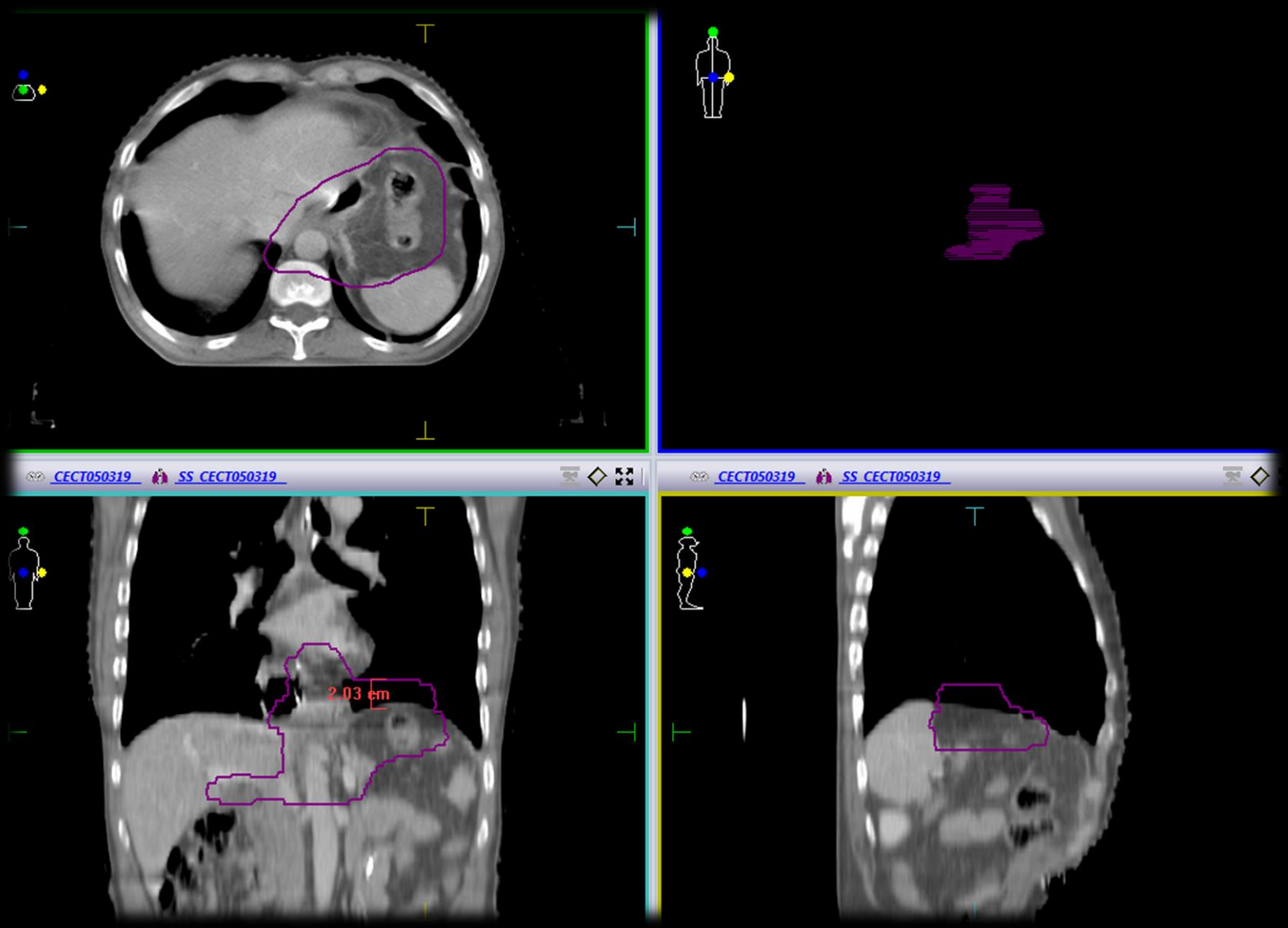
# Simulation


- Patient education/Fasting
- Consent
- Positioning-  patient supine, hands over head
- Immobilization
- IV/oral contrast

## Mean Maximal Movement (cm)

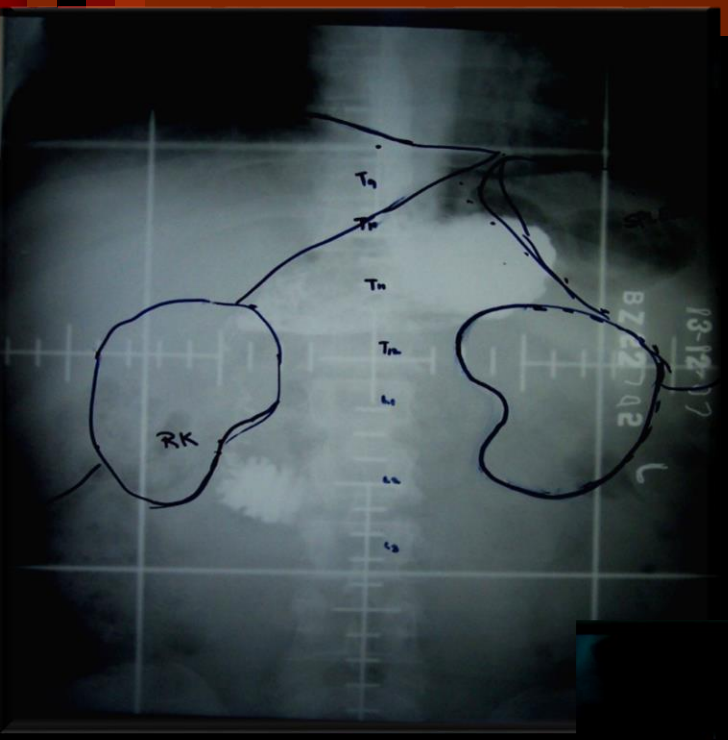
| | |
|---|---|
| Cranio – Caudal | 2.4 +/- 1.6 |
| Left – Right | 1.2 +/- 0.9 |
| Ant – Post | 0.6 +/- 0.3 |

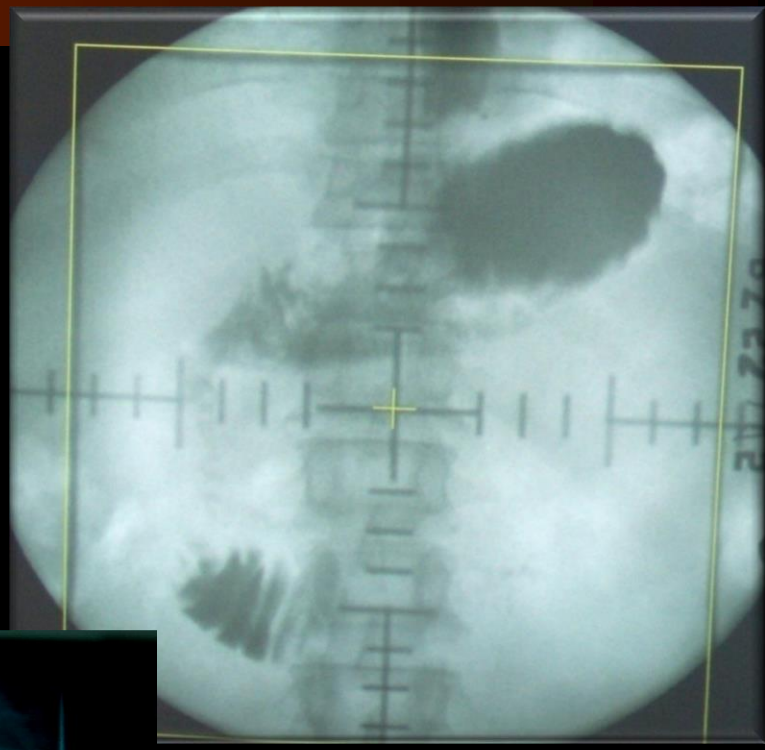
Respiration-induced movement of the upper abdominal organs: a pitfall for the 3DCRT treatment of pancreatic cancer: *Bussels B et al, Radiotherapy and Oncology 2003*

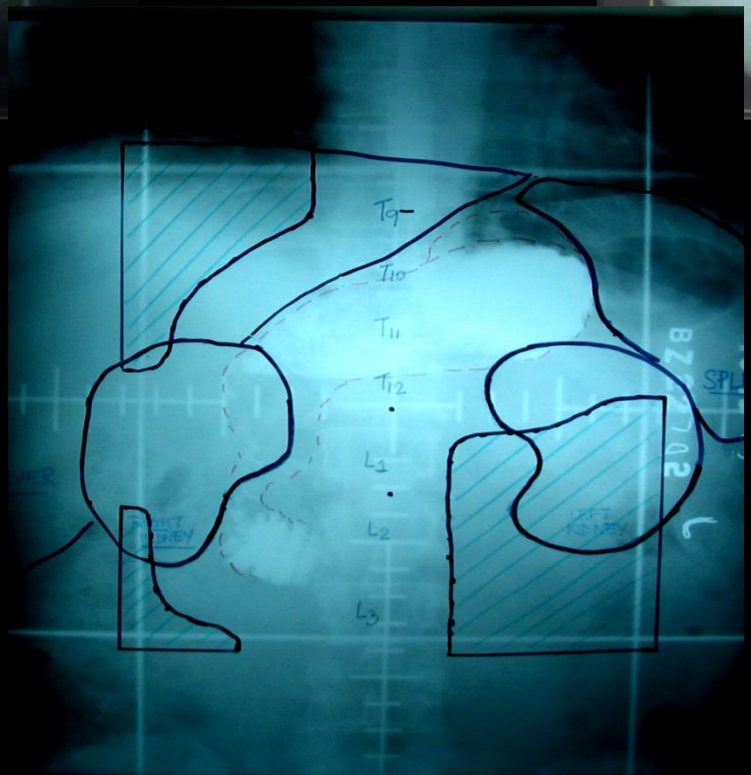



**Margin to account diaphragm movement**

# Simulation cont..





# Guidelines for Treatment Volume


Int. J. Radiation Oncology Biol. Phys., Vol. 77, No. 4, pp. 1166–1170, 2010

0360-3016/$–see front matter

doi:10.1016/j.ijrobp.2009.06.023

**CLINICAL INVESTIGATION** **Stomach**

# INTEROBSERVER VARIATION OF CLINICAL TARGET VOLUME DELINEATION IN GASTRIC CANCER

EDWIN P. M. JANSEN, M.D.,* JASPER NIJKAMP, M.SC.,* MICHAEL GUBANSKI, M.D.,†
PEHR A. R. M. LIND, M.D., PH.D.,† AND MARCEL VERHEIJ, M.D., PH.D.*

* Department of Radiotherapy, The Netherlands Cancer Institute/Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands; and
† Department of Oncology, Karolinska Institute, Stockholm, Sweden

**Purpose:** To evaluate interobserver variability in clinical target volume (CTV) delineation in gastric cancer performed with the help of a delineation guide.

**Patients and Methods:** Ten radiotherapy centers that participate in the CRITICS Phase III trial were provided with a delineation atlas, preoperative CT scans, a postoperative planning CT scan, and clinical information for a gastric cancer case and were asked to construct a CTV and create a dosimetric plan according to departmental policy.

**Results:** The volumes of the CTVs and planning target volumes (PTVs) differed greatly, with a mean (SD) CTV volume of 392 (176) $cm^3$ (range, 240–821$cm^3$) and PTV volume of 915 (312) $cm^3$ (range, 634–1677$cm^3$). The overlapping volume was 376$cm^3$ for the CTV and 890$cm^3$ for the PTV. The greatest differences in the CTV were seen at the cranial and caudal parts. After planning, dose coverage of the overlapping PTV volume showed less variability than the CTV.

**Conclusion:** In this series of 10 plans, variability of the CTV in postoperative chemoradiotherapy for gastric cancer is large. Strict and clear delineation guidelines should be provided, especially in Phase III multicenter studies. Adaptations of these guidelines should be evaluated in clinical studies. 

# Radiation Treatment Parameters in the Adjuvant Postoperative Therapy of Gastric Cancer

*Joel E. Tepper and Leonard L. Gunderson*

**Table 2.** General Guidelines of Impact of T and N Stage on Inclusion of Remaining Stomach, Tumor Bed, Nodal Sites Within Irradiation Fields

| *TN Stage* | *Remaining Stomach*** | *Tumor Bed* | *Nodes* |
|---|---|---|---|
| T1-2 (not into subserosa) N0 | N | N | N |
| T2N0 (into subserosa)* | Variable | Y | N |
| T3N0 | Variable | Y | N |
| T4N0 | Variable | Y | Variable |
| T1-2N+ | Y | N | Y |
| T3-4N+ | Y | Y | Y |

*Posterior wall T2N0 lesions, or those that extend beyond muscularis propria, especially tumors located in the proximal or distal stomach, are at risk for local relapse. In addition, patients with low-stage disease with close or positive surgical margins should be considered for treatment to the tumor bed.

**Inclusion of the remaining stomach is preferable in most patients if two thirds of one kidney can be excluded. This is dependent on the extent of surgical resection and uninvolved margins (in centimeters).

*Semin Radiat Oncol 2002*

Cont..

**Table 3.** Impact of Site of Primary Lesion and TN Stage on Irradiation Treatment Volumes—EG Junction (General Guidelines)

| *Site of Primary and TN Stage* | *Remaining Stomach* | *Tumor Bed Volumes*** | *Nodal Volumes* | *Tolerance Organ Structures* |
|---|---|---|---|---|
| 1) EG junction | If allows exclusion of 2/3 R kidney | T-stage dependent | N-stage dependent | Heart, lung, spinal cord, kidneys, |
| T2N0 with invasion of subserosa | Variable dependent on surgical-pathologic findings* | Medial left hemidiaphragm; adjacent body of pancreas | None or perigastric, periesophageal*** | |
| T3N0 | Variable dependent on surgical-pathologic findings* | Medial left hemidiaphragm; adjacent body of pancreas | None or perigastric, periesophageal mediastinal, celiac*** | |
| T4N0 | Preferable but dependent on surgical-pathologic findings* | As for T3N0 plus site(s) of adherence with 3-5 cm margin | Nodes related to site of adherence, +/− perigastric, periesophageal mediastinal, celiac | |
| T1-2 N+ | Preferable | Not indicated for T1, as above for T2 into subserosa | Periesophageal, mediastinal, prox perigastric, celiac | |
| T3-4 N+ | Preferable | As for T3, T4N0 | As for T1-2N+ and T4N0 | |

*For tumors with wide (>5 cm) surgical margins confirmed pathologically, treatment of residual stomach optional, especially if this would result in substantial increase in normal tissue morbidity.
**Use preop imaging (CT, barium swallow), surgical clips and postop Imaging (CT, barium swallow).
***Optional node inclusion for T2-3N0 lesions if there has been an adequate surgical node dissection (D2 dissection) and at least 10-15 nodes have been examined pathologically.

## GE Junction

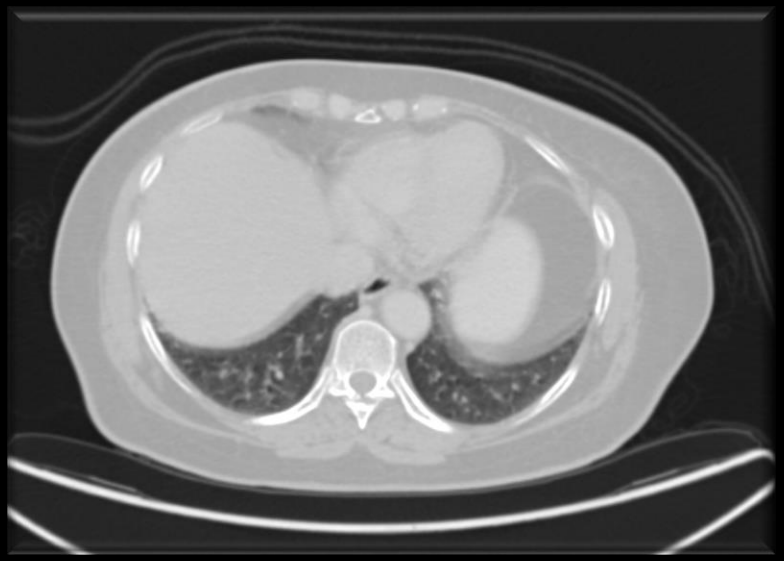
## Cardia/Proximal Stomach

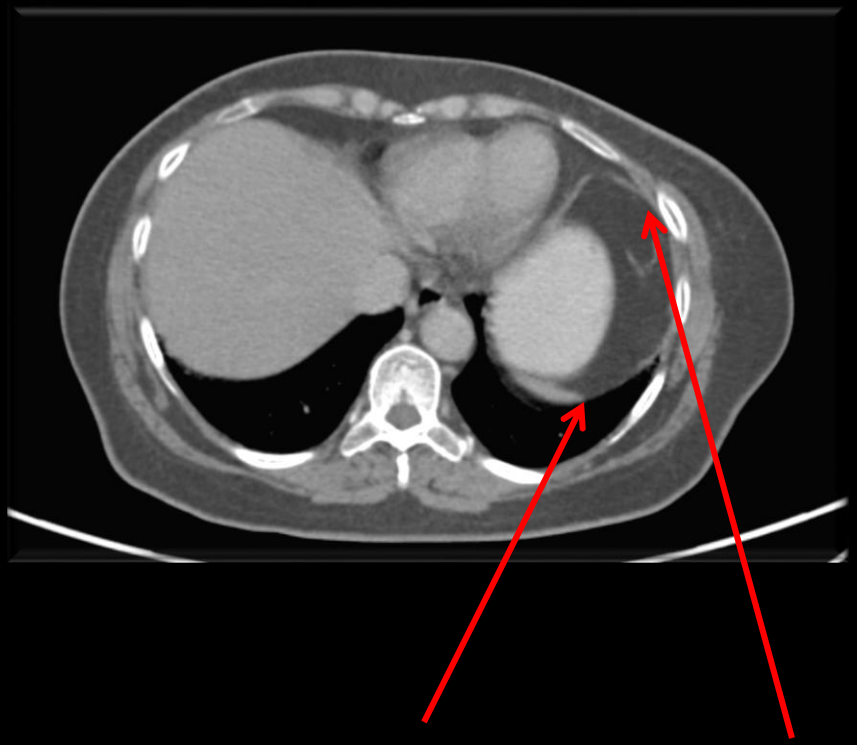
**Table 4.** Impact of Site of Primary Gastric Lesion and TN Stage on Irradiation Treatment Volumes—Cardia/Proximal One Third of Stomach (General Guidelines)

| *Site of Primary and TN Stage* | *Remaining Stomach* | *Tumor Bed Volumes*** | *Nodal Volumes* | *Tolerance Organ Structures* |
|---|---|---|---|---|
| 2) Cardia/prox 1/3 of stomach | Preferred, but spare 2/3 of one kidney (usually R) | T-stage dependent | N-stage dependent | kidneys, spinal cord, liver, heart, lung |
| T2N0 with invasion of subserosa | Variable dependent on surgical-pathologic findings* | Medial L hemidiaphragm, adjacent body of pancreas (+/− tail) | None or perigastric† | |
| T3N0 | Variable dependent on surgical-pathologic findings* | Medial L hemidiaphragm, adjacent body of pancreas (+/− tail) | None or perigastric: optional: periesophageal, mediastinal, celiac#† | |
| T4N0 | Variable dependent on surgical-pathologic findings* | As for T3N0 plus site(s) of adherence with 3-5 cm margin | Nodes related to site of adherence, +/− perigastric, periesophageal, mediastinal, celiac | |
| T1-2N+ | Preferable | Not indicated for T1, as above for T2 into subserosa | Perigastric, celiac, splenic, suprapancreatic, +/− periesophageal, mediastinal, panc-duod, porta hepatis*** | |
| T3-4 N+ | Preferable | As for T3, T4N0 | As for T1-2N+ and T4N0 | |

*For tumors with wide (>5 cm) surgical margins confirmed pathologically, treatment of residual stomach not necessary, especially if this would result in substantial increase in normal tissue morbidity.
**Use preop imaging (CT, barium swallow), surgical clips and postop imaging (CT, barium swallow).
***Pancreaticoduodenal and portahepatis nodes are at low risk if nodal positivity is minimal (ie, 1-2 pos nodes with 10-15 nodes examined), and this region does not need to be irradiated. Periesophageal and mediastinal nodes are at risk if there is esophageal extension.
†Optional node inclusion for T2-3N0 lesions if there has been an adequate surgical node dissection (D2 dissection) and at least 10-15 nodes have been examined pathologically.

# To identify Diaphragm

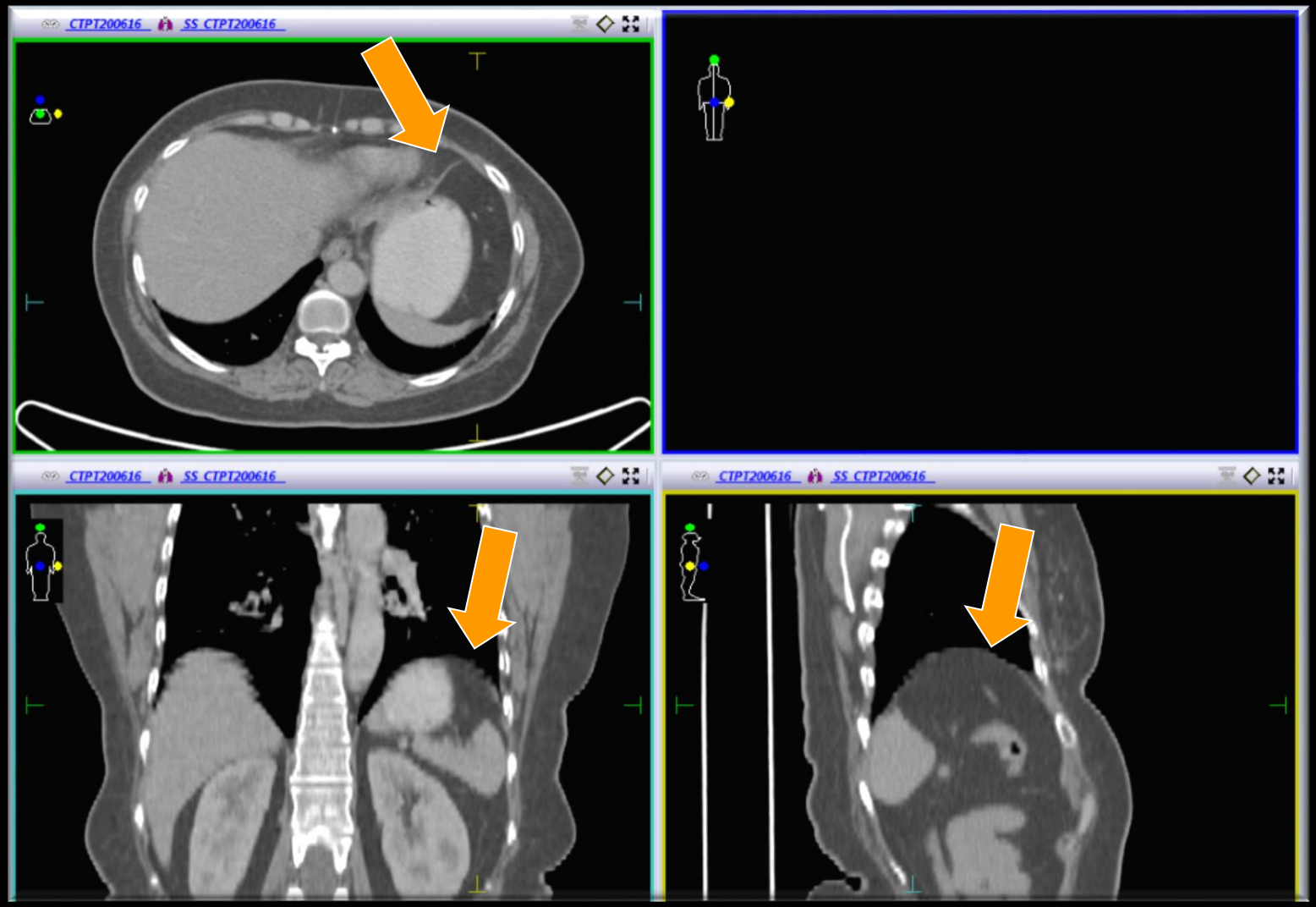




**Lung window:**

**Abdominal cavity & Lung interface**

**Diaphragm**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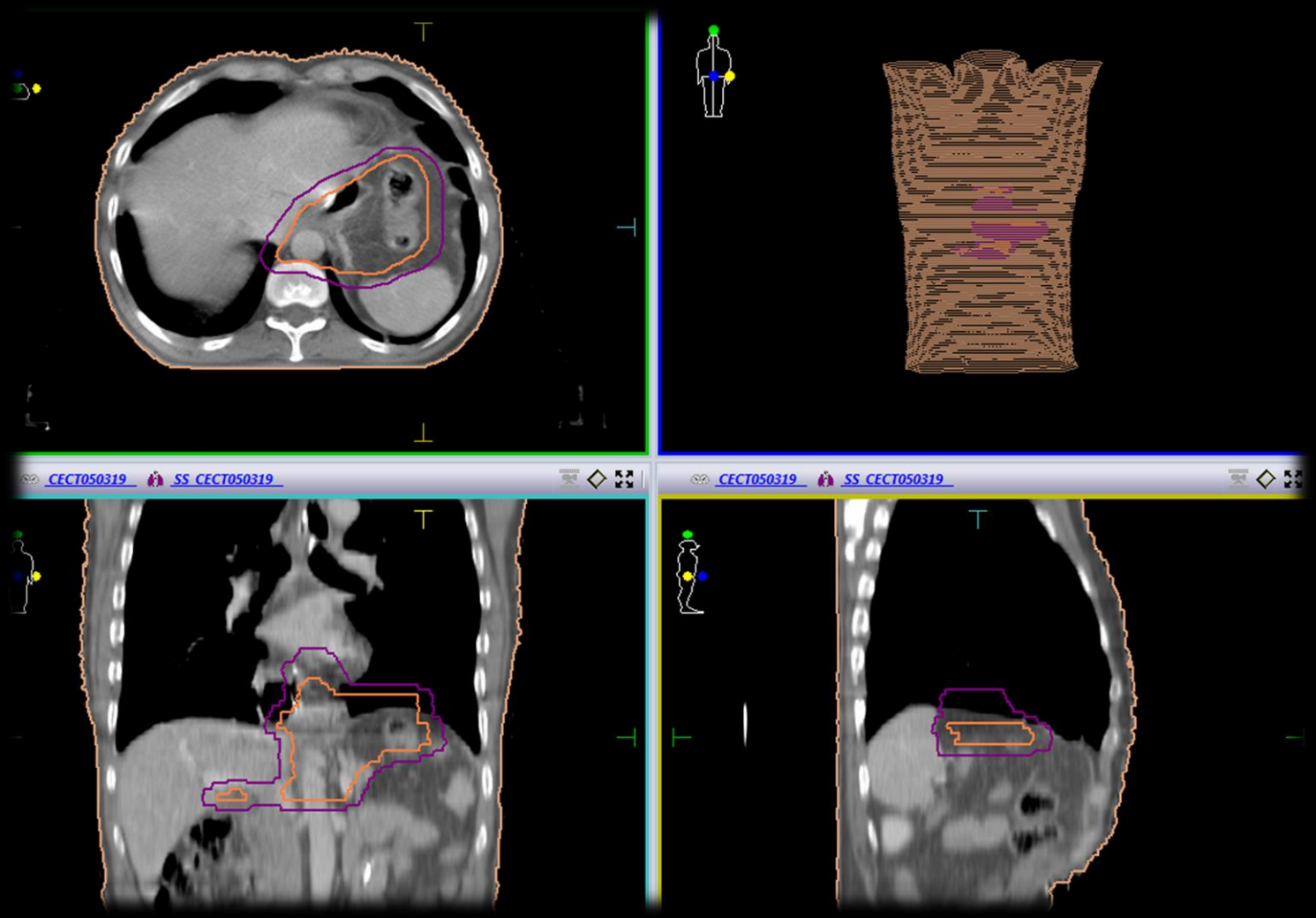
# Diaphragm




**Proximal Stomach Tumor**

**Inclusion of medial 2/3rd of Lt Hemidiaphragm in CTV**

**Table 5.** Impact of Site of Primary Gastric Lesion and TN Stage on Irradiation Treatment Volumes—Body/Middle One Third of Stomach (General Guidelines)

| *Site of Primary and TN Stage* | *Remaining Stomach* | *Tumor Bed Volumes** | *Nodal Volumes* | *Tolerance Organ Structures* |
|---|---|---|---|---|
| 3) Body/mid-1/3 of stomach | Yes, but spare 2/3 of one kidney | T-stage dependent | N-stage dependent, spare 2/3 of one kidney | Kidneys, spinal cord, liver |
| T2N0 with invasion of subserosa—esp. post wall | Yes | Body of pancreas (+/− tail) | None or perigastric; optional: celiac, splenic, supra-pancreatic, pancreatico-duodenal, portahepatis** | |
| T3N0 | Yes | Body of pancreas (+/− tail) | None or perigastric; optional; celiac, splenic, supra-pancreatic, pancreatico-duodenal, portahepatis** | |
| T4N0 | Yes | As for T3N0 plus site(s) of adherence with 3-5 cm margin | Nodes related to site of adherence +/− perigastric, celiac, splenic, supra-pancreatic, pancreatico-duodenal, portahepatis | |
| T1-2 N+ | Yes | Not indicated for T1 | Perigastric, celiac, splenic, supra-pancreatic, pancreatico-duodenal, porta hepatis | |
| T3-4N+ | Yes | As for T3, T4N0 | As for T1-2N+ and T4N0 | |

*Use preop imaging (CT, barium swallow), surgical clips, and postop imaging (CT, barium swallow).
**Optional node inclusion for T2-3N0 lesions if there has been adequate surgical node dissection (D2 dissection) and at least 10-15 nodes have been examined pathologically.

Body/Middle 1/3rd

Pyloric/Distal 1/3rd

**Table 6.** Impact of Site of Primary Gastric Lesion and TN Stage on Irradiation Treatment Volumes—Antrum/Pylorus/Distal One Third of Stomach (General Guidelines)

| *Site of Primary and TN Stage* | *Remaining Stomach* | *Tumor Bed Volumes*** | *Nodal Volumes* | *Tolerance Organ Structures* |
|---|---|---|---|---|
| 4) Pylorus/distal 1/3 stomach | Yes, but spare 2/3 of one kidney (usually L) | T-stage dependent | N-stage dependent | Kidneys, liver, spinal cord |
| T2N0 with invasion of subserosa | Variable dependent on surgical-pathologic findings* | Head of pancreas, (+/− body), 1st and 2nd duodenum | None or perigastric; optional: pancreatico-duodenal, porta hepatis, celiac, supra-pancreatic*** | |
| T3N0 | Variable dependent on surgical-pathologic findings* | Head of pancreas, (+/− body), 1st and 2nd duodenum | None or perigastric; optional: pancreatico-duodenal, porta hepatis, celiac, supra-pancreatic*** | |
| T4N0 | Preferable but dependent on surgical-pathologic findings* | As for T3N0 plus site(s) of adherence with 3-5 cm margin | Nodes related to site(s) of adherence +/− perigastric, pancreatico-duodenal, portahepatis, celiac, supra-panc | |
| T1-2N+ | Preferable | Not indicated for T1 | Perigastric, pancreatico-duodenal, portahepatis, celiac, supra-pancreatic; Optional splenic hilum*** | |
| T3-4N+ | Preferable | As for T3, T4N0 | As for T1-2N+ and T4N0 | |

*For tumors with wide (>5 cm) surgical margins confirmed pathologically, treatment of residual stomach is optional if this would result in substantial increase in normal tissue morbidity.
**Use preop imaging (CT, barium swallow), surgical clips, and postop imaging (CT, barium swallow).
***Optional node inclusion for T2-3N0 lesions if there has been an adequate surgical node dissection (D2 dissection) and at least 10-15 nodes have been examined pathologically.

Radiotherapy and Oncology 92 (2009) 164–175

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journal homepage: www.thegreenjournal.com

Guidelines

# EORTC-ROG expert opinion: Radiotherapy volume and treatment guidelines for neoadjuvant radiation of adenocarcinomas of the gastroesophageal junction and the stomach

Oscar Matzinger[a,b,*], Erich Gerber[c], Zvi Bernstein[d], Philippe Maingon[e], Karin Haustermans[f], Jean François Bosset[g], Akos Gulyban[a], Philip Poortmans[h], Laurence Collette[a], Abraham Kuten[d]

[a] EORTC Headquarters, Brussels, Belgium

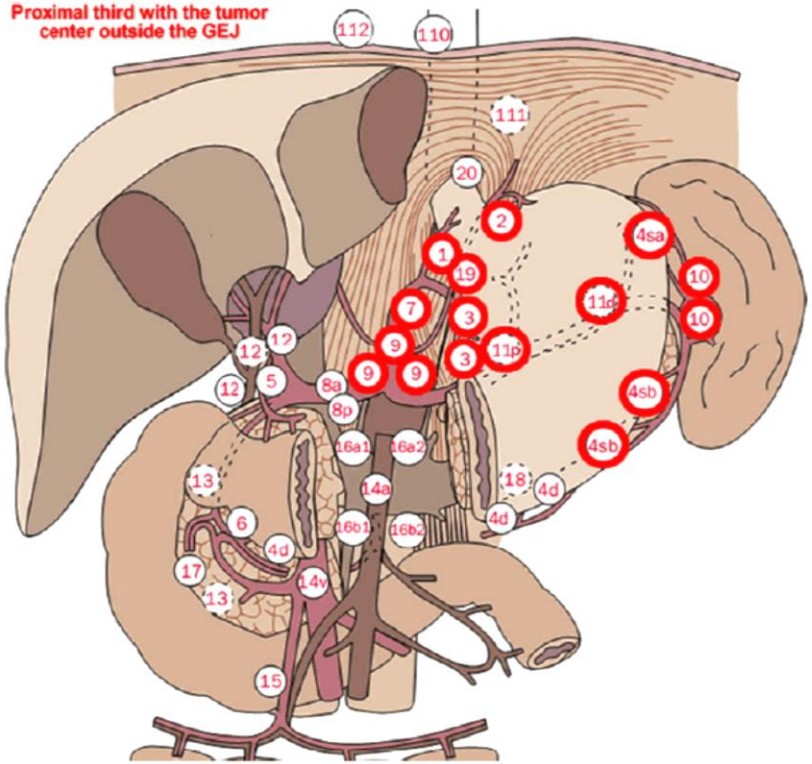


**Fig. 7.** Corresponding elective lymph node stations for GC tumours of the proximal third with their tumour centre outside of the gastroesophageal junction: 1, right paracardial LN; 2, left paracardial LN; 3, LN along the lesser curvature; 4sa, LN along the short gastric vessels; 4sb, LN along the left gastroepiploic vessels; 7, LN along the left gastric artery; 9, LN around the celiac artery; 10, LN at the splenic hilum; 11p, LN along the proximal splenic artery; 11d, LN along the distal splenic artery; 19, infradiaphragmatic LN.

**Ca Proximal Stomach**

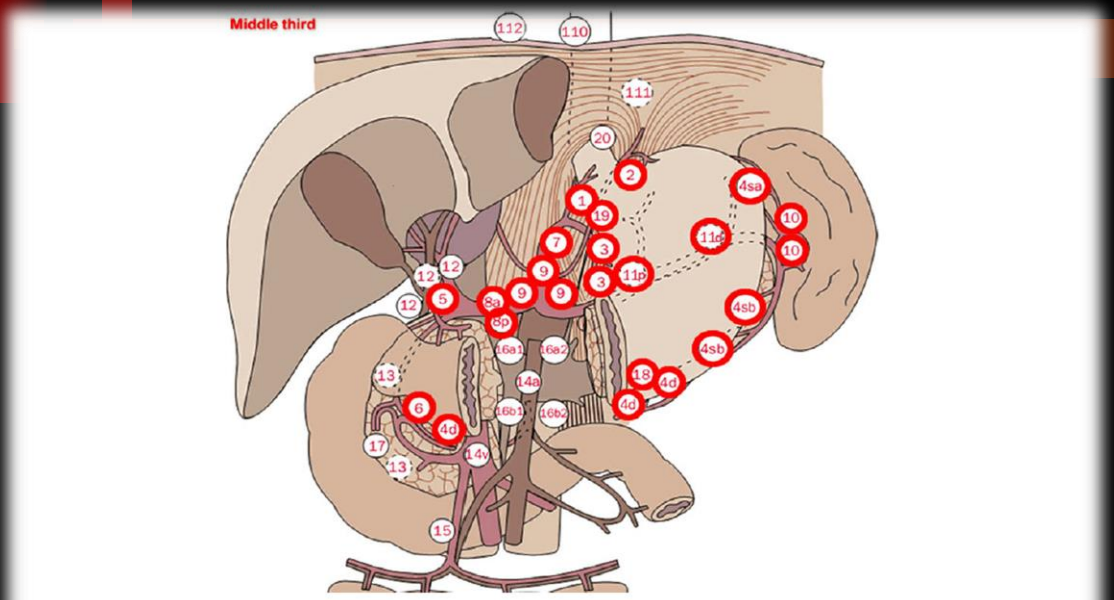


Fig. 8. Corresponding elective lymph node stations for GC tumours of the middle third: 1, right paracardial LN; 2, left paracardial; LN; 3, LN along the lesser curvature; 4sa, LN along the short gastric vessels; 4sb, LN along the left gastroepiploic vessels; 4d, LN along the right gastroepiploic vessels; 5, suprapyloric LN; 6, Infrapyloric LN; 7, LN along the left gastric artery; 8a, LN along the common hepatic artery (anterosuperior group); 8b, LN along the common hepatic artery (posterior group); 9, LN around the celiac artery; 10, LN at the splenic hilum; 11p, LN along the proximal splenic artery; 11d, LN along the distal splenic artery; 18, LN along the inferior margin of the pancreas; 19 infradiaphragmatic LN.

## Mid1/3rd Stomach

## Distal 1/3rd Stomach

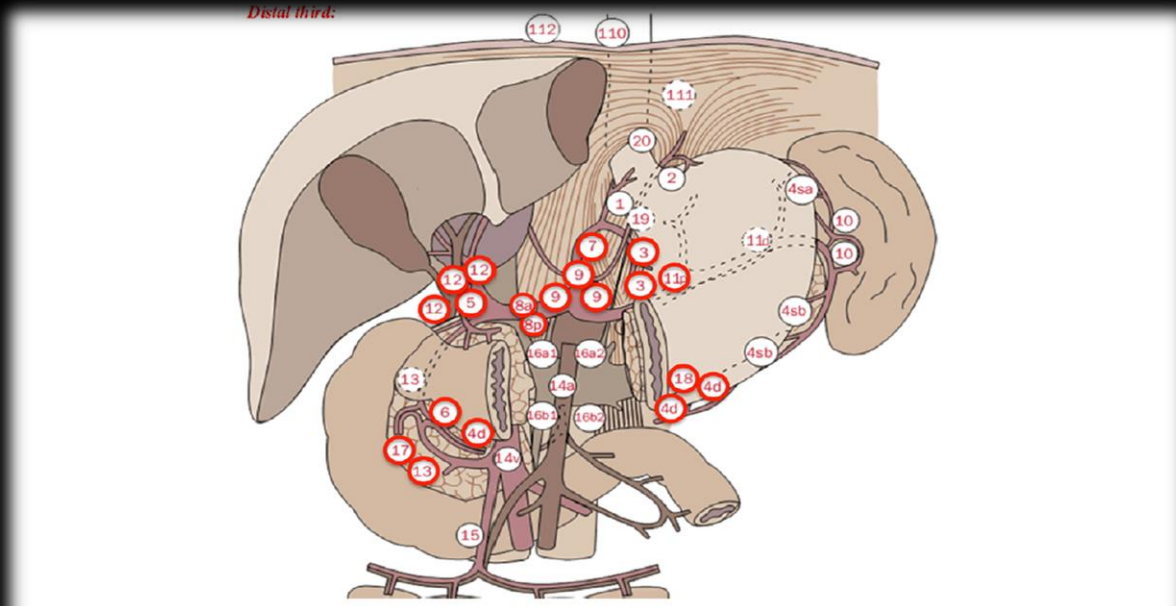


Fig. 9. Corresponding elective lymph node stations for GC tumours of the distal third: 3, LN along the lesser curvature; 4d, LN along the right gastroepiploic vessels; 5, suprapyloric LN; 6, infrapyloric LN; 7, LN along the left gastric artery; 8a, LN along the common hepatic artery (anterosuperior group); 8b, LN along the common hepatic artery (posterior group) 9, LN around the celiac artery; 11p, LN along the proximal splenic artery; 12a, LN in the hepatoduodenal ligament (along the hepatic artery); 12b, LN in the hepatoduodenal ligament (along the bile duct); 12p, LN in the hepatoduodenal ligament (behind the portal vein); 13, LN on the posterior surface of the pancreatic head; 17, LN on the anterior surface of the pancreatic head; 18, LN along the inferior margin of the pancreas.

Practical Radiation Oncology (2013) 3, e11–e19

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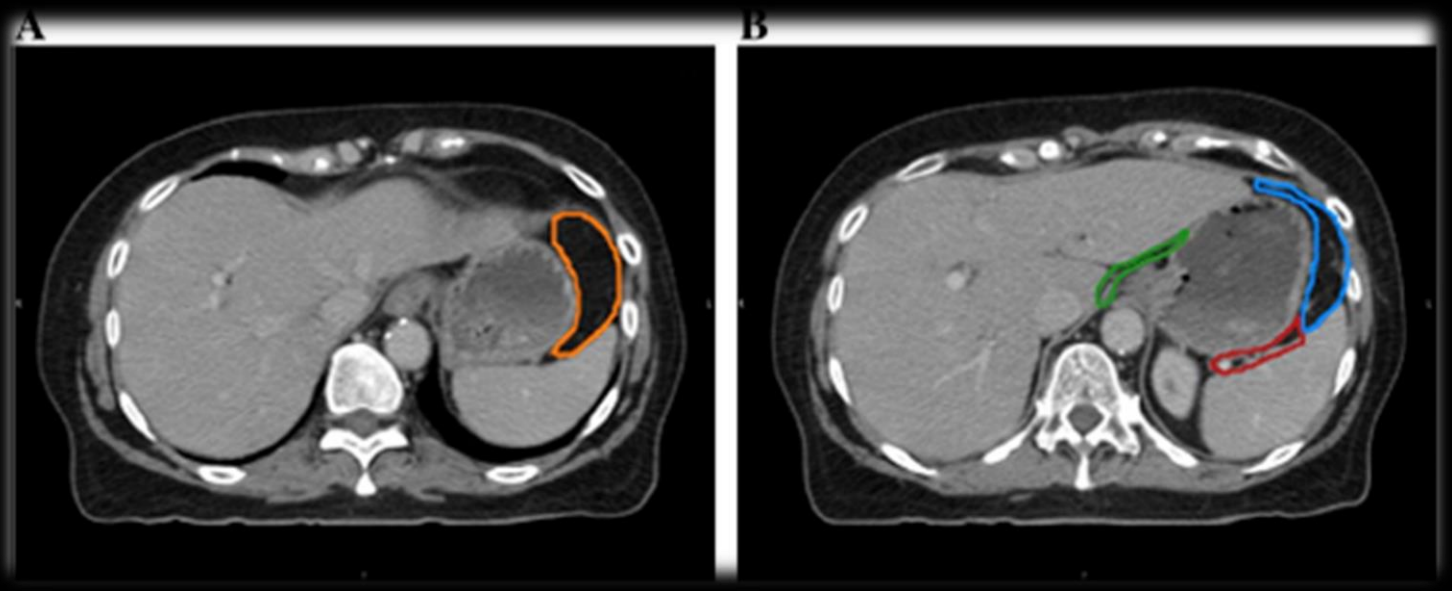
Original Report

# Gastric lymph node contouring atlas: A tool to aid in clinical target volume definition in 3-dimensional treatment planning for gastric cancer

Jennifer Y. Wo MD [a,*], Sam S. Yoon MD [b], Alexander R. Guimaraes MD, PhD [c], John Wolfgang PhD [a], Harvey J. Mamon MD, PhD [d], Theodore S. Hong MD [a]




encountered are the left paracardial LNs (Fig 1A). The left paracardial LNs are anatomically defined medially by the gastric fundus, anterolaterally by the visceral peritoneum, posteriorly by the spleen, superiorly by the hemidiaphragm, and inferiorly by the greater curvature LNs. Generally, the region anterior to the gastric body is devoid of any nodal tissue.

greater curvature LNs, splenic hilum LNs, and right paracardial LNs (Fig 1B). Once the greater curvature is encountered, the nodal tissue on the left lateral perigastric region is termed the greater curvature LNs. The greater curvature LNs run along the short gastric vessels and both right and left gastroepiploic vessels, and they are bordered medially by the gastric body, anterolaterally by the ribs, and posteriorly by the spleen and splenic hilum LNs. Lying posterior to the greater curvature LNs, the splenic hilum LNs represent the nodal basin lying between the spleen and gastric body, bordered posterolaterally by the spleen, medially by the kidneys, extending inferiorly to cover all of the splenic hilum vasculature. In Fig 1B, the right paracardial LNs can also be identified, representing the narrow anatomic space that lies between gastric cardia

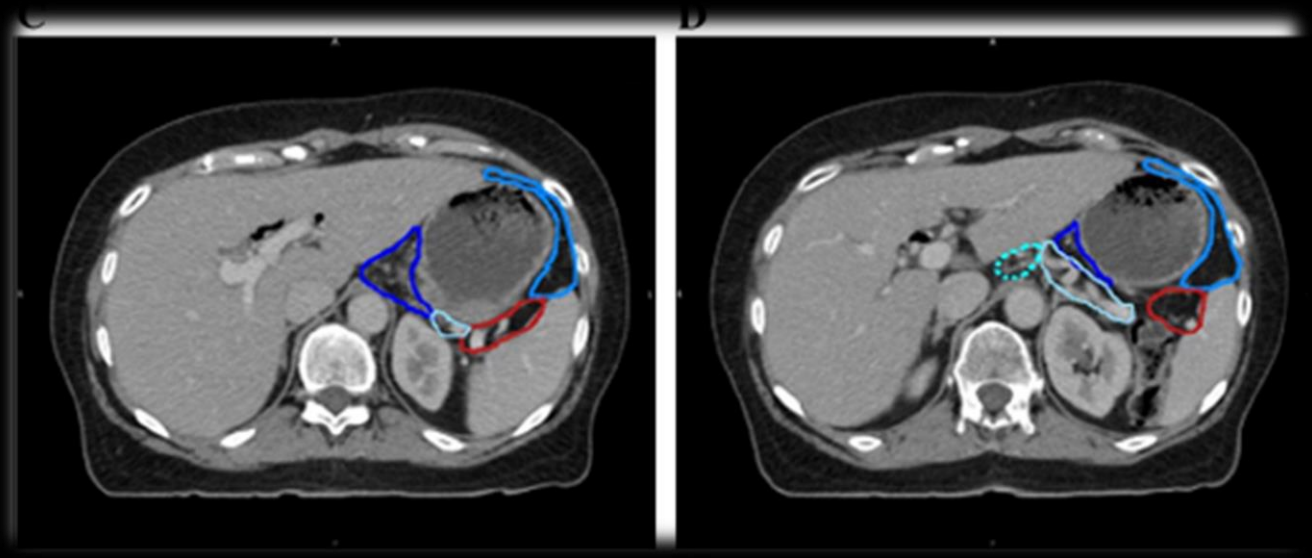
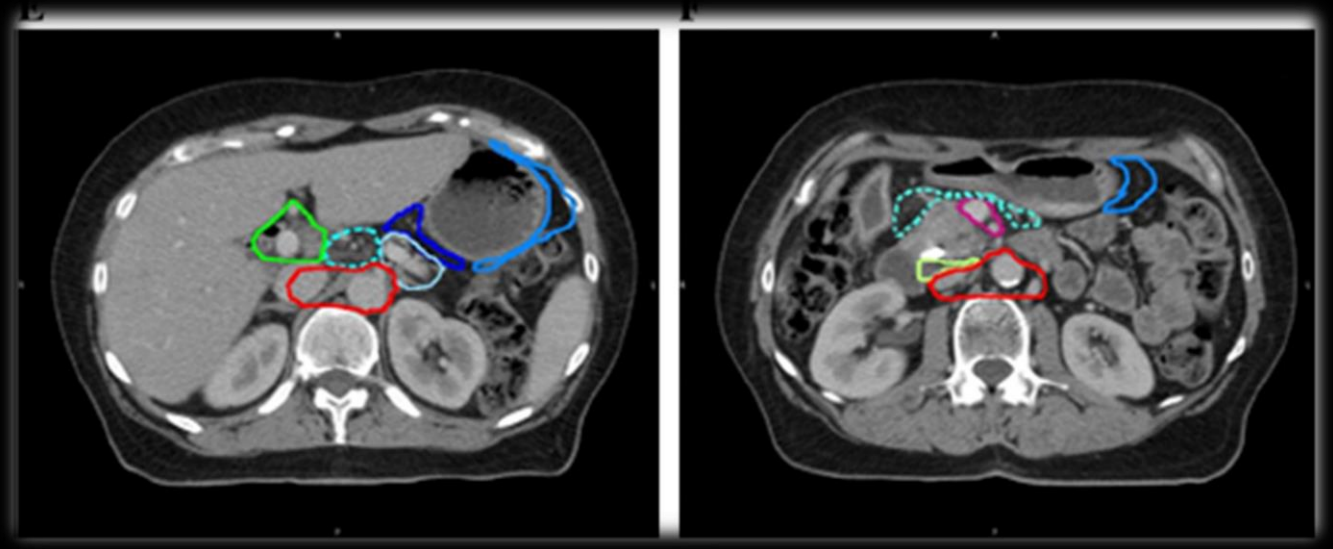


Figure 1C depicts the lesser curvature and splenic artery LNs in relation to greater curvature and splenic hilum LNs. The lesser curvature LNs are defined superiorly by the right paracardial LNs, anteromedially by the liver, inferomedially by the suprapyloric LNs, laterally by the gastric body, and posteriorly by the kidney. The splenic artery LN basin surrounds the splenic artery. It is bordered anteriorly by the posterior aspect of the gastric body, posteriorly by the left kidney, laterally by the splenic hilum LNs, and medially by the celiac axis LNs. Figure 1D illustrates the location of the left gastric LNs in the context of other previously described LN stations. The left gastric LN station is defined as regional tissue surrounding the left gastric artery, starting inferiorly from its origin of the celiac axis to superiorly, running along the superior portion of the lesser curvature, where these LNs merge with the lesser curvature LNs. The left gastric LN station is bordered medially by the liver, superolaterally by the splenic artery LN basin, and inferolaterally by the celiac LNs.



Continuing inferiorly, Figure 1E illustrates the location of hepatoduodenal and paraortic LN stations. The hepatoduodenal LNs lie along the proper hepatic artery, common bile duct, and the portal vein, extending superiorly from the under surface of the liver to the superior portion of the duodenum inferiorly. The paraortic LNs are located within the region between and immediately adjacent to the aorta and inferior vena cava. Through consensus discussion, the superior border of the paraortic LNs was designated as 5-mm below the origin of the celiac axis. This LN basin extends inferiorly to the duodenal sweep, medially to the vertebral body, and laterally extending to 2-mm left of the aorta.

As named, the common hepatic LNs (Fig 1F) can best be identified by first identifying the common hepatic artery, which terminates to form the proper hepatic artery and gastroduodenal artery. This LN basin is bordered posteriorly by the paraortic LNs, posteromedial by the celiac LNs, anteriorly by the liver, anteroinferiorly by the suprapyloric LNs, and laterally by the hepatoduodenal LNs. Similarly, the celiac LNs are defined by the celiac artery, starting from its origin from the aorta to its termination where it branches and gives off the common hepatic artery, left gastric artery, and splenic artery.

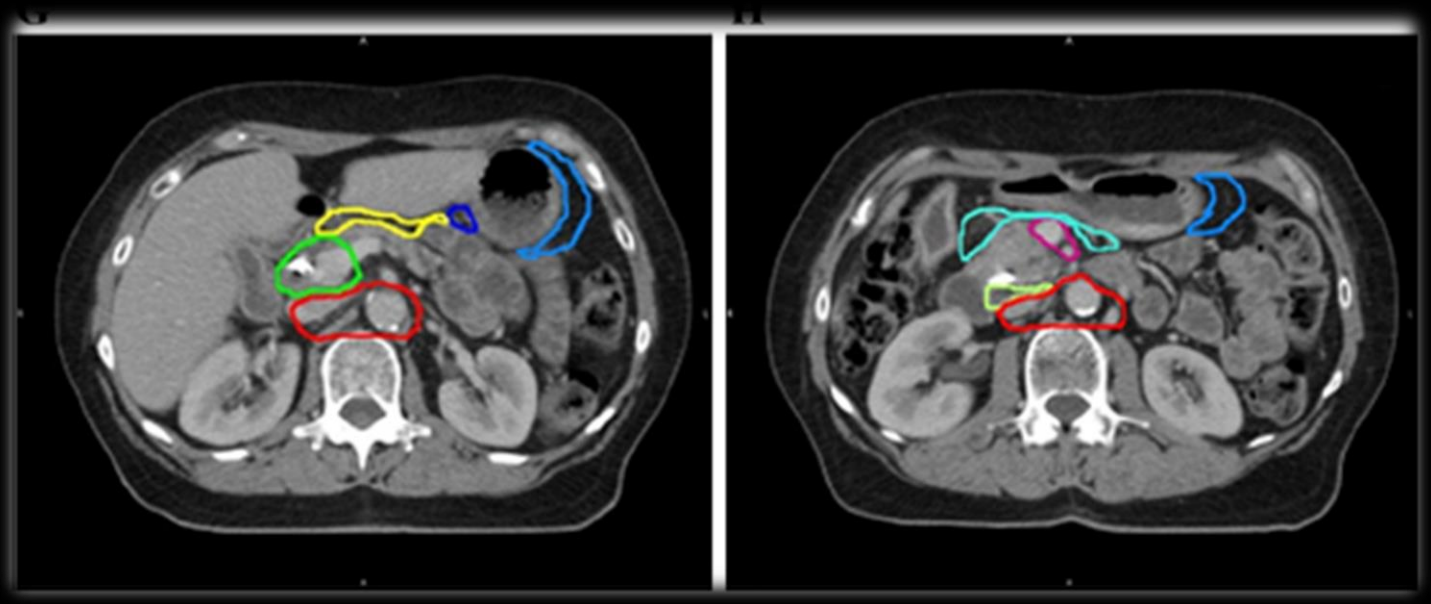


Figure 1G illustrates the suprapyloric LNs, which lie directly superior to the gastric pylorus. The common hepatic LNs flow into the suprapyloric LNs, then flow leftward to join up with the lesser curvature LNs. The suprapyloric LNs are bordered anteriorly by the left lobe of the liver, posteriorly by the pancreatic body, and to the left by the inferior portion of the lesser curvature LNs.

Lastly, the infrapyloric LNs, posterior pancreatic LNs, and the superior mesenteric LNs can be appreciated. The infrapyloric LNs lie immediately inferior to the gastric pylorus and anterior to the pancreatic head and superior mesenteric vessels. The posterior pancreatic LNs lie immediately posterior to the pancreatic head and anterior to the paraortic LNs. The superior mesenteric LNs reside anteriorly along the surface of the pancreatic head and neck, from the junction of the superior mesenteric artery and vein superiorly to the duodenal sweep inferiorly.

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Phase II trial

# A new approach to delineating lymph node target volumes for post-operative radiotherapy in gastric cancer: A phase II trial

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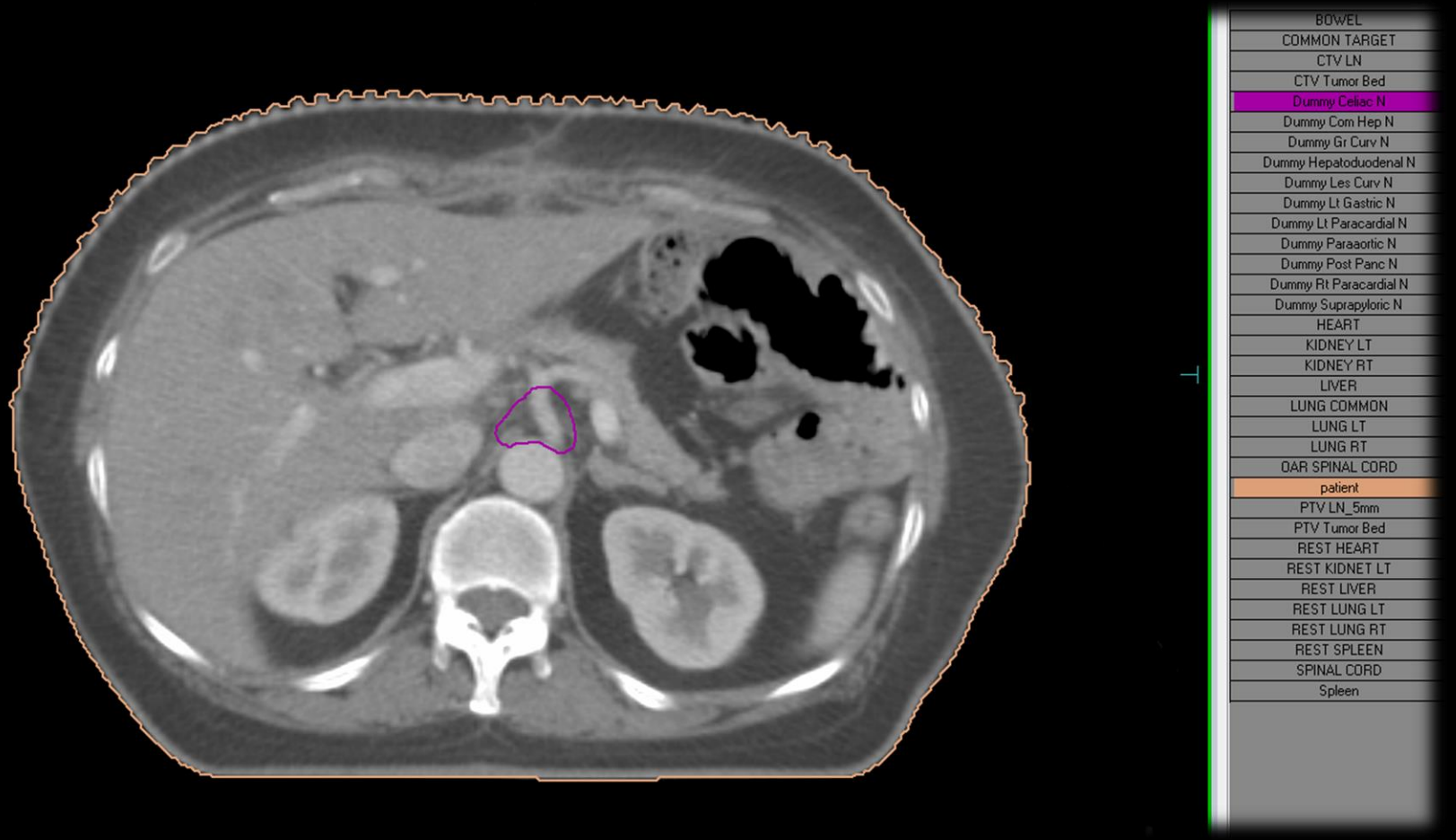
Table 1
The radiation indication and principal of target volume delineation for gastric lymph nodes (LNs).

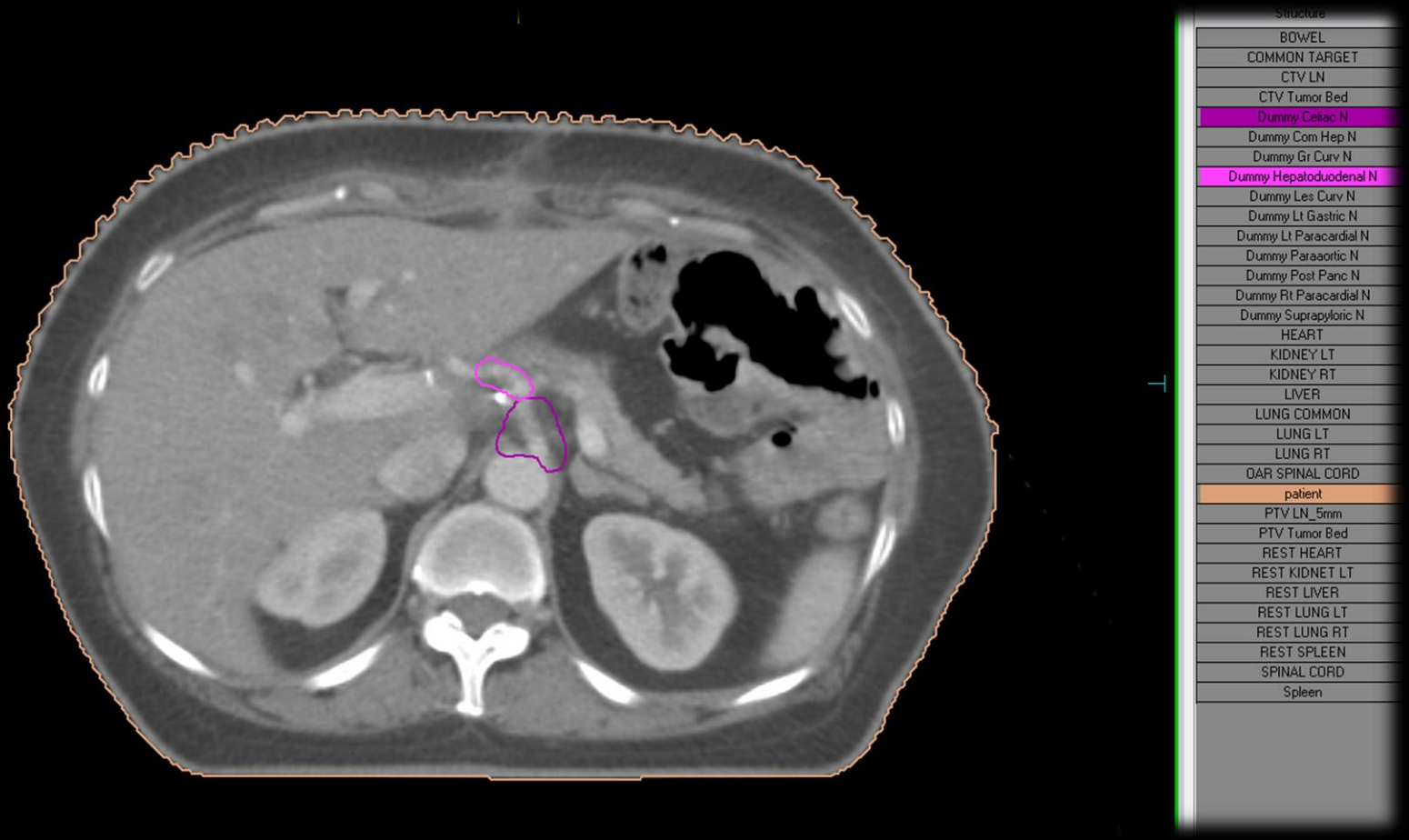
| Lymph node station | | Target volume delineation | Radiation indication |
|---|---|---|---|
| 1–6 | Perigastric LNs | Residual stomach and 0.5–1 cm expansion | Any perigastric LNs involved |
| 7 | LNs along the left gastric artery | The interspace between the liver and the stomach<br>Cranial–lower border of the cardia<br>Caudal–upper border of the celiac trunk<br>Anterior–anterior border of the lesser gastric curvature<br>Posterior–anterior border of the abdominal aorta<br>Right–left border of the liver<br>Left–right border of the stomach | Lesions occur in the lesser curvature, involve the lower esophagus, or involve the station 1 or 3a LNs |
| 8 | LNs along the common hepatic artery | The common hepatic artery and 0.5–1 cm expansion | Lesions located in the lesser curvature near the pylorus or in the lower portion of the greater curvature, or involvement to the station 3b, 5, 6, and 4d lymph nodes |
| 9 | LNs around the celiac artery | The celiac trunk and 0.5–1 cm expansion | Any LNs involved |
| 10 | LNs at the splenic hilum | The splenic artery distal to the pancreatic tail and the vessels at the splenic hilum, with an additional 0.5–1 cm margin | Lesions at the fundus or the left gastroepiploic artery-supplying area, or involvement of the 4sa or 4sb LNs |
| 11p | Proximal splenic artery LNs | The splenic artery from its origin to halfway between its origin and the pancreatic tail end, then with an additional 0.5–1 cm margin | Lesions at the left gastroepiploic artery-supplying area or station 6 LNs involved |
| 11d | Distal splenic artery LNs | The splenic artery from halfway between its origin and the pancreatic tail end to the end of the pancreatic tail, then with an additional 0.5–1 cm margin | Lesions at the fundus or the left gastroepiploic artery-supplying area |
| 12a | Hepatoduodenal ligament LNs along the proper hepatic artery | The proper hepatic artery from its gives rise to the left and right hepatic artery to the common hepatic artery | Lesions at the lesser curvature near the pylorus or at the lower portion of the greater curvature, or involvement of the station 3b, 5, 6, 4d, and 8 LNs |
| 12p | Hepatoduodenal ligament LNs along the portal vein | The portal vein from the right hepatic vein joins the portal vein to the right border of the pancreas | Lesions at the lesser curvature |
| 13 | LNs on the posterior surface of the pancreatic head | Cranial—the upper border of pancreatic head<br>Caudal—the lower border of pancreatic head<br>Right—the duodenum<br>Left—the abdominal aorta<br>Anterior–posterior border of the pancreas<br>Posterior–anterior border of the inferior vena cava | Signet-ring cell carcinoma or mucinous adenocarcinoma at the gastric antral, or the pancreas involved |
| 14v | LNs along the superior mesenteric vein | The superior mesenteric vein from the lower border of the pancreas to the level of bifurcation of colic vein, then with an additional 0.5–1 cm margin | Station 6 LNs involved |
| 14a | LNs along the superior mesenteric artery | The proximal 2.5 cm to 3.0 cm of the superior mesenteric artery and 1 cm expansion | Lesions invading into the adjacent tissues or organs such as the pancreas or the transverse colon |
| 15 | LNs along the middle colic vessels | The region from the involved transverse colon to the root of the superior mesenteric vessels | Lesions at the greater curvature and invading into the transverse colon or its mesentery |
| 16a1* | LNs around the abdominal aorta | Para-aortic LNs in the diaphragmatic aortic hiatus | Lesions at gastroesophageal junction |
| 16a2* | | Cranial: the upper margin of the origin of the celiac artery<br>Caudal: the lower border of the left renal vein | Any LNs involved |
| 16b1* | | Cranial: the lower border of the left renal vein<br>Caudal: the upper border of the origin of the inferior mesenteric artery | Any LNs involved, excluding lesions at gastroesophageal junction |
| 16b2* | | Cranial: the upper border of the origin of the inferior mesenteric artery<br>Caudal: the aortic bifurcation | Station 16b2 is generally not included in the CTV |

Left: left border of abdominal aorta with an additional 1–1.5 cm margin; Right: right border of abdominal aorta with an additional 2 cm margin; Anterior: anterior border of abdominal aorta with an additional 1.5–2 cm margin; Posterior: posterior border of abdominal aorta with an additional 0.3–0.5 cm margin.
* 16a1, 16a2, 16b1 and 16b2 have same left, right, anterior and posterior border

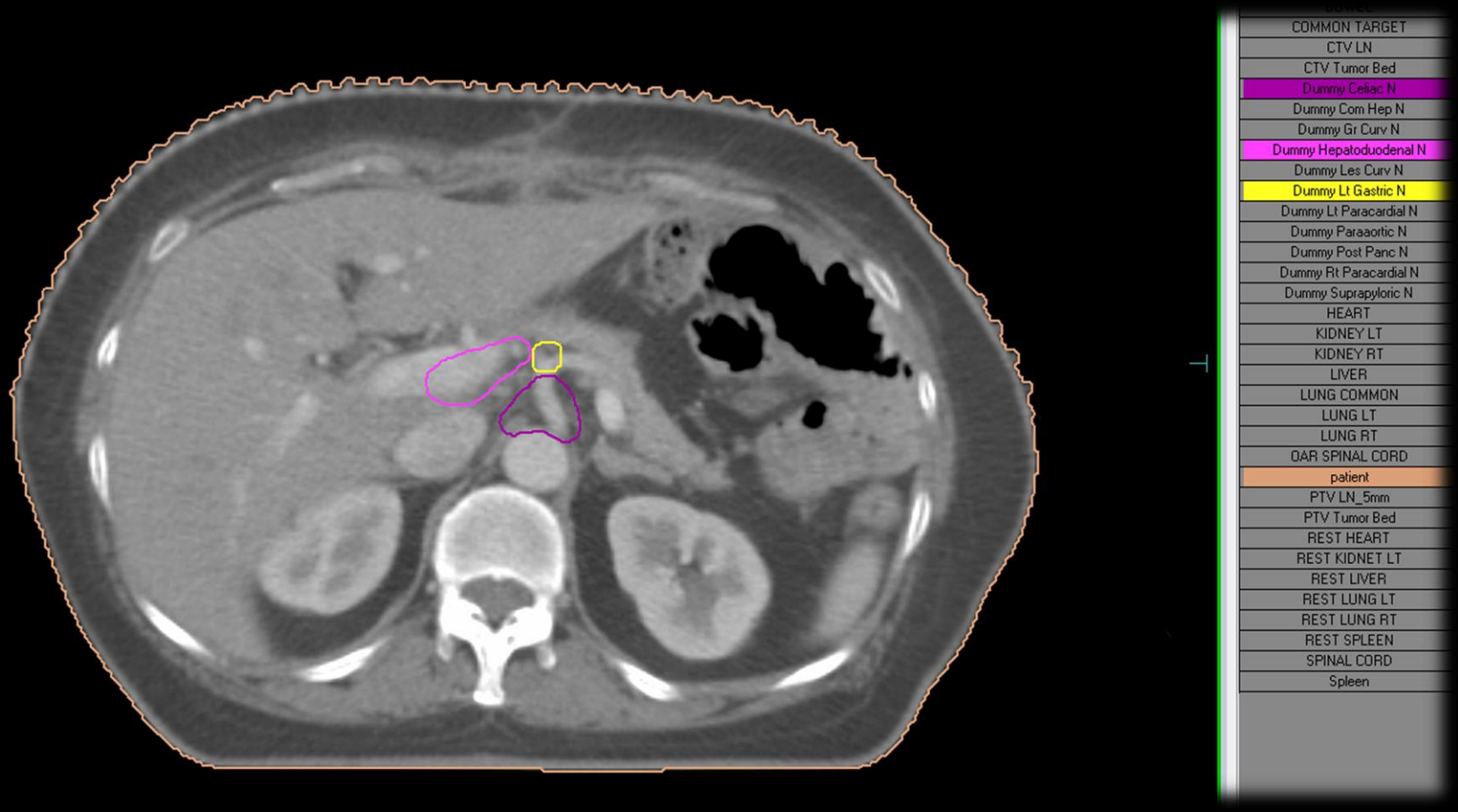
# Nodal Contours



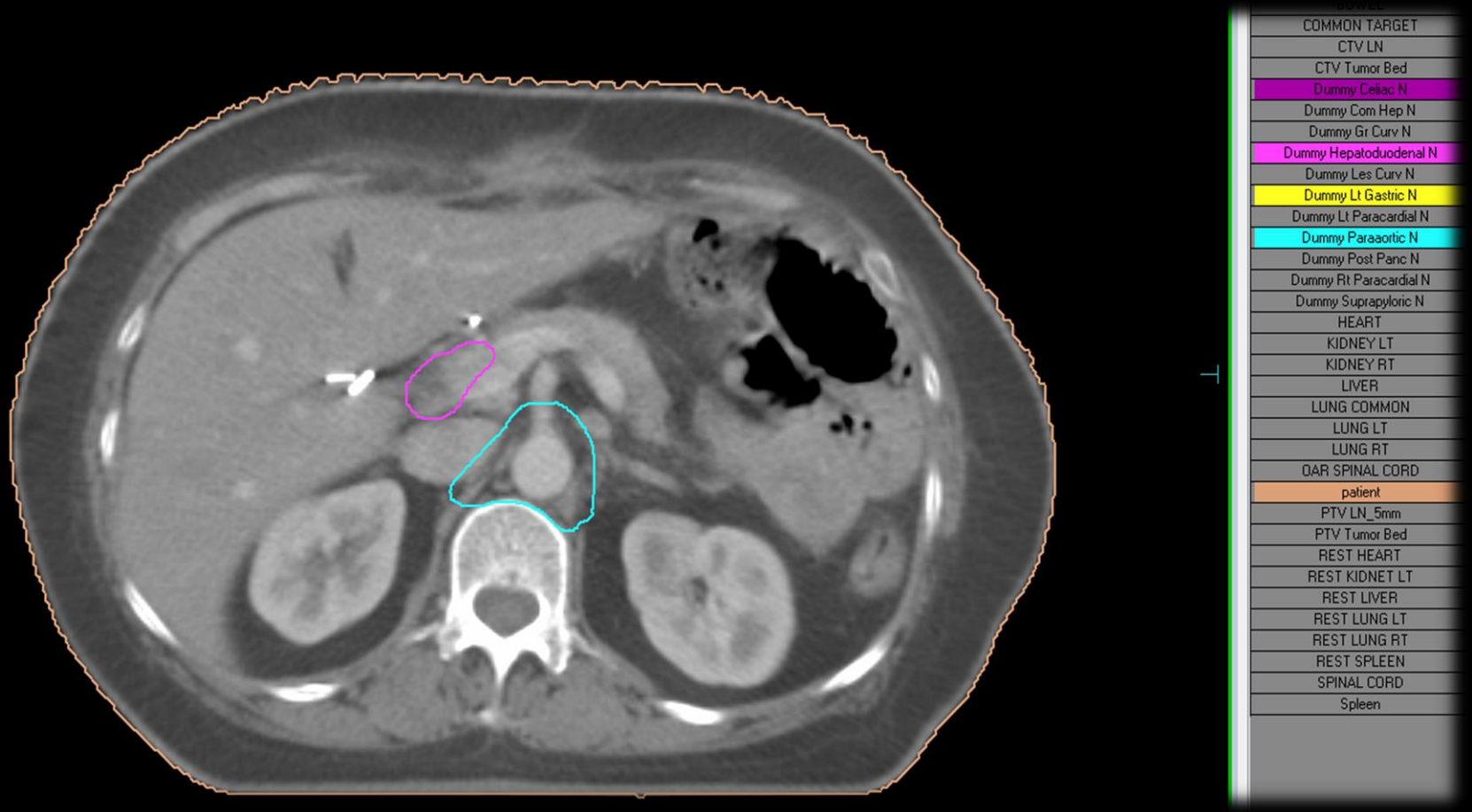

**Celiac Nodes**



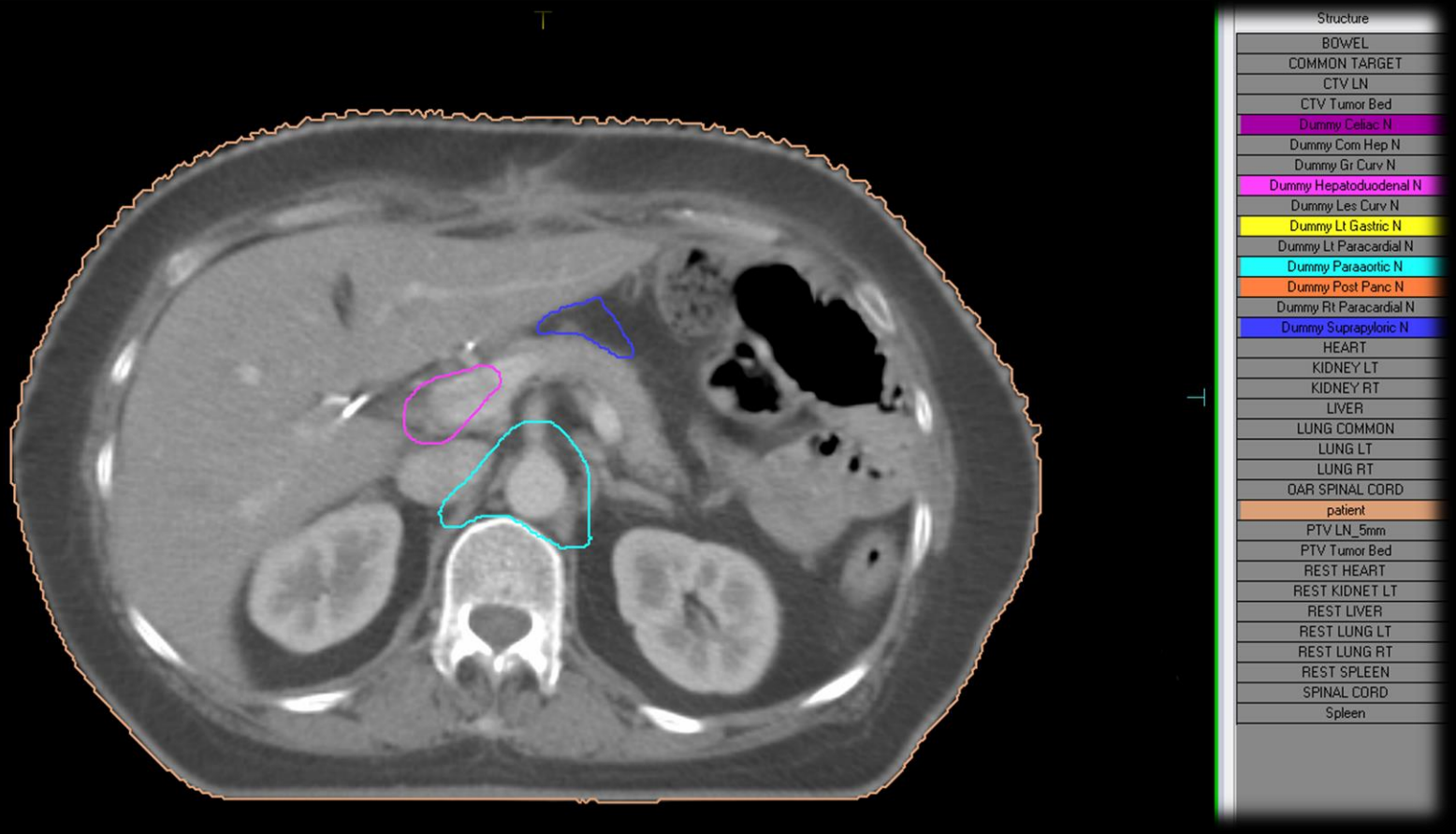

# Hepatoduodenal Nodes



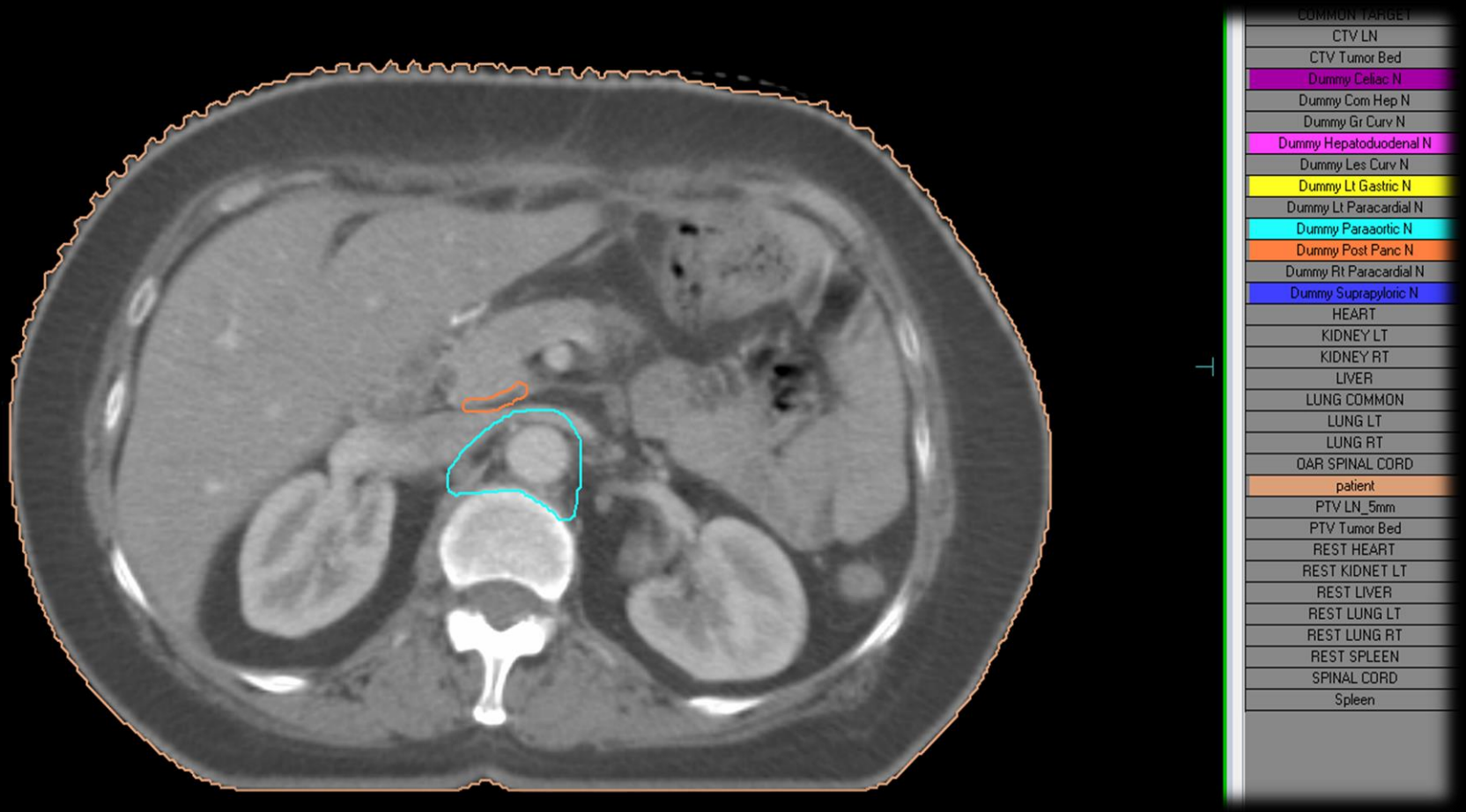

# Left Gastric Nodes



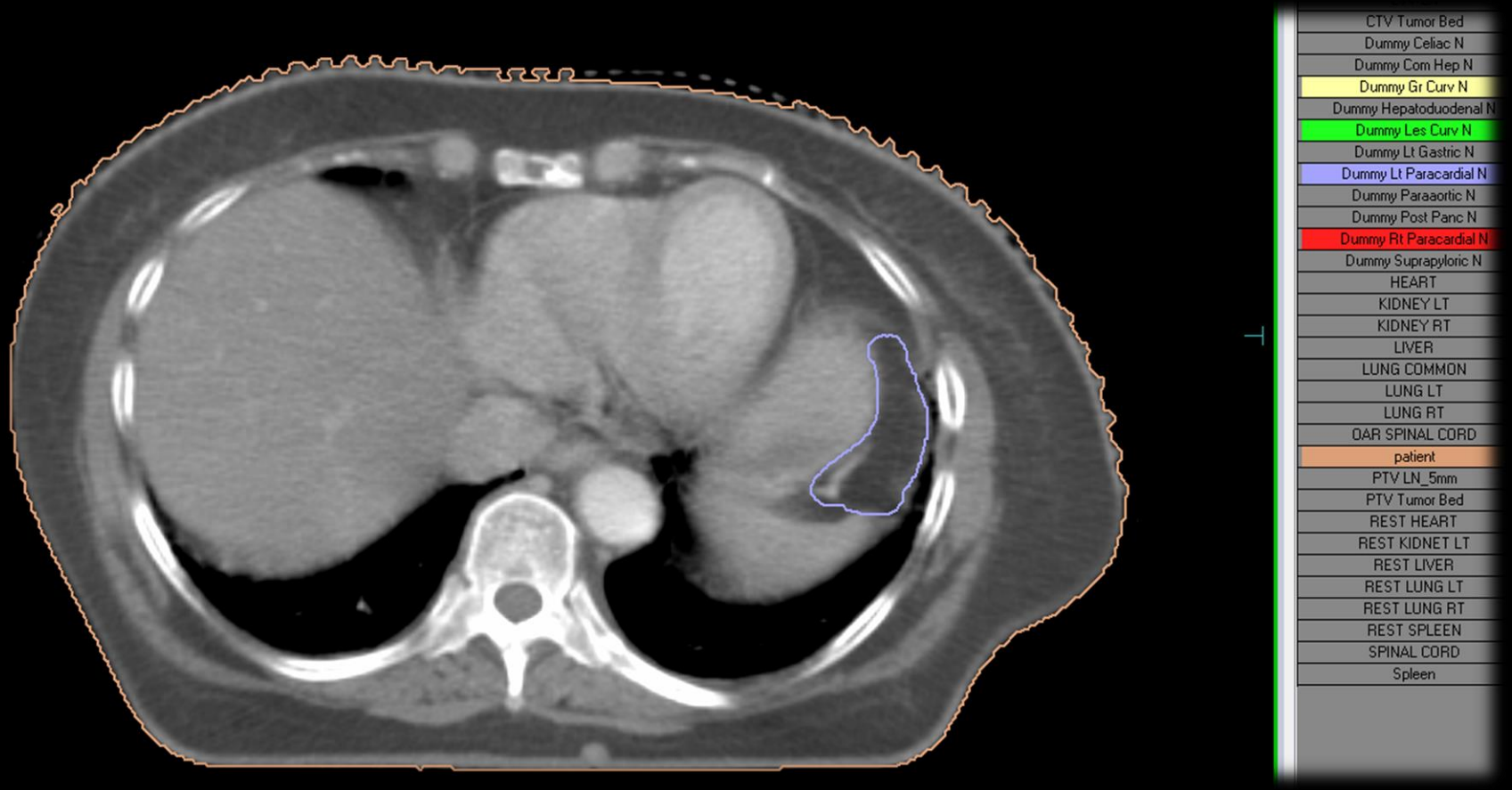

# Paraaortic Nodes



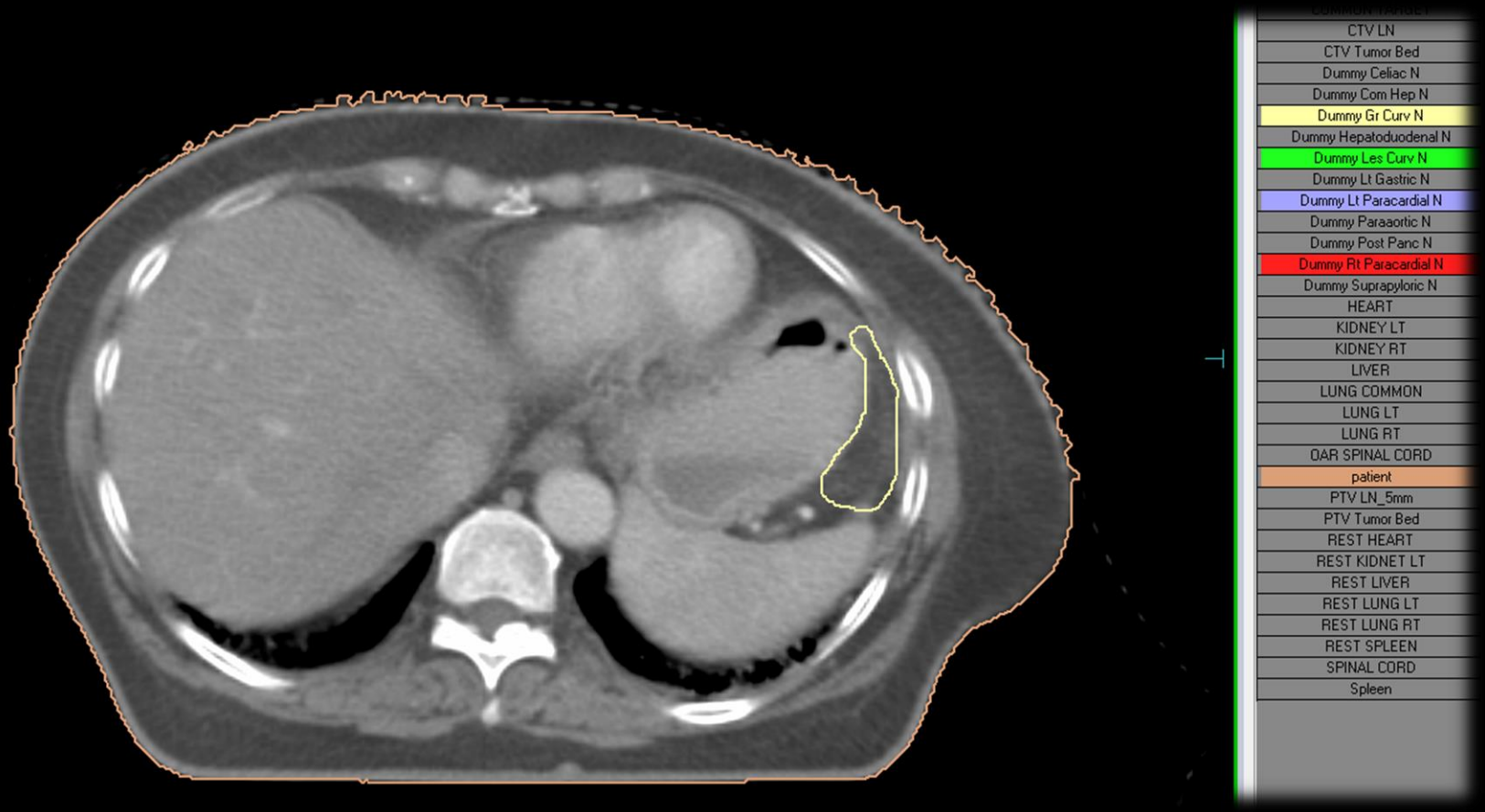

# Suprapyloric Nodes



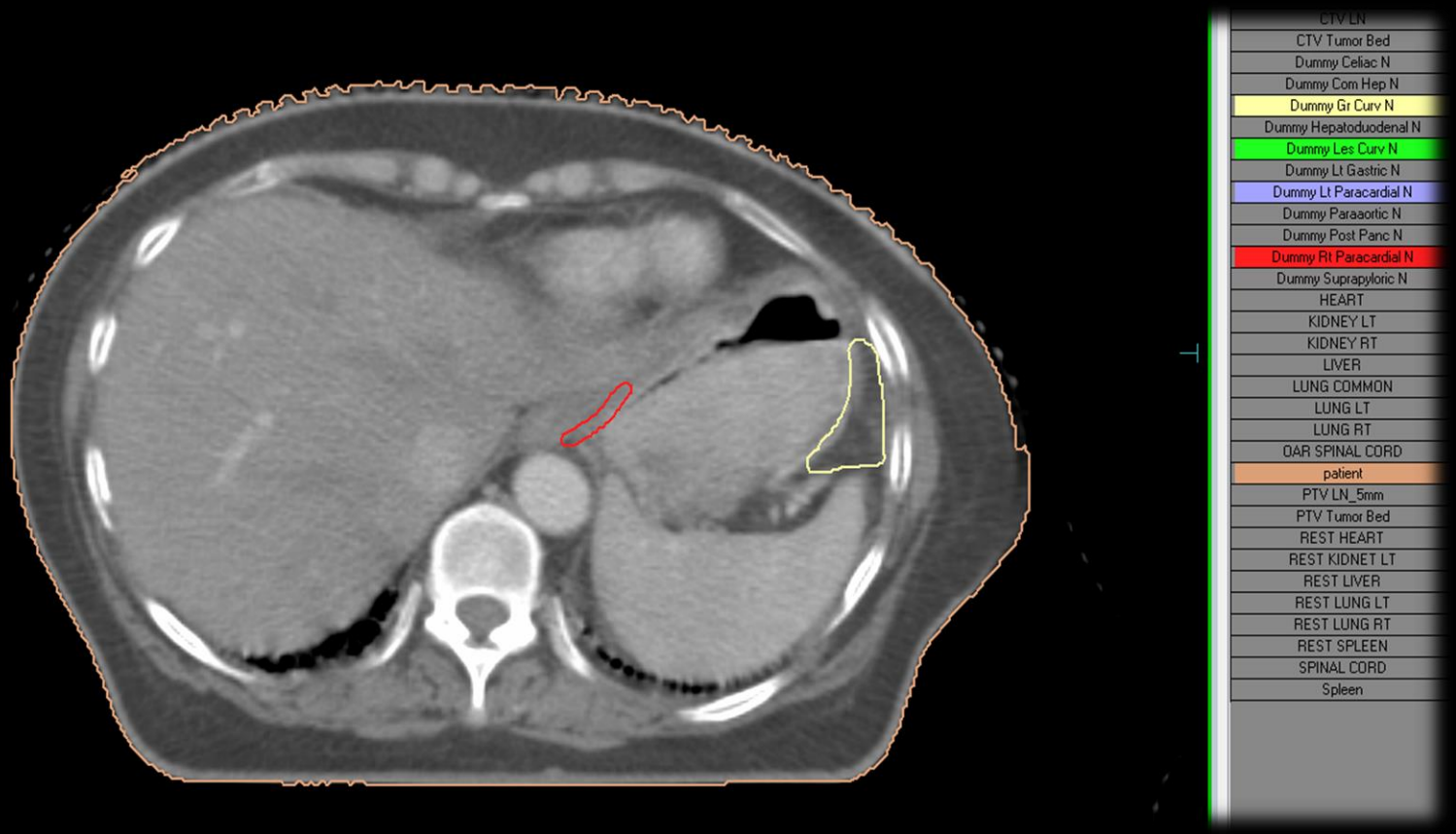

# Posterior Pancreatic Nodes



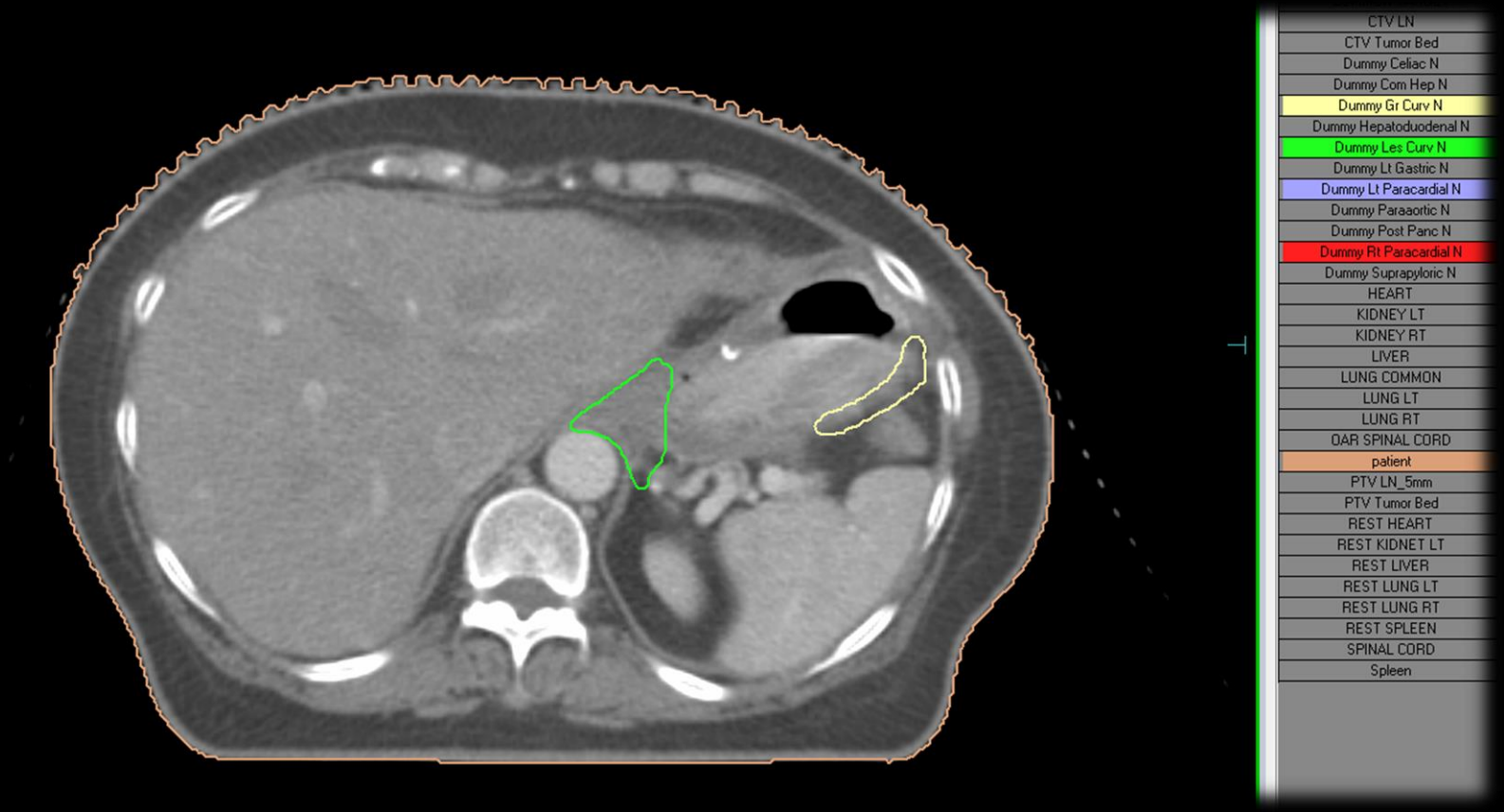

# Left Paracardial Nodes



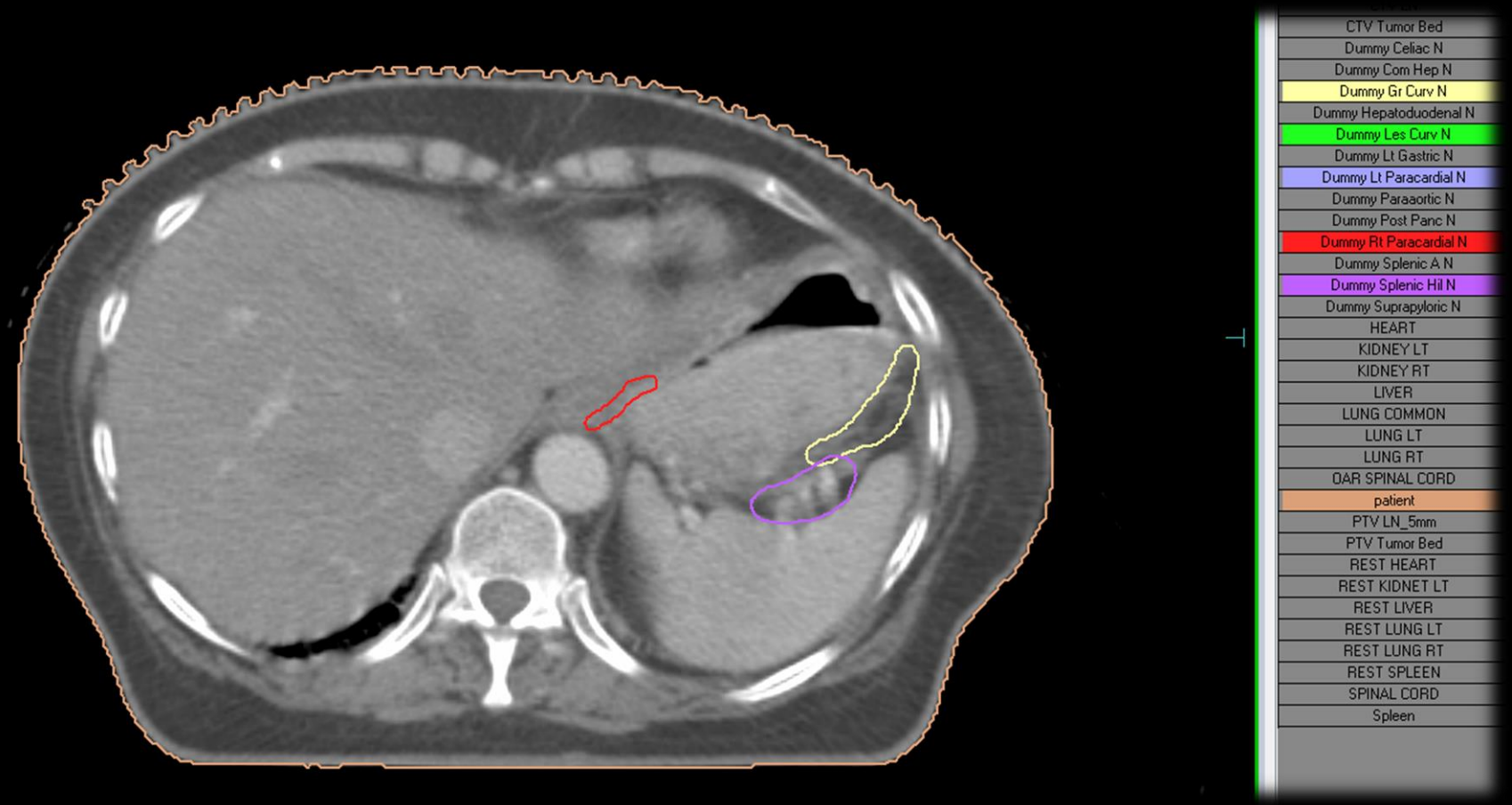

# Greater Curvature Nodes



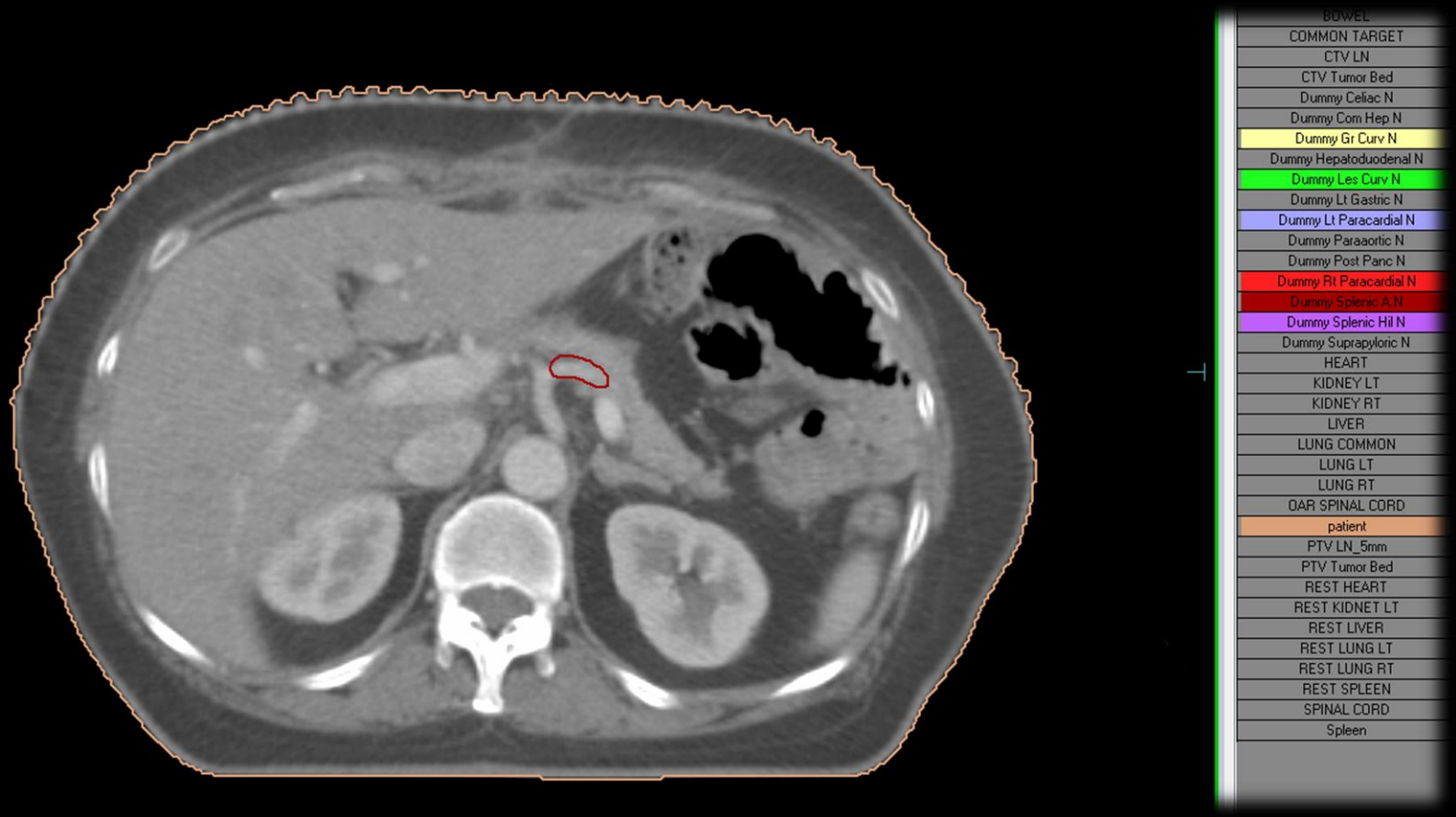

# Right Paracardial Nodes



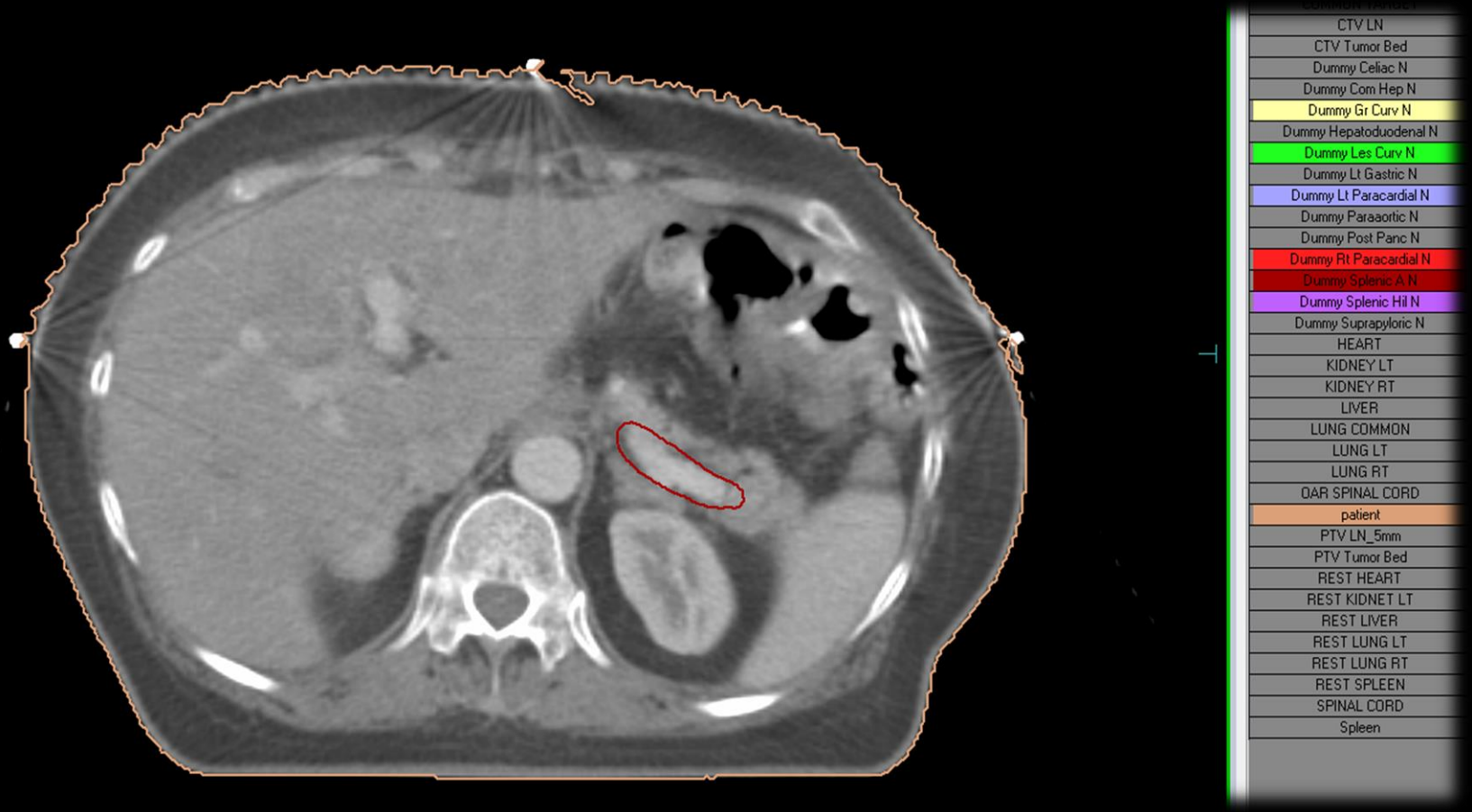

# Lesser Curvature Nodes



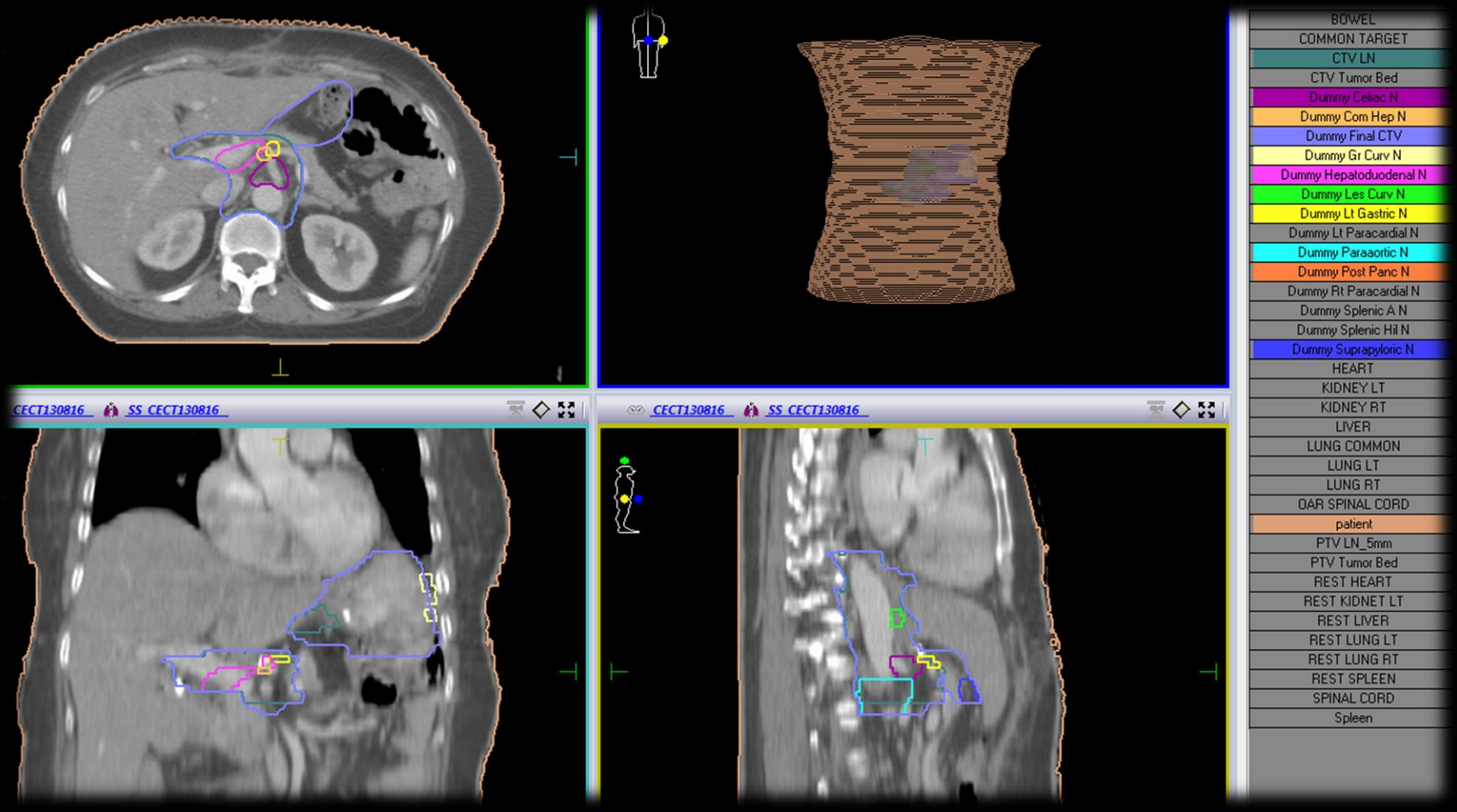

# Splenic Hilar Nodes



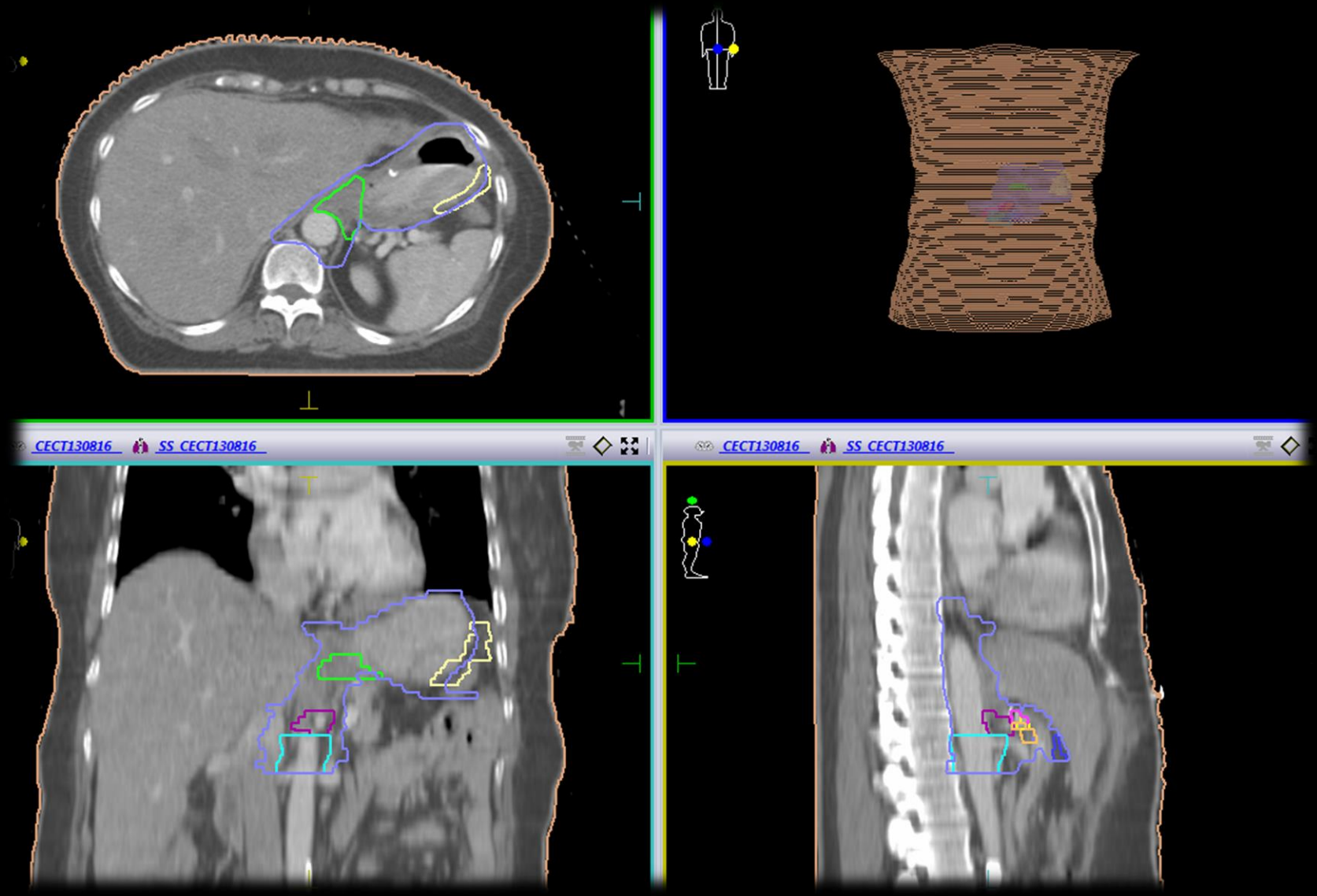

# Splenic Arterial Nodes




# Splenic Arterial Nodes




# Regional Lymphatics of Stomach




# Lymphatics Contour vs CTV

# Post-operative Radiotherapy

## Dose –

- R0 resection - 45-50.4Gy @1.8Gy/fr
- R+ resection – 55-60Gy (to smaller volume)

## OAR constraints –

- Spinal Cord: $D_{max} \leq 45Gy$
- Lungs: V20Gy < 20-30%; Dmean < 20Gy
- Bowel: V45Gy < 195cc
- Heart: V30Gy < 30% (closer to 20% preferred)
  Dmean < 30Gy
- Kidneys (evaluate each separately):
  Dmean < 18Gy; V20Gy < 33%
- Liver: Dmean < 25Gy; V30Gy < 33%

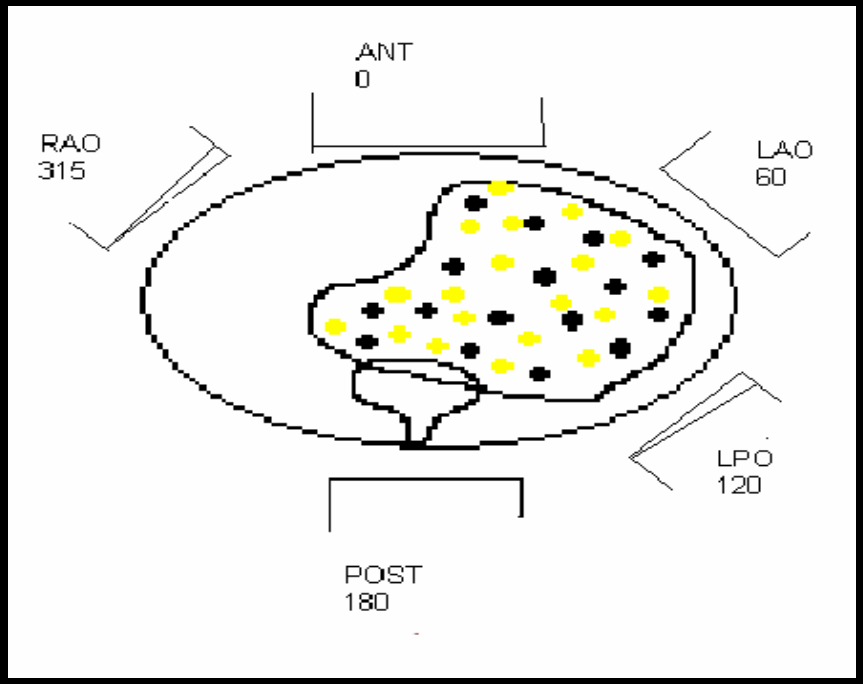
*Jansen EP et al, IJROBP 2007;*
*Dewit L et al, Eur J Cancer 1993;*
*Dawson LA et al, IJROBP 2001*

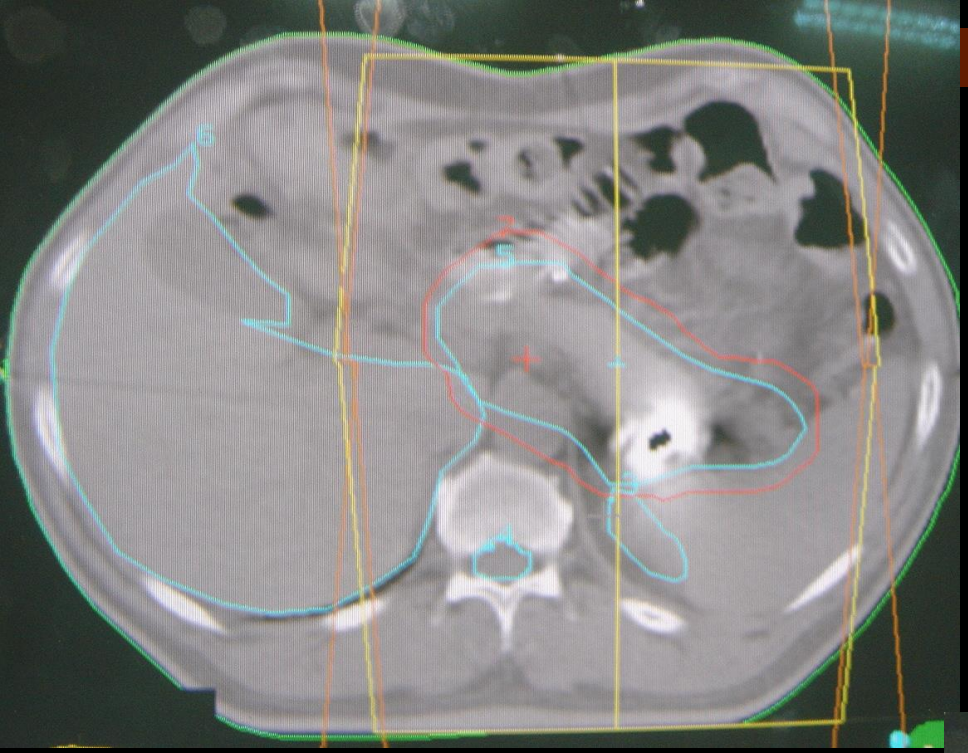
## BEAM ARRANGEMENT

- AP/PA portals
- Anteriorly weighted beams to reduce spinal cord doses
- Reduced fields with obliques or laterals used after 45 Gy
- AP/PA +LATERAL/ oblique port can be used from beginning to decrease spinal cord dose till 20 Gy. Lateral port to be removed thereafter to decrease liver dose

# 3DCRT

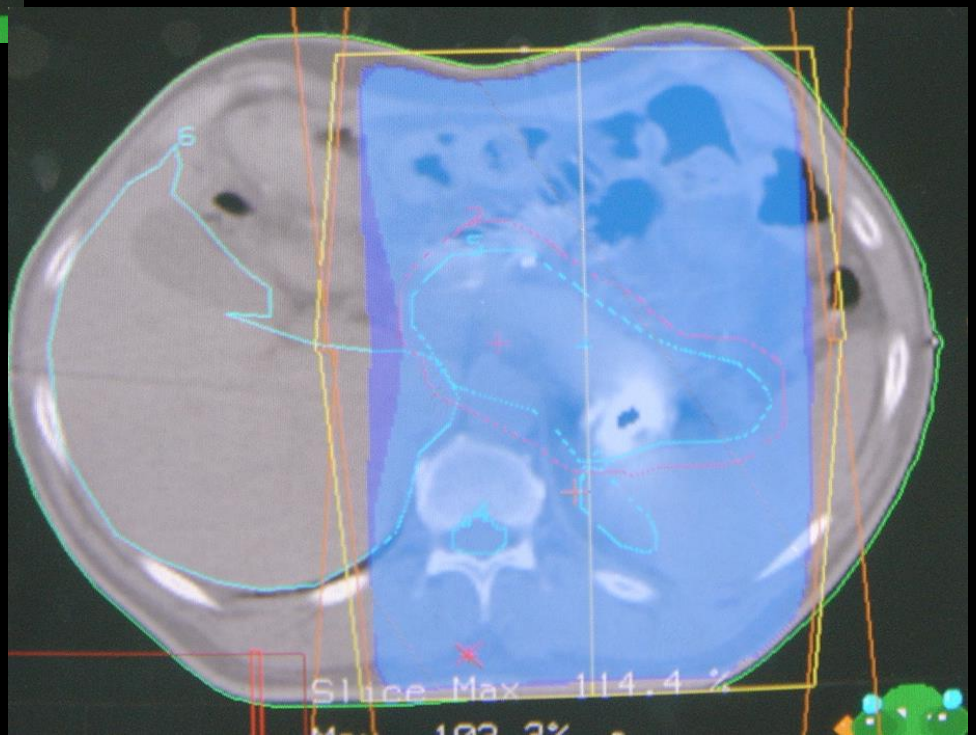
- **Beam arrangement –**
  **AP, PA, Obliques**
- **Fields may be weighted to maximize sparing of kidneys**
- **MLCs**



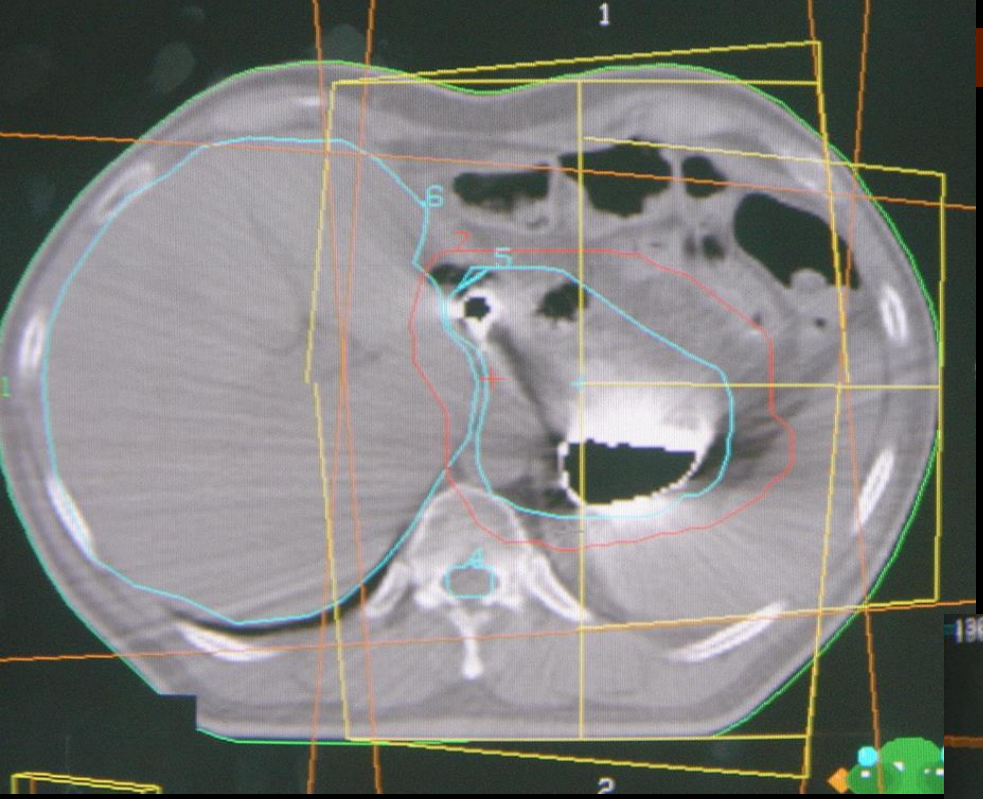


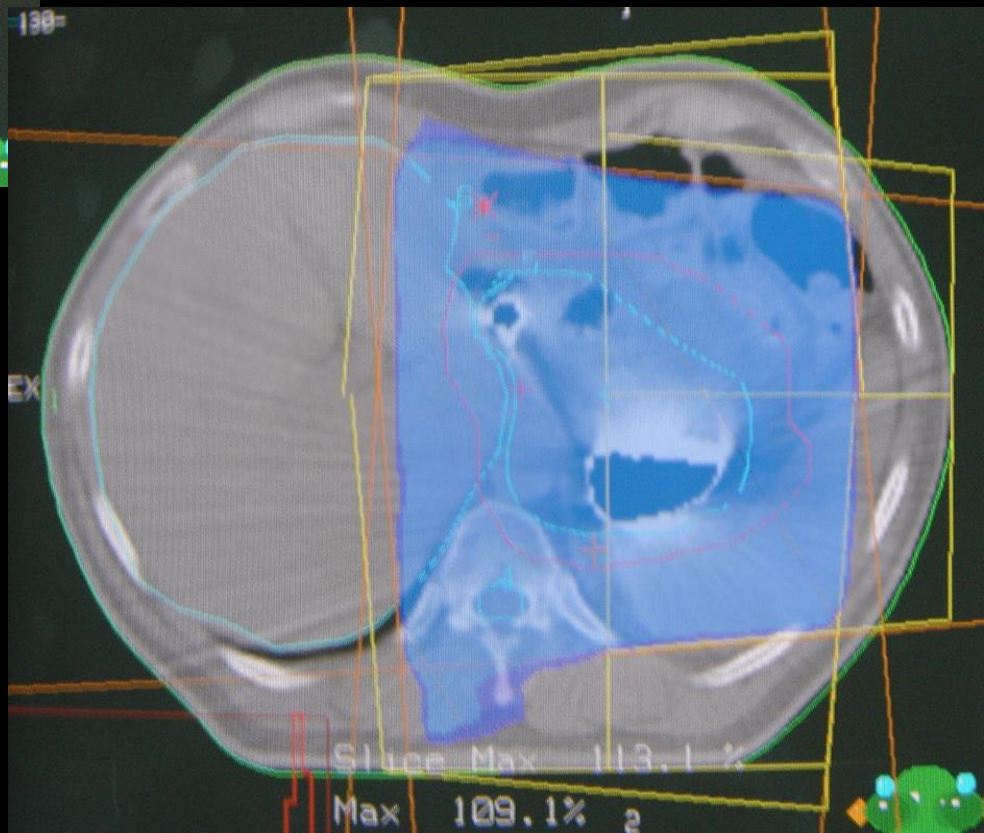
## AP/PA beam portals

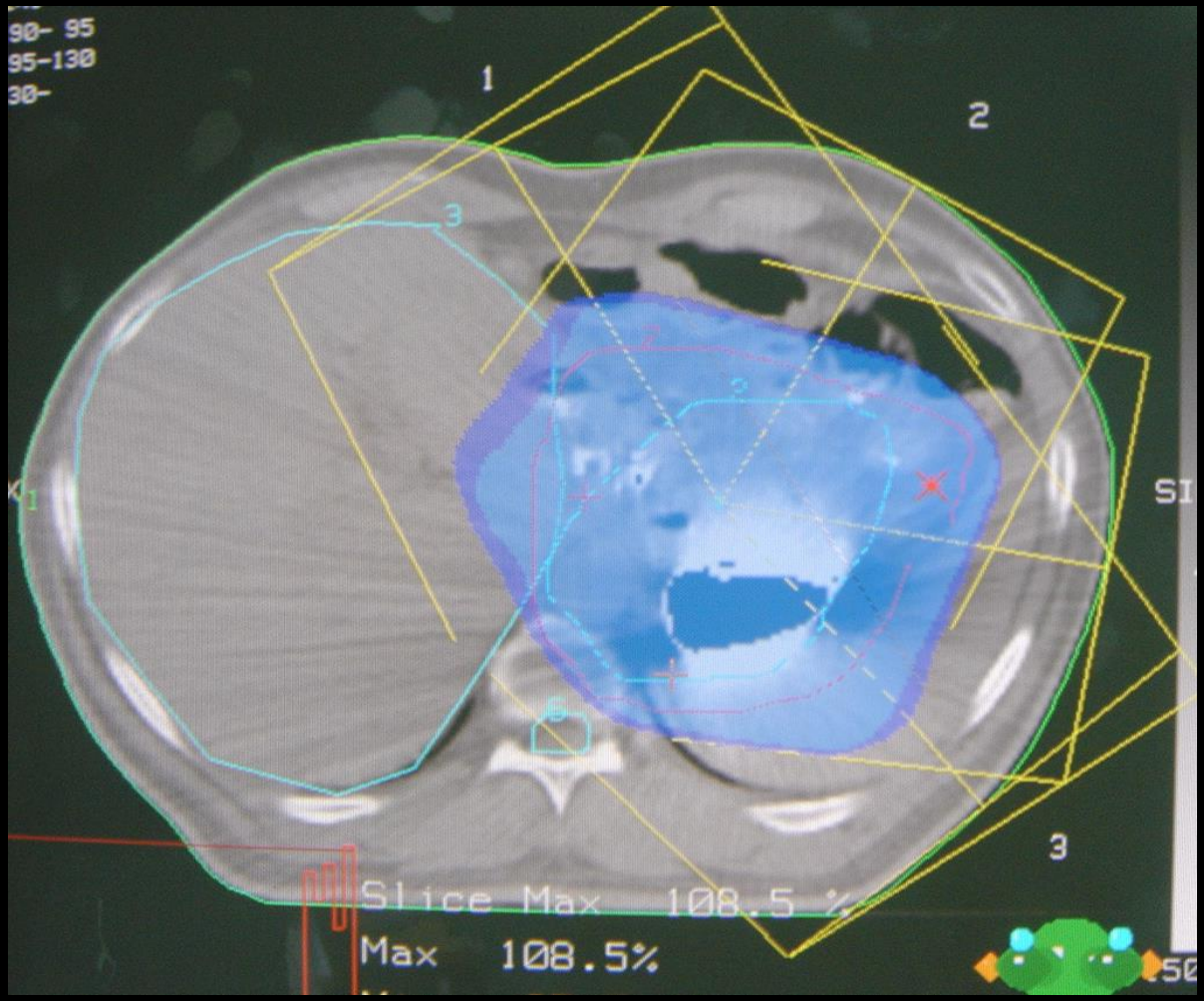
Full doses to cord, bowel



## AP/PA/LAT portals



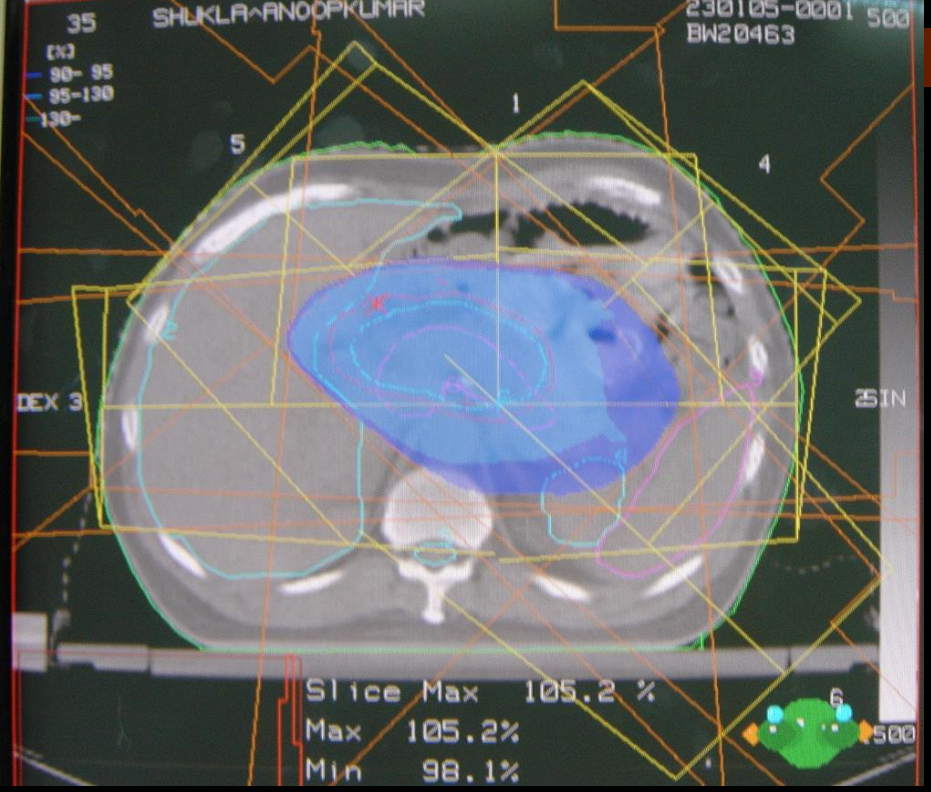


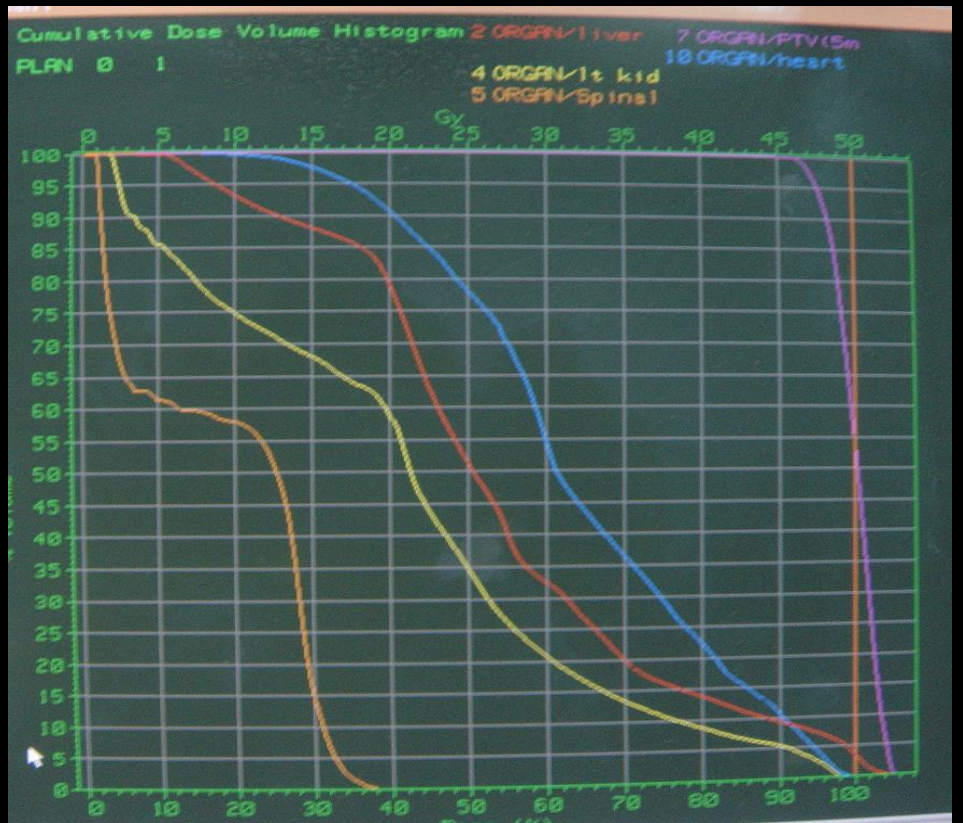


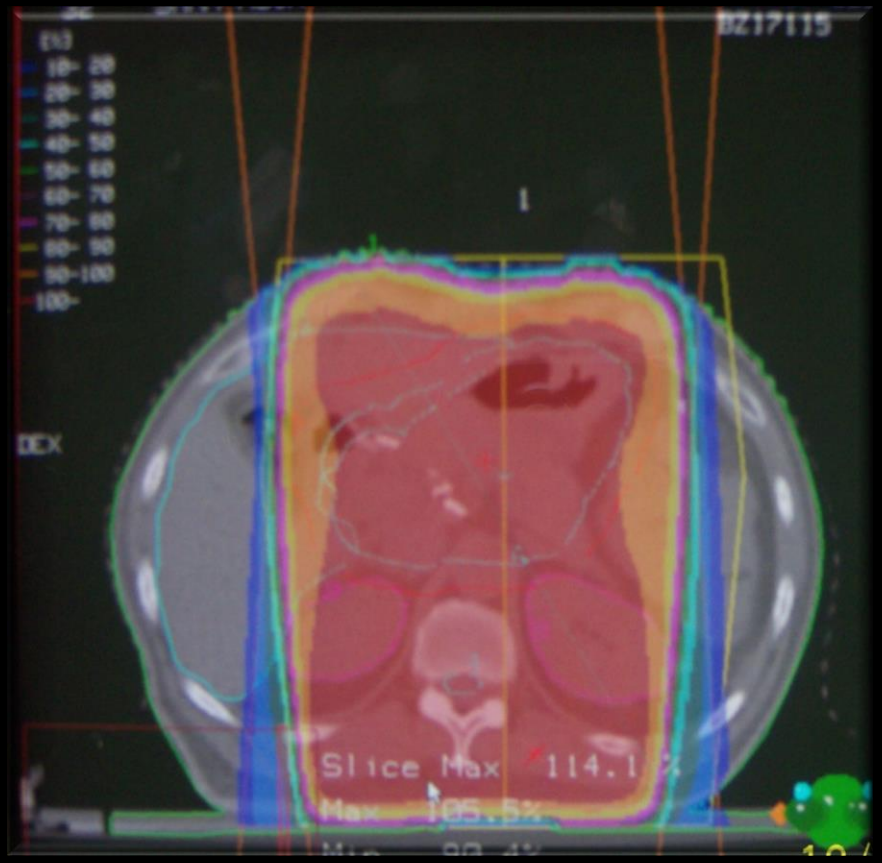

## Oblique beams

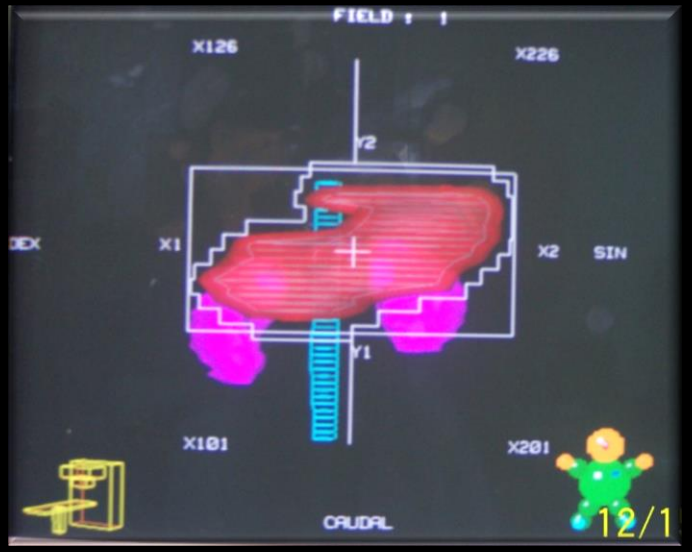
**Relative sparing of cord, bowel**

# LAT + Obliques



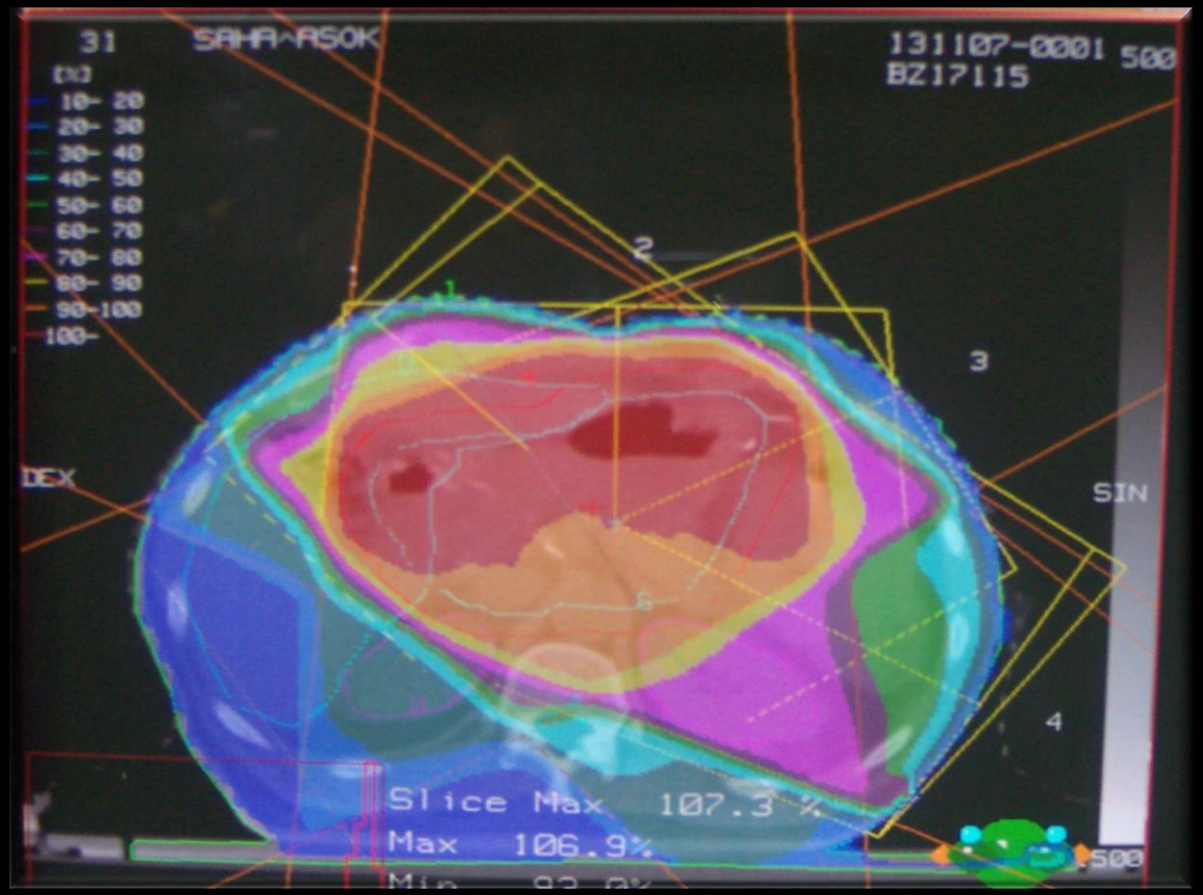






**AP/PA beams**

**Liver & B/L Kidneys 90-100% isodose**




**Oblique beams**

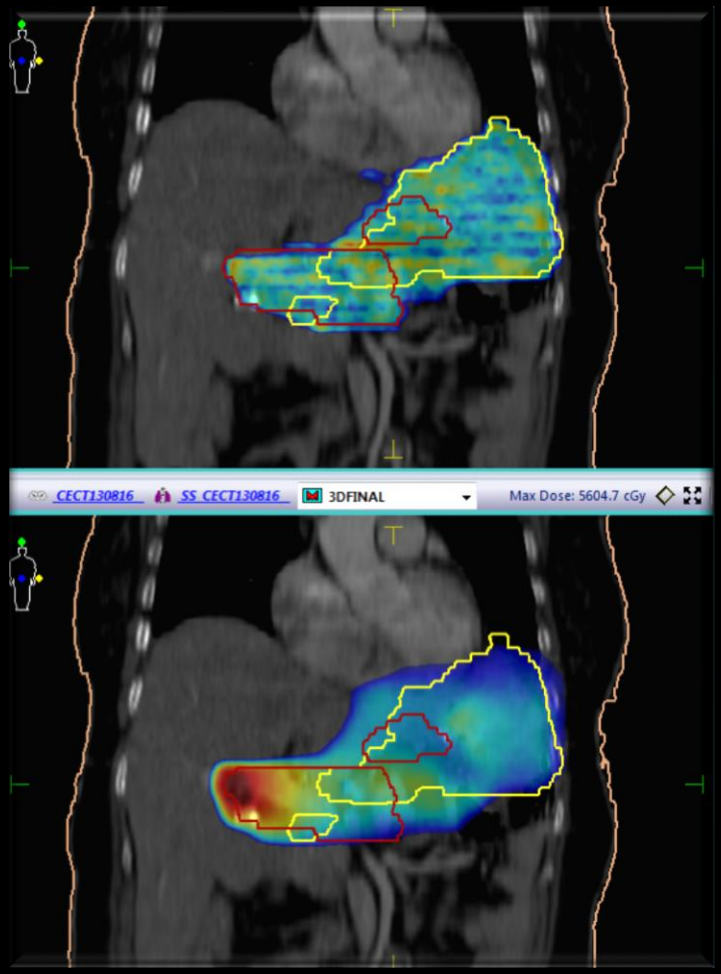
**Kidneys 70-80% isodose**

**54/F,**

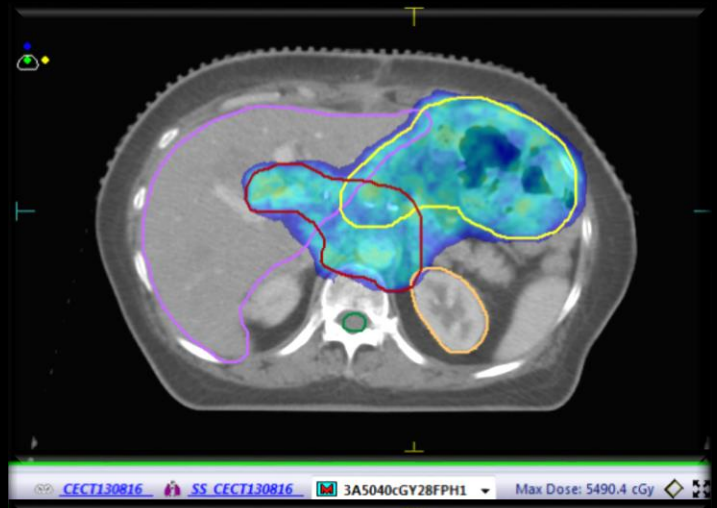
**Carcinoma Pyloric Antrum (s/p Distal Gastrectomy, pT2pN3M0)**

**Adjuvant RT – 45Gy/25#**

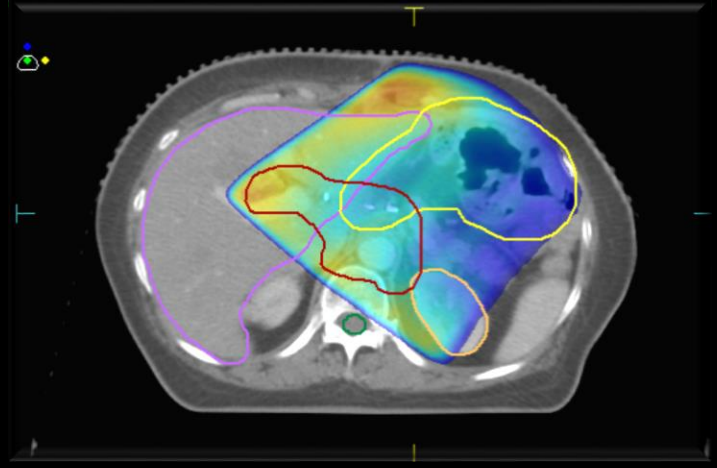
**3DCRT vs VMAT plans**


CECT130816
SS CECT130816
3DFINAL
Max Dose: 5604.7 cGy

VMAT

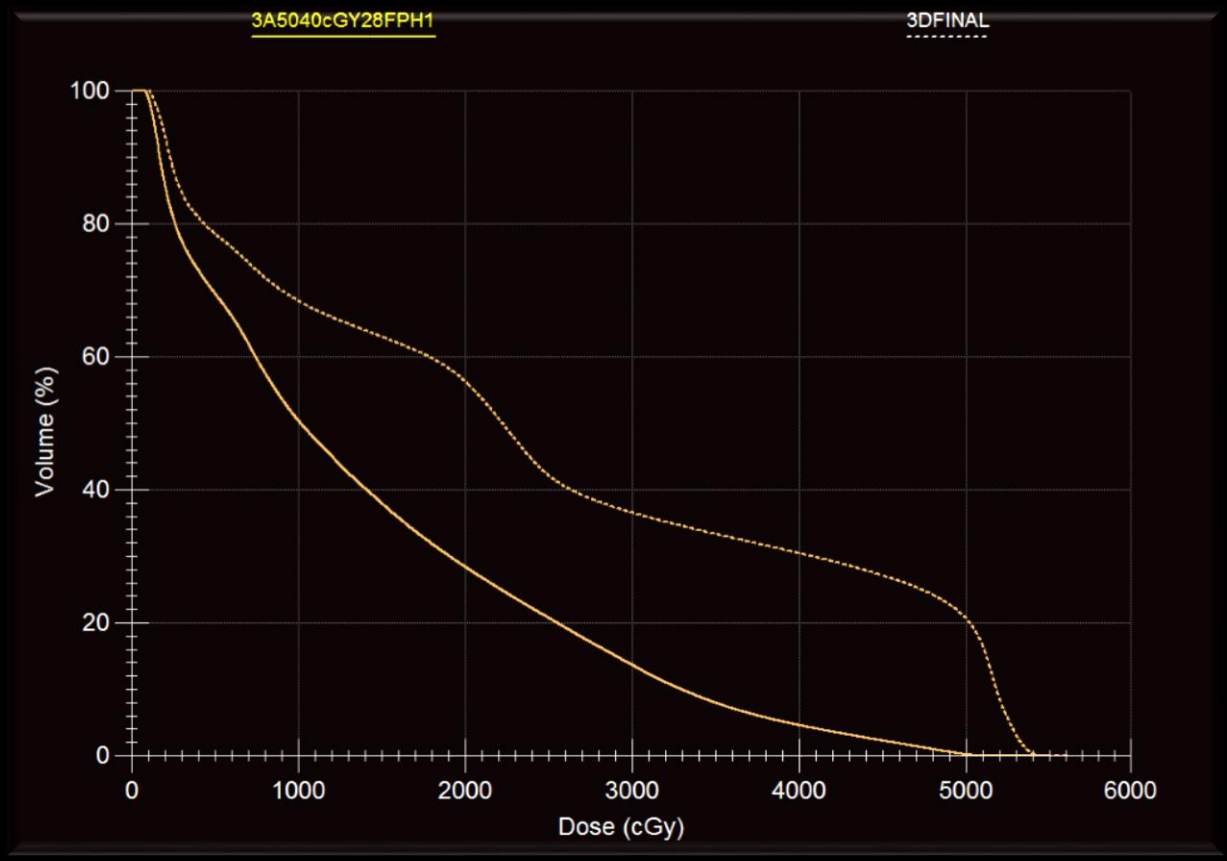

CECT130816
SS CECT130816
3A5040cGY28FPH1
Max Dose: 5490.4 cGy

3DCRT



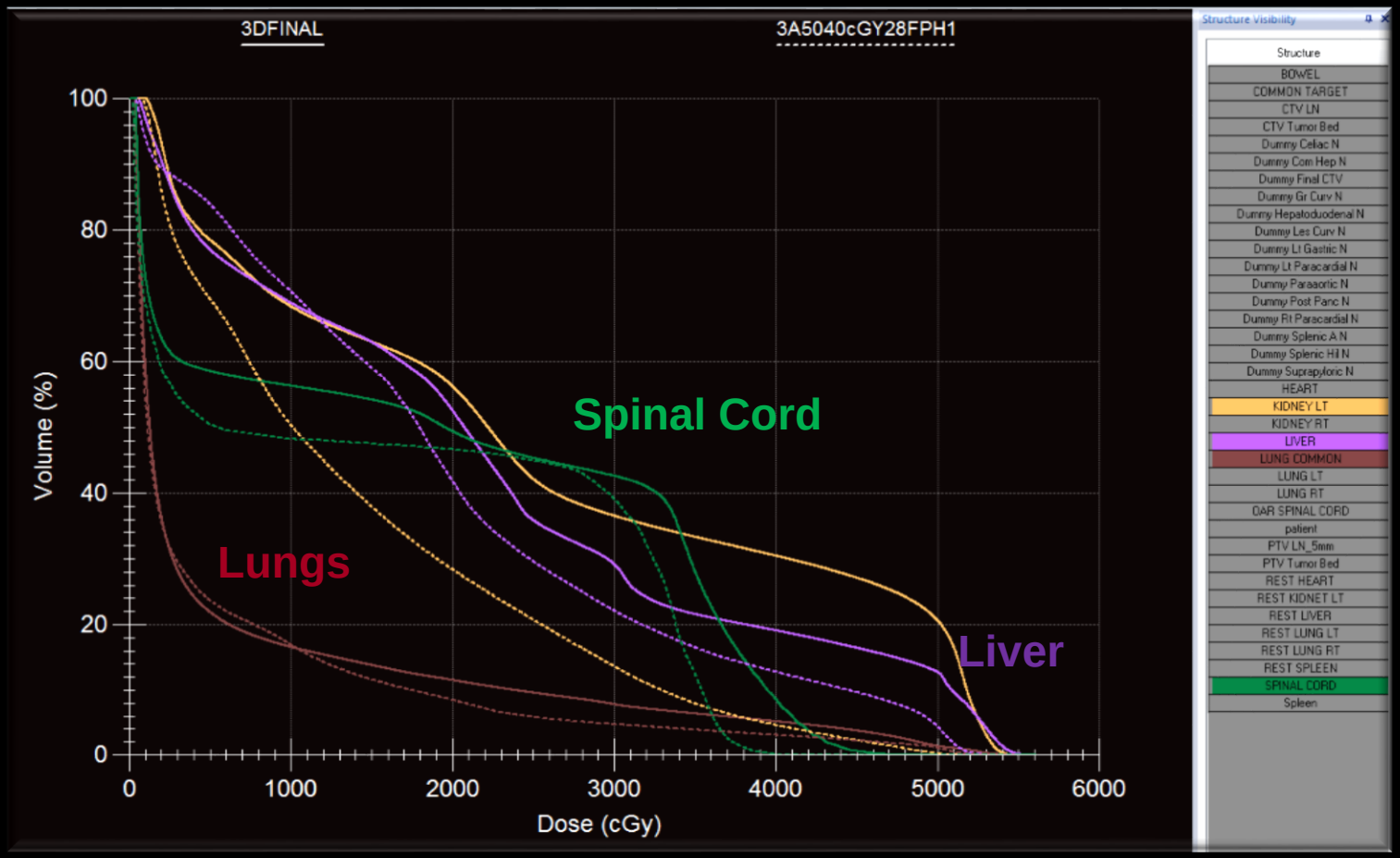
# DVH

***Left Kidney***




| | 3DCRT | VMAT |
|---|---|---|
| Dmean | 25.2 Gy | 14.1 Gy |
| V20Gy | 56% | 28% |

# DVH


3DFINAL
3A5040cGY28FPH1
Volume (%)
100
80
60
40
20
0
0
1000
2000
3000
4000
5000
6000
Dose (cGy)
Spinal Cord
Lungs
Liver
Structure Visibility
Structure
BOWEL
COMMON TARGET
CTV LN
CTV Tumor Bed
Dummy Celiac N
Dummy Com Hep N
Dummy Final CTV
Dummy Gr Curv N
Dummy Hepatoduodenal N
Dummy Les Curv N
Dummy Lt Gastric N
Dummy Lt Paracardial N
Dummy Paraaortic N
Dummy Post Panc N
Dummy Rt Paracardial N
Dummy Splenic A N
Dummy Splenic Hil N
Dummy Suprapyloric N
HEART
KIDNEY LT
KIDNEY RT
LIVER
LUNG COMMON
LUNG LT
LUNG RT
OAR SPINAL CORD
patient
PTV LN_5mm
PTV Tumor Bed
REST HEART
REST KIDNET LT
REST LIVER
REST LUNG LT
REST LUNG RT
REST SPLEEN
SPINAL CORD
Spleen

Statistics | Display

| Structure | Volume (cm³) | Plan | Min. Dose (cGy) | Max. Dose (cGy) | Mean Dose (cGy) | Cold Ref. (cGy) | Volume < (cm³) | Volume < (%) | Hot Ref. (cGy) | Volume > (cm³) | Volume > (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BOWEL | 573.653 | 3A5040cGY28FPH1 | 69.1 | 5490.4 | 925.4 | **4029.7** | 547.766 | 95.49 | **4500.0** | 15.178 | 2.65 |
| BOWEL | 573.653 | 3DFINAL | 123.5 | 5145.2 | 1241.4 | **4029.7** | 519.119 | 90.49 | **4500.0** | 33.504 | 5.84 |
| HEART | 447.152 | 3A5040cGY28FPH1 | 102.9 | 5368.9 | 1905.8 | | | | 444.0 | **330.906** | **74.00** |
| HEART | 447.152 | 3DFINAL | 127.0 | 5190.0 | 1947.6 | | | | 521.1 | **330.906** | **74.00** |
| KIDNEY LT | 151.233 | 3A5040cGY28FPH1 | 77.3 | 5115.6 | 1417.1 | | | | **3000.0** | 20.644 | 13.65 |
| KIDNEY LT | 151.233 | 3DFINAL | 105.9 | 5471.1 | 2520.5 | | | | **3000.0** | 55.239 | 36.53 |
| KIDNEY RT | 143.293 | 3A5040cGY28FPH1 | 56.8 | 4111.0 | 1027.8 | | | | | | |
| KIDNEY RT | 143.293 | 3DFINAL | 83.9 | 5054.7 | 1636.4 | | | | | | |
| LIVER | 1503.551 | 3A5040cGY28FPH1 | 31.8 | 5431.9 | 1982.7 | | | | | | |
| LIVER | 1503.551 | 3DFINAL | 55.7 | 5569.5 | 2221.8 | | | | | | |
| LUNG COMMON | 1700.468 | 3A5040cGY28FPH1 | 18.1 | 5454.4 | 552.5 | | | | **2000.0** | 143.965 | 8.47 |
| LUNG COMMON | 1700.468 | 3DFINAL | 33.1 | 5480.2 | 643.2 | | | | **2000.0** | 196.184 | 11.54 |
| PTV LN_5mm | 319.703 | 3A5040cGY28FPH1 | 4046.9 | 5438.5 | 5076.0 | | | | 4937.7 | **303.718** | **95.00** |
| PTV LN_5mm | 319.703 | 3DFINAL | 4636.4 | 5569.5 | 5155.5 | | | | 4949.0 | **303.718** | **95.00** |
| PTV Tumor Bed | 559.347 | 3A5040cGY28FPH1 | 4072.3 | 5458.7 | 5076.6 | | | | 4933.4 | **531.380** | **95.00** |
| PTV Tumor Bed | 559.347 | 3DFINAL | 3950.4 | 5472.9 | 5042.1 | | | | 4842.0 | **531.380** | **95.00** |
| SPINAL CORD | 24.893 | 3A5040cGY28FPH1 | 21.7 | 4101.3 | 1630.6 | | | | **4500.0** | 0.000 | 0.00 |
| SPINAL CORD | 24.893 | 3DFINAL | 39.8 | 4757.9 | 1913.1 | | | | **4500.0** | 0.138 | 0.55 |
| patient(Unsp.Tiss.) | 19223.305 | 3A5040cGY28FPH1 | 0.0 | 5424.1 | 453.4 | | | | | | |
| patient(Unsp.Tiss.) | 19223.305 | 3DFINAL | 1.7 | 5603.2 | 550.8 | | | | | | |

# Supportive Care

- Nutrition, review weekly
- Prophylactic antiemetics
- B12, Fe, Folate, Vitamins as indicated
- CBC weekly during treatment, then monthly

*Let us not cast aside*
*What belongs to the past,*
*for,*
*It is only with the Past*
*That we can weave the fabric of the*
*Future*

*….Anatole France*

# Thank You