CONSENSUS PANEL CONTOURING ATLAS FOR THE DELINEATION OF THE CLINICAL TARGET VOLUME IN THE POSTOPERATIVE TREATMENT OF PANCREATIC CANCER

RTOG
RADIATION THERAPY ONCOLOGY GROUP

Collaborators

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Background

- Radiotherapy (RT) quality assurance is essential to validate treatment efficacy
- RT fields were prospectively reviewed in the RTOG 97-04 study demonstrating that 48% of treatment plans did not meet protocol requirements.
- Based on “per protocol” versus “not per protocol” radiation delivery, the frequency of grade 3/4 toxicity did not vary significantly on the 5-FU arm but did show a trend of less toxicity for patients on the gemcitabine arm.
- Survival was significantly increased for patients treated per protocol ($p=0.019$).

Background

- In RTOG 0848, prospective radiation quality control is required
- Central review will be performed prior to treatment delivery
- CT-based planning is required
- Either 3D conformal (3DCRT) or intensity-modulated radiotherapy (IMRT) planning
- The normal tissues must be delineated and a clinical target volume (CTV) will be defined

Background

- To ensure the adequacy of the post-operative CTV and to develop standardized contouring guidelines for RTOG 0848, a consensus committee of six radiation oncologists, with expertise in gastrointestinal RT, developed a stepwise contouring approach based on identifiable regions of interest (ROI) and margin expansions.
- Using these ROI's and margin expansions, reproducible CTV's can be created that cover the post-operative bed, nodal regions at risk as well as minimize inclusion of the highly radiosensitive abdominal organs at risk (OAR).

Treatment Volumes: GTV

- By definition there is no GTV (tumor has been resected)
- Location of pancreatic tumor prior to resection must be reviewed and contoured based on preoperative axial imaging/simulation
- Pre-operative diagnostic or simulation scans can be fused with post-operative CT to facilitate localization of tumor bed
- Surgical and pathological information must be reviewed at time of treatment planning

Treatment Volumes: CTV

- The post operative CTV is that area where there is likely to be the highest concentration of residual sub-clinical tumor that can be treated with radiotherapy without resulting in a treatment volume that encompasses an excessive amount of normal organs and normal tissue.
  1. Post-operative bed
     - Based on location of initial tumor from pre-operative imaging and pathology reports
  2. Anastomoses
     - Pancreaticojejunostomy(PJ)
     - Choledochal or hepaticojunostomy
  3. Abdominal nodal regions
     - Peripancreatic
     - Celiac
     - Superior mesenteric
     - Porta hepatis
     - Para-aortic

ROI Delineation: CA and SMA

- The most proximal 1.0-1.5 cm of the celiac artery (CA)
- The most proximal 2.5 to 3.0 cm of the superior mesenteric artery (SMA)

ROI Delineation: PV

- Include the portal vein (PV) segment that runs slightly to the right of, in front of (anterior) and anteromedial to the inferior vena cava (IVC).
- Contour from the bifurcation of the PV to, but do not include, the PV confluence with either the SMV or Splenic Vein (SV).
  - The PV bifurcation can be extrahepatic or almost intrahepatic.
  - The PV most often will merge first with the SMV, but may merge with the SV.

ROI Delineation: Post-op Bed

- The location of the pancreatic tumor prior to resection should be reviewed and contoured based on the preoperative imaging or simulation
- Surgical clips placed for purposes of delineating areas of concern intraoperatively such as close margins, uncinate margin, etc, may be included
  - Surgical clips should only be included as an ROI if there is documentation in the operative note or other written documentation from the surgeon of clips placed for a specific tumor-related or radiotherapy planning-related purposes.

ROI Delineation: PJ and Ao

- The pancreaticojejunostomy (PJ) is identified by following the pancreatic remnant medially and anteriorly until the junction with the jejunal loop is noted.

- The aorta (Ao) from the most cephalad contour of either the celiac axis, PV, or PJ (whichever among these 3 is the most cephalad) to the bottom of the L2 vertebral body. If the GTV contour extends to or below the bottom of L2 then contour the aorta towards the bottom of the L3 vertebral body as needed to cover the region of the preoperative tumor location.

ROI Expansions

- The celiac axis, SMA, and PV ROI's should be expanded by 1.0 - 1.5 cm in all directions. In most cases case 1.0 cm expansions will be sufficient.
- The PJ should be expanded 0.5 -1.0 cm in all directions.
- Delineated clips may be expanded by 0.5 – 1.0 cm in all directions or used without expansion.
- If all of these structures are uniformly expanded by 1.0 cm, they can be expanded as a single unit (Expansion 1 on slides 16-18)

ROI Expansions

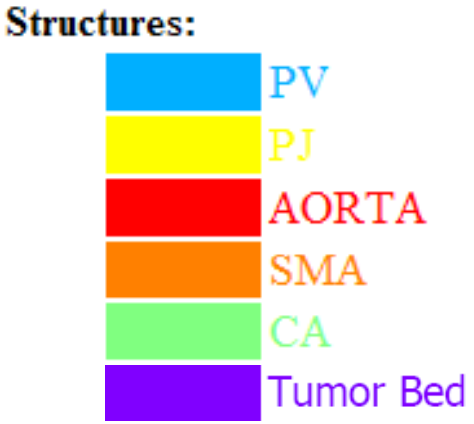
- The aortic ROI should be expanded asymmetrically to include prevertebral nodal regions from top of the PJ, PV, or CA (whichever is most superior) to the bottom of L2 (or L3 if GTV location low).
- Suggested approximate expansion amounts for the aortic ROI are as follows: 2.5 to 3.0 cm to the right,1.0 cm to the left, 2.0 to 2.5 cm anteriorly, 0.2 cm posteriorly towards the anterior edge of the vertebral body.
- Goal is to cover paravertebral nodes laterally while avoiding kidneys
- The PJ or PV expansion may extend cephalad to above the level of celiac axis. The aortic expansion should then be extended cephalad to the same level as the highest CT slice of the PV or PJ expansion (whichever is more cephalad).
- This is Expansion 2 (see slides 16-18)

ROI Expansion

- The CTV should then be created by merging the above ROI/ ROI expansions (CA, SMA, PV, GTV, Aortic, PJ, HJ, clips) with the following constraints and notes:
  - The posterior margin should follow the contour of the anterior aspect of the vertebral body without actually including more than 0.10 cm of the anterior vertebral body anterior edge.
  - If the PJ cannot be identified the CTV should be generated without it.
  - If the surgeon has created a pancreaticogastrosotomy, do not include it into the CTV.
  - If the CTV with the noted expansions protrudes into a dose limited normal organ such as the liver or stomach, the CTV should be edited to be adjacent (may touch the edge of) the relevant structure.

Summary:
Stepwise Approach to Contouring

- Delineate ROI's
  - Portal Vein (PV)
  - Pancreaticojenunostomy (PJ)
  - Celiac Artery (CA)
  - Superior Mesenteric Artery (SMA)
  - Aorta
  - Tumor Bed
- Expansion 1
  - 1.0 cm expansion on PV, PJ, CA, and SMA
- Expansion 2
  - 2.5 to 3.0 cm to the right,1.0 cm to the left, 2.0 to 2.5 cm anteriorly, 0.2 cm posteriorly on Aorta
- CTV
  - Boolean addition (merging) of Expansion 1 and 2
  - Confirm that CTV encompasses tumor bed and contoured clips
- PTV
  - 0.5 cm expansion on CTV



Case Examples

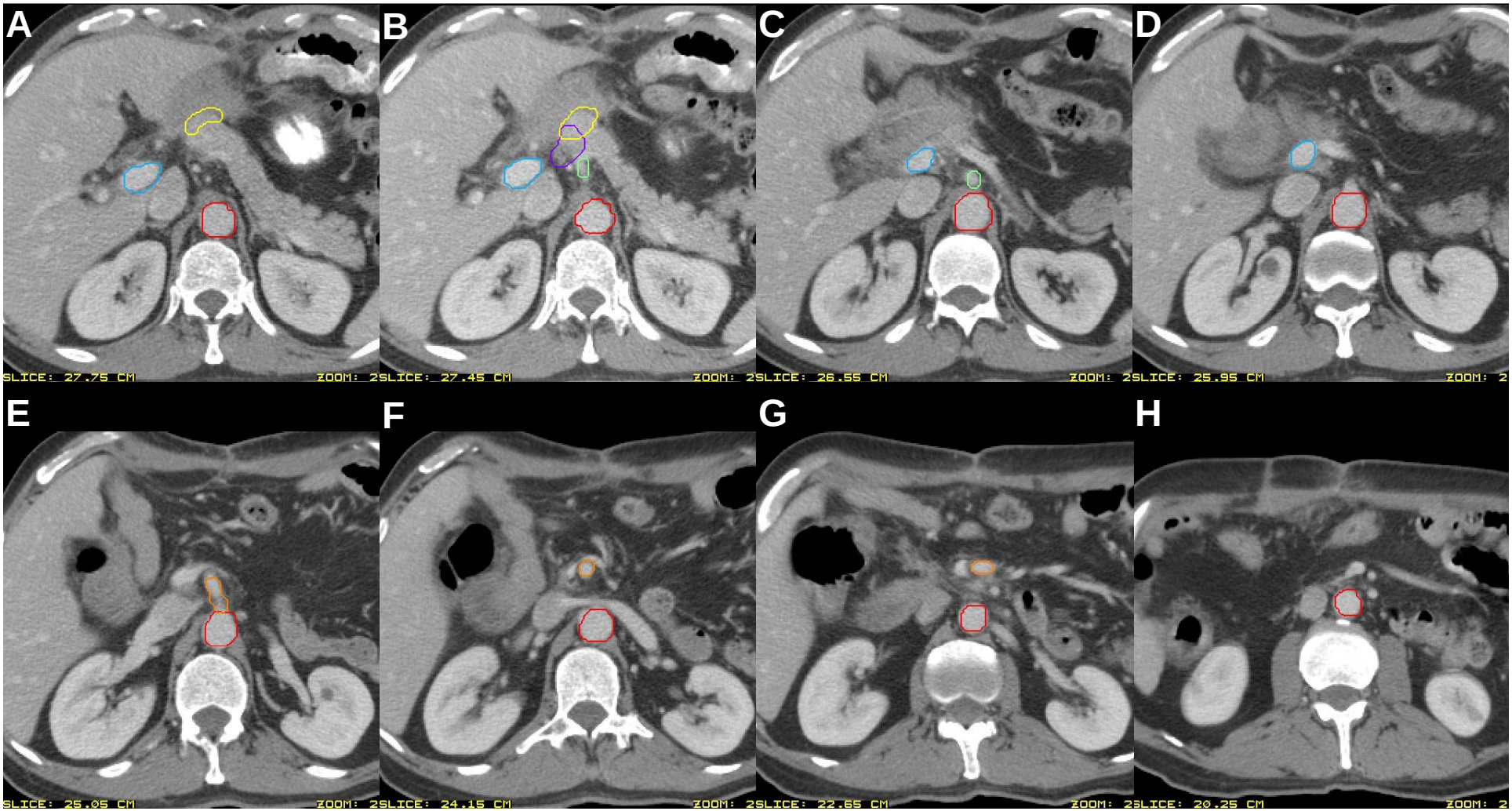
Case 1

- 49-year-old gentleman with a 4 to 5-month history of episodic fevers and chills. Work-up revealed elevated alkaline phosphatase and ALT; abdominal ultrasound demonstrated 13 mm dilatation of the common bile duct with a distended gallbladder; ERCP showed a periampullary mass and a stent was placed.
- Pathology demonstrated biliary papillary adenoma with adenocarcinoma in situ but no definite invasion.
- Endoscopic ultrasound revealed a 1 x 2 hypoechoic periampullary mass with likely involvement of the head of the pancreas and a few scattered hyperechoic foci in the pancreatic parenchyma suggestive of mild chronic pancreatitis.
- CT of the abdomen and pelvis showed a fatty liver with cysts, some extrahepatic common bile duct dilatation with stent in place and findings suggestive of a small periampullary mass. No vascular encasement or retroperitoneal lymphadenopathy was seen.

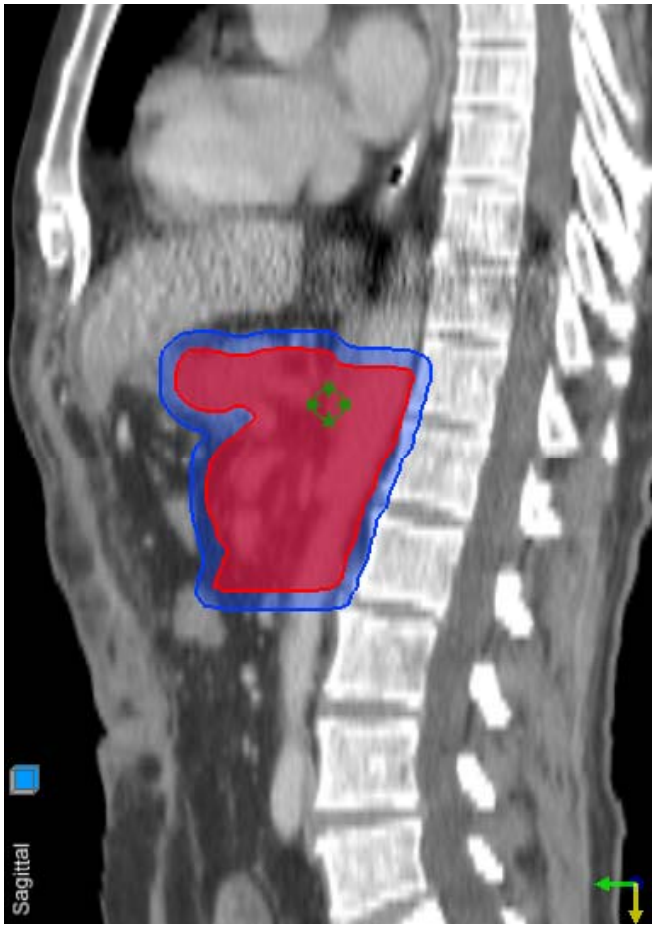
Case 1

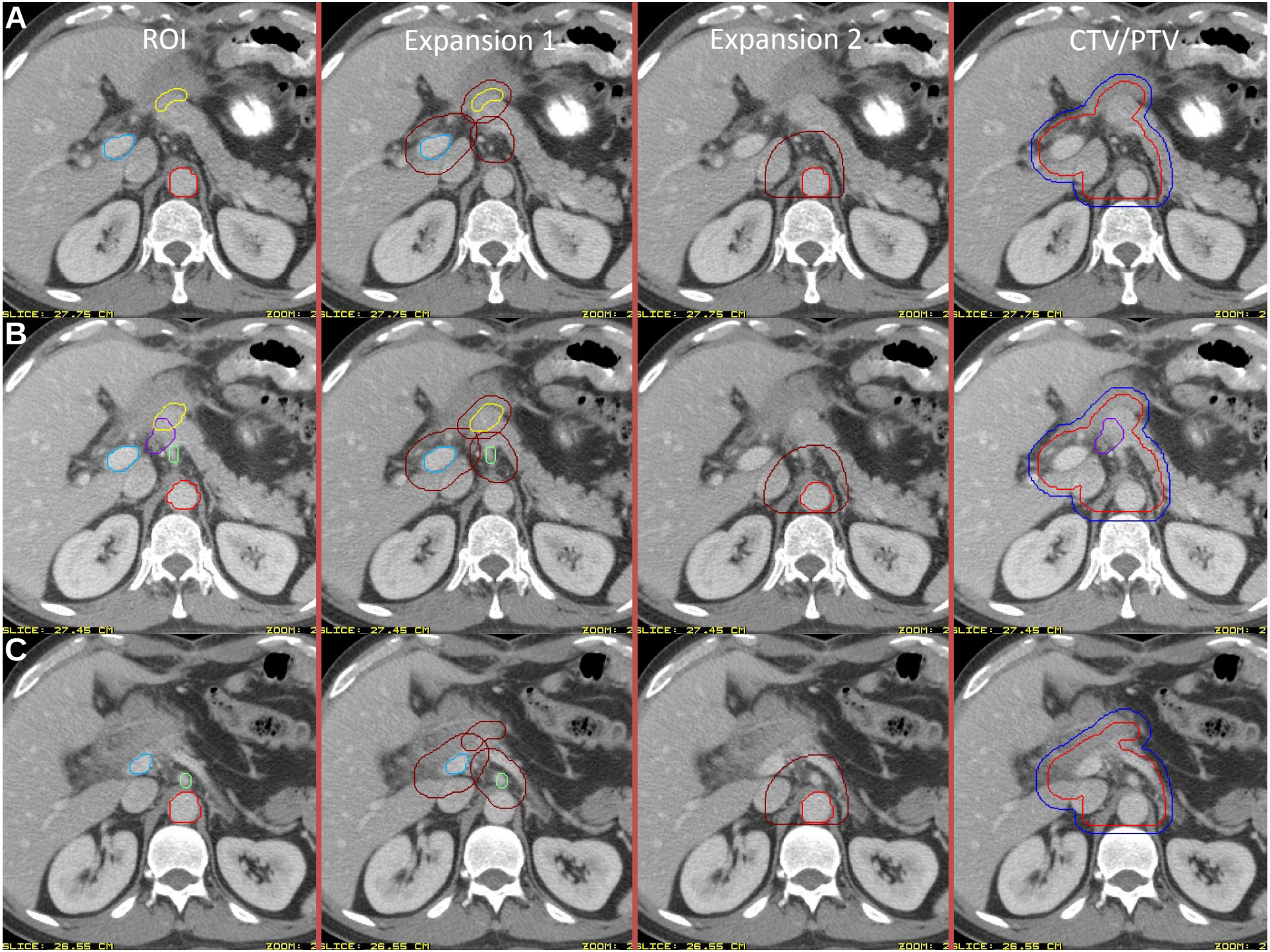
- A Whipple procedure was performed, the pathology showed a 1.3 cm moderately differentiated invasive adenocarcinoma in the pancreatic head with lymphovascular invasion. The margins were negative; however, 1 of the 15 lymph nodes sampled was positive. His CA19-9 was less than 3 preoperatively, indicating that he quite likely did not produce this marker.
- He was staged as pT1N1M0 (AJCC Stage IIB)
- The patient was referred for adjuvant chemoradiation, the following slides demonstrate the regions of interest (ROIs) for this patient, the expansion on the vessels and pancreaticojejunostomy (expansion 1), the expansion on the aorta (expansion 2), and the resultant merging of the expansions to create the CTV.

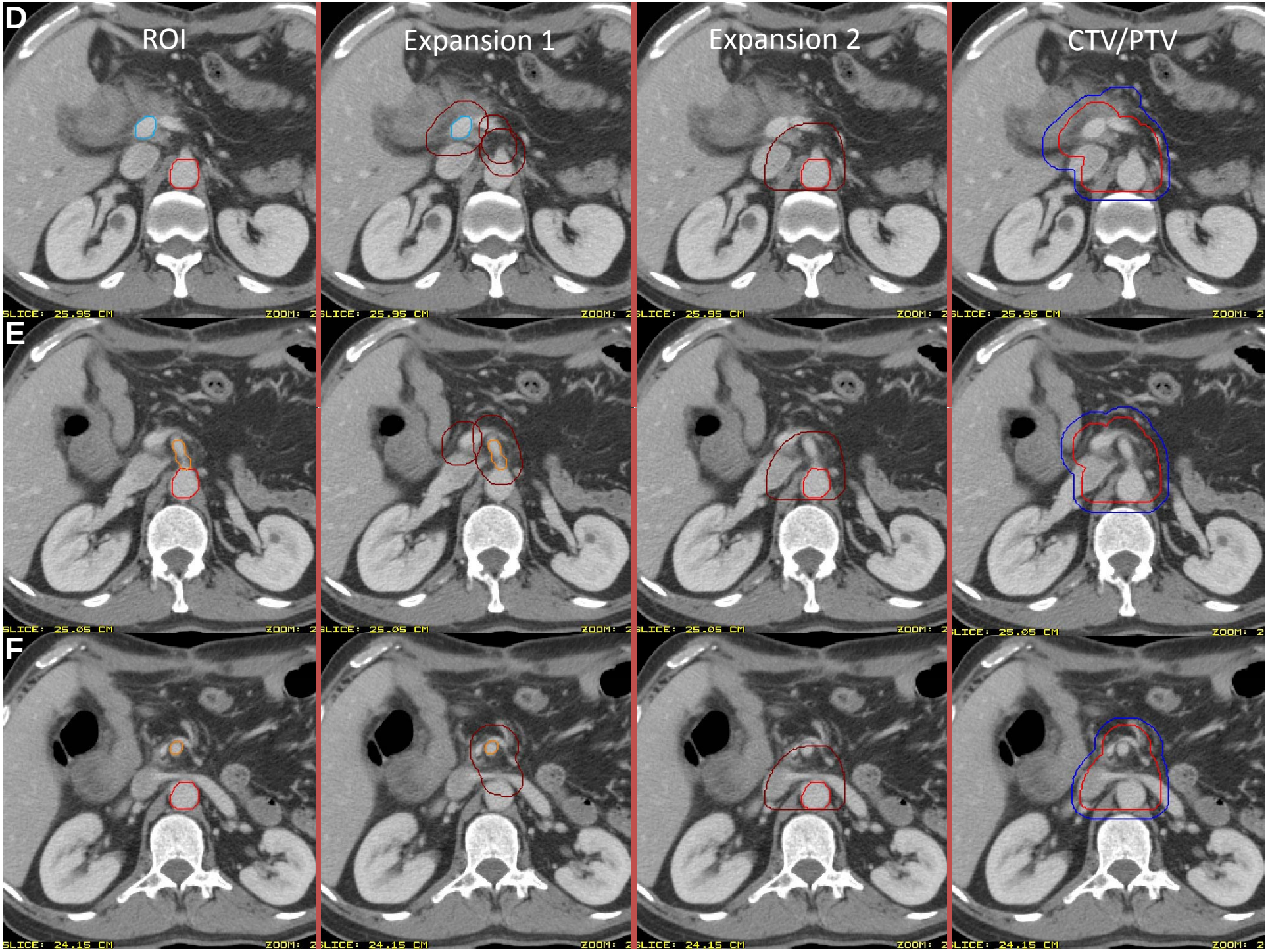
Case 1: ROI's

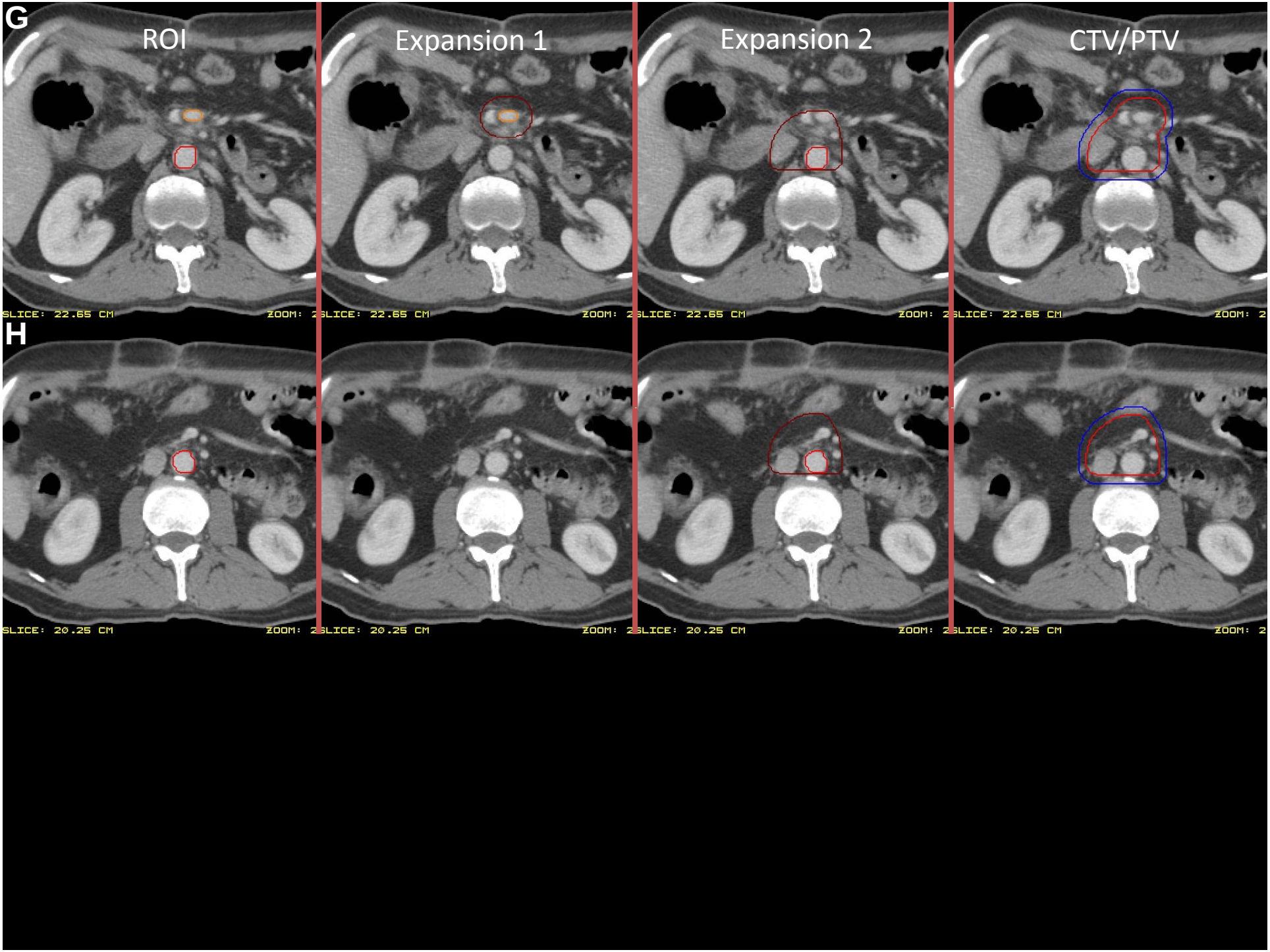

Structures:
PV
PJ
AORTA
SMA
CA
Tumor Bed
A
B
C
D
E
F
G
H
SLICE: 27.75 CM
ZOOM: 2
SLICE: 27.45 CM
ZOOM: 2
SLICE: 26.55 CM
ZOOM: 2
SLICE: 25.95 CM
ZOOM: 2
SLICE: 25.05 CM
ZOOM: 2
SLICE: 24.15 CM
ZOOM: 2
SLICE: 22.65 CM
ZOOM: 2
SLICE: 20.25 CM
ZOOM: 2

Case 1: Coronal/Sagittal Views

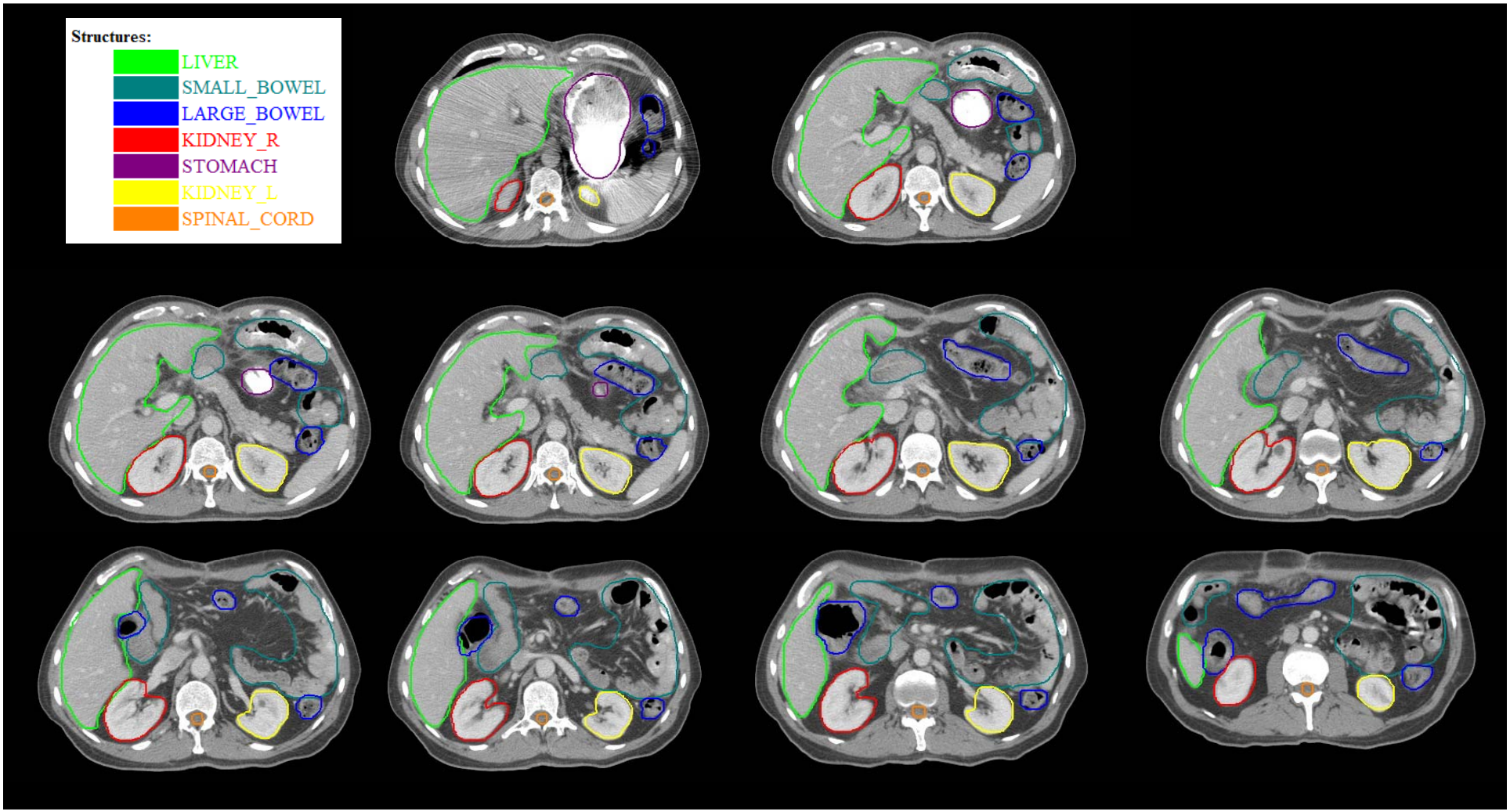



A
ROI
Expansion 1
Expansion 2
CTV/PTV
B
C


D
ROI
Expansion 1
Expansion 2
CTV/PTV
E
F


G
ROI
Expansion 1
Expansion 2
CTV/PTV
SLICE: 22.65 CM
ZOOM: 2
H
SLICE: 20.25 CM
ZOOM: 2

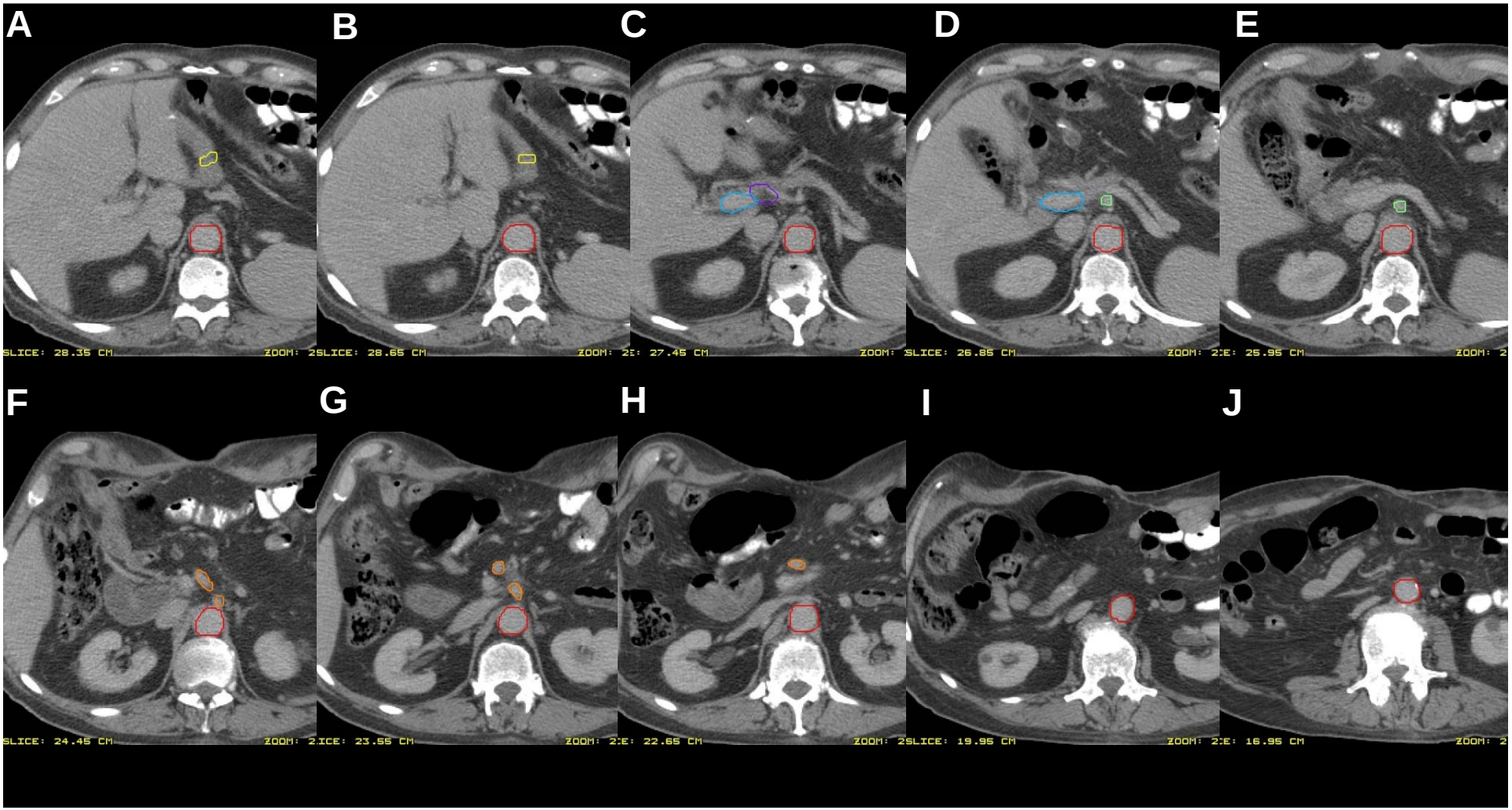
Case 1: Normal Tissues



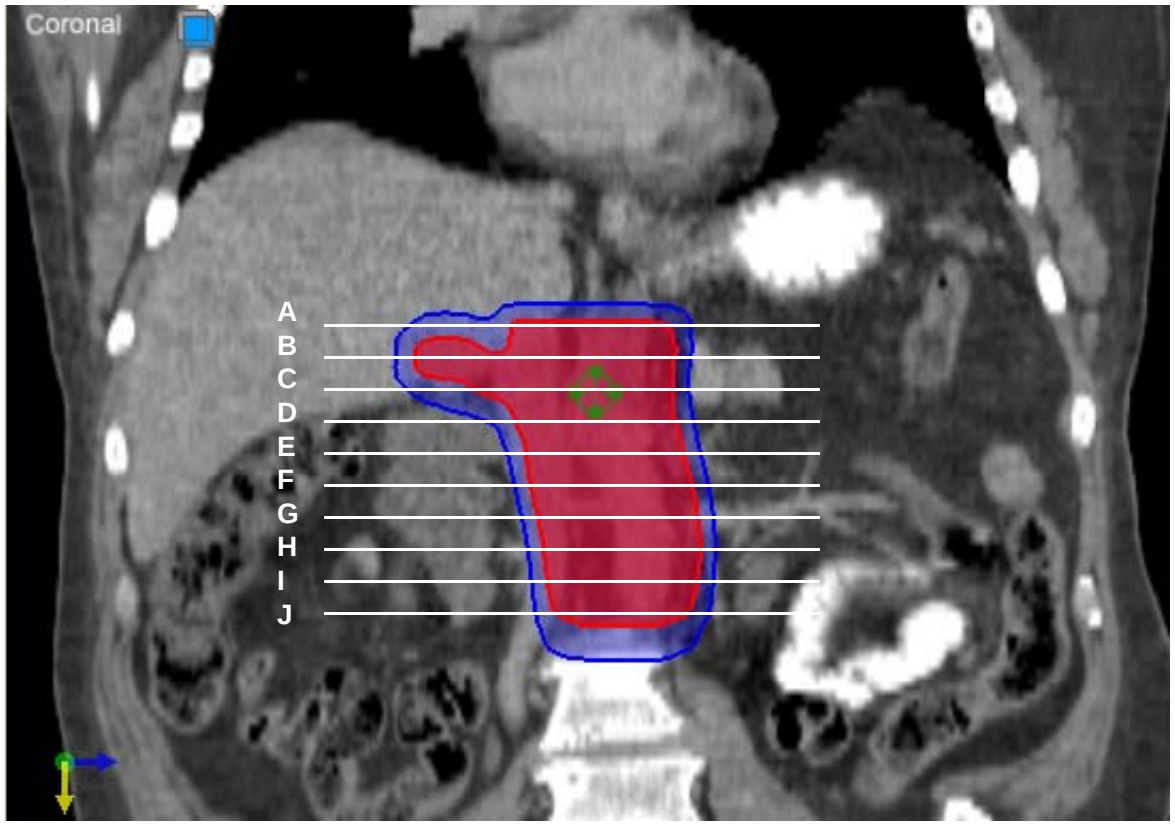
Case 2

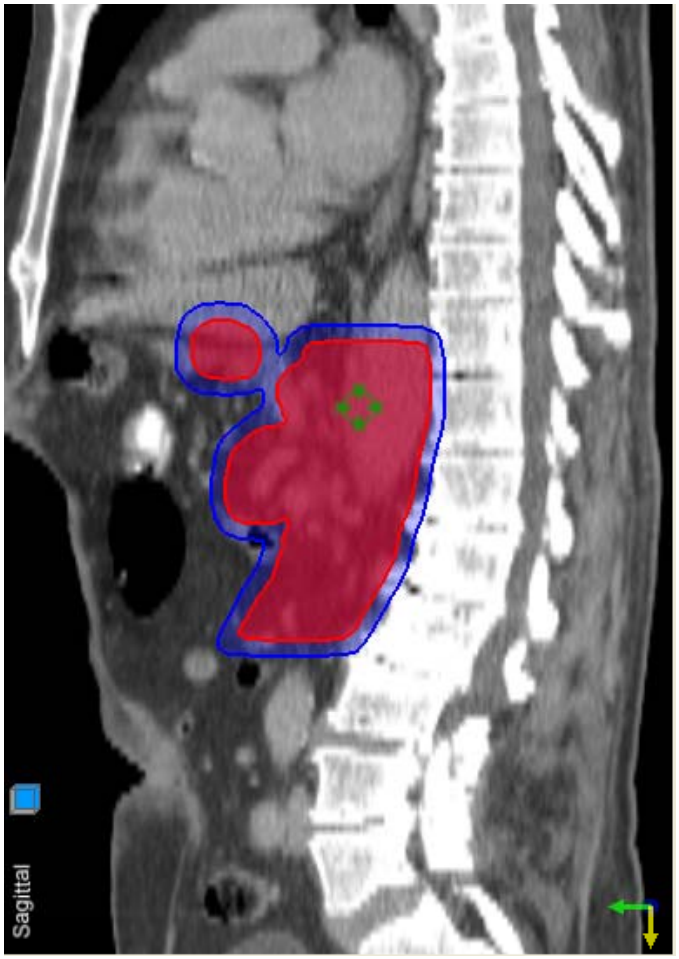
- 67-year-old gentleman who was noted to be jaundiced by his primary care physician and had abnormal lab results.
- CT scan and MRCP showed a radiologically resectable head of the pancreas mass as well as a 1-cm indeterminate lesion on the dome of the liver.
- ERCP with stent placement and biopsy of the pancreatic mass showed adenocarcinoma.
- A Whipple with a wedge resection of the liver lesion was performed. Specimens obtained from this procedure yielded pathology showing adenocarcinoma in the neck of the pancreas with positive microscopic margins at the atrophic and inflamed pancreatic tissue of the margin. Also seen was adenocarcinoma, ductal type, in the head of the pancreas, extending to the superior mesenteric/portal vein groove with perineural invasion. None of the 12 lymph nodes sampled were involved, and the lesion on the dome of the liver was negative (scar tissue).

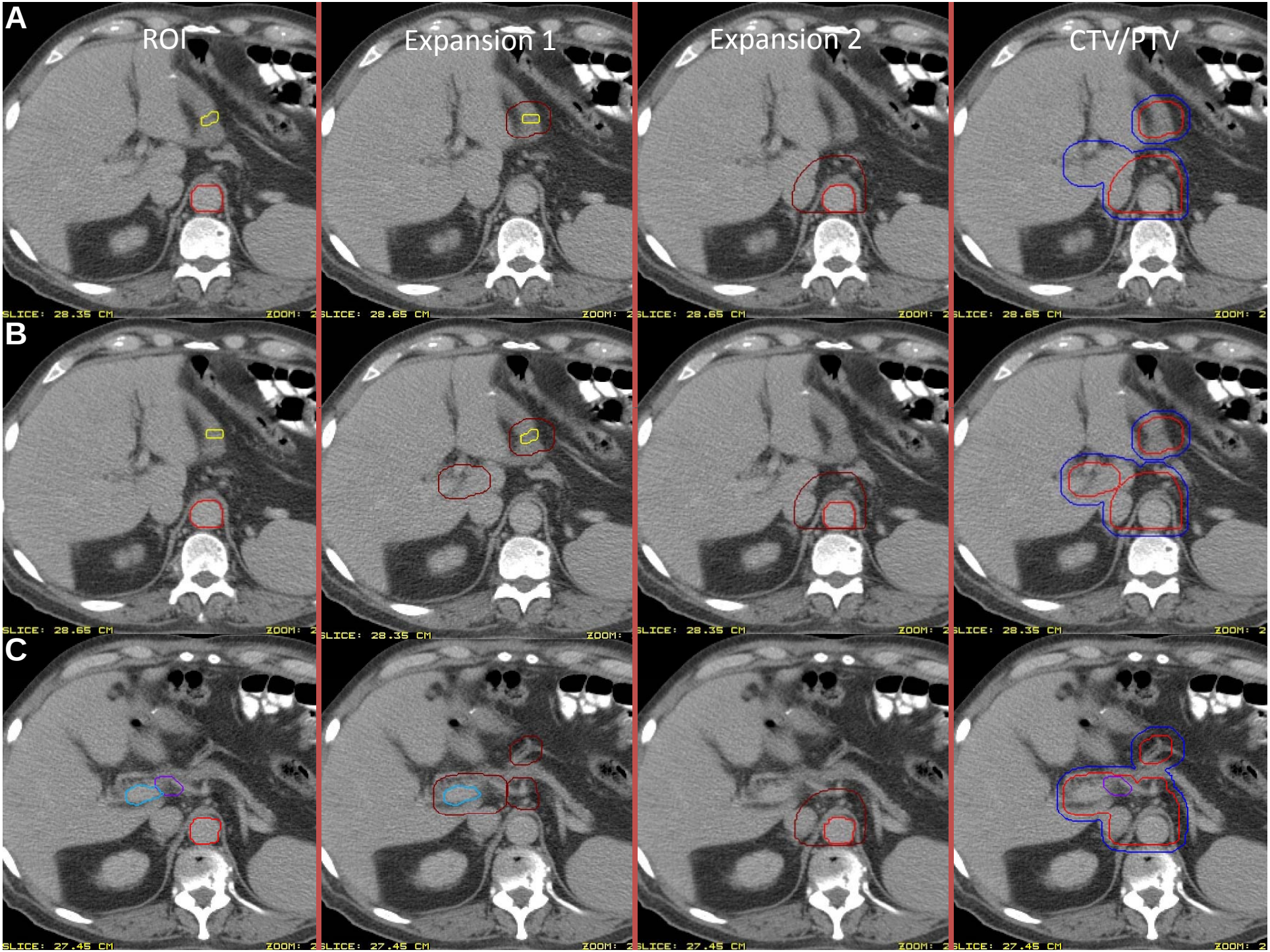
Case 2: ROI's

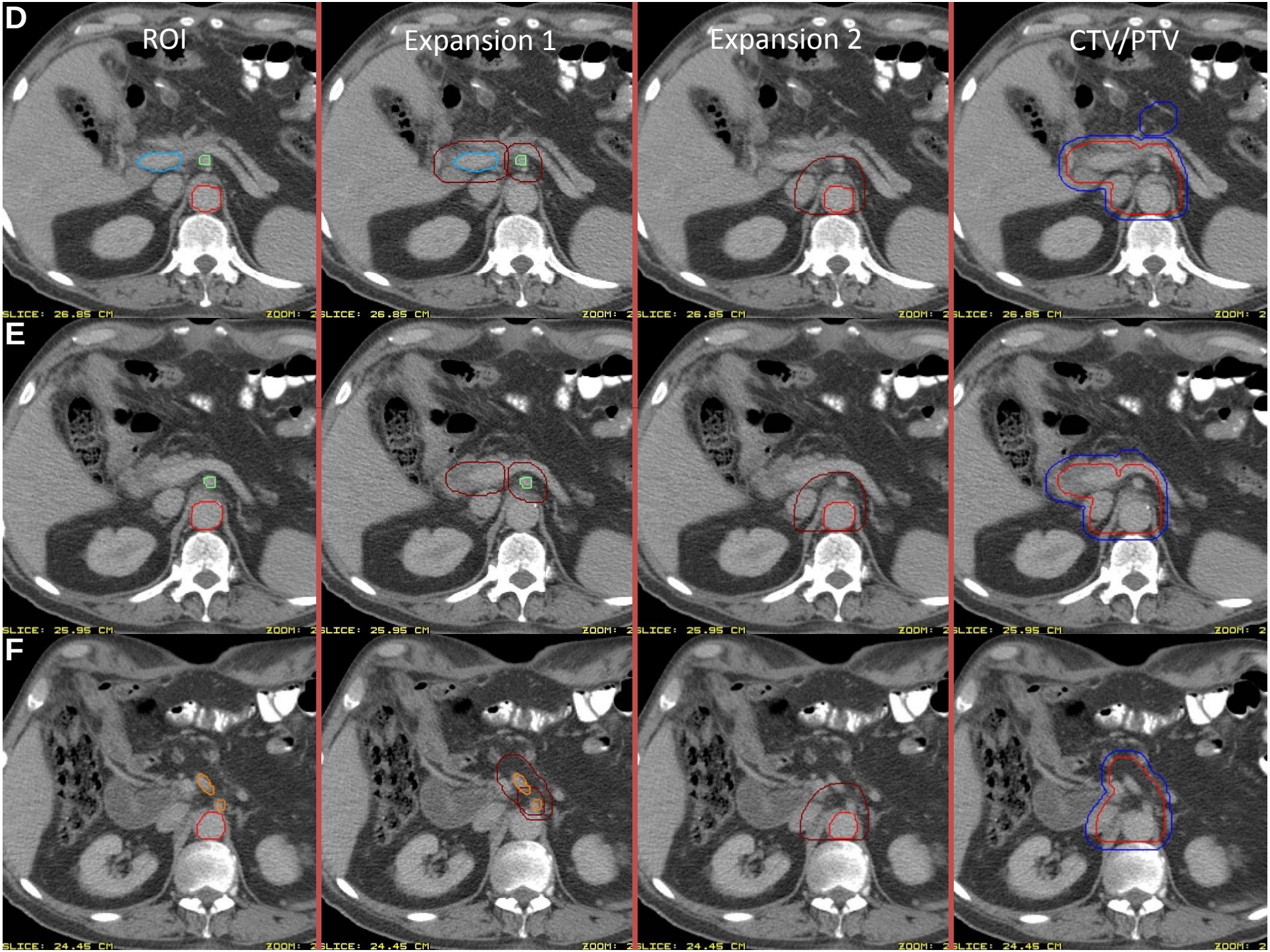


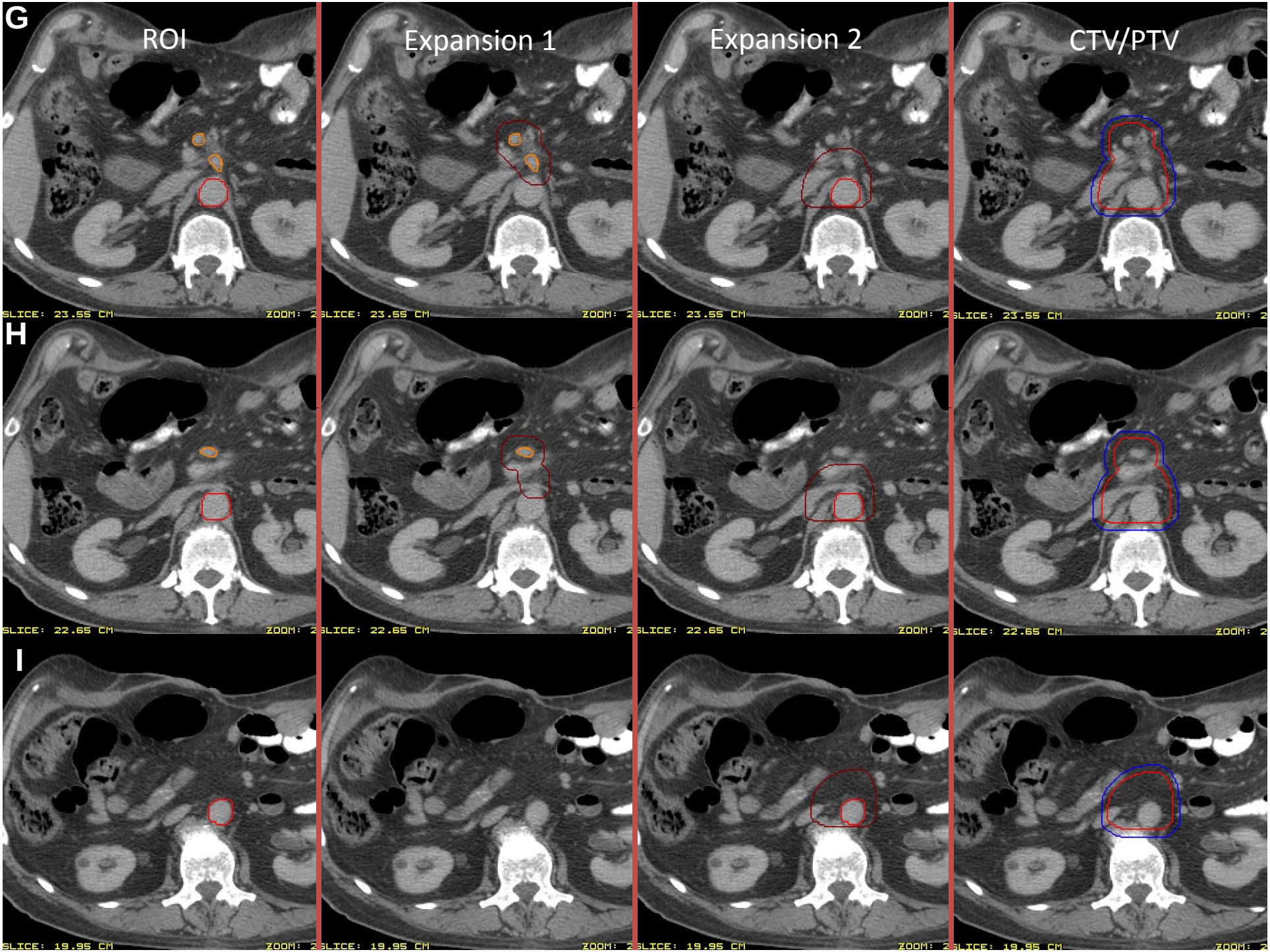
Case 2:Coronal/Sagittal Views






A
ROI
Expansion 1
Expansion 2
CTV/PTV
B
C


D
ROI
Expansion 1
Expansion 2
CTV/PTV
E
F
SLICE: 26.85 CM
SLICE: 25.95 CM
SLICE: 24.45 CM
ZOOM:


G
ROI
Expansion 1
Expansion 2
CTV/PTV
H
I

Case 2: Normal Tissues