

# Characterization of the location, extent, and proximity to critical structures of target volumes provides detail for improved outcome predictions among pancreatic cancer patients



JOHNS HOPKINS  
MEDICINE  
RADIATION ONCOLOGY &  
MOLECULAR RADIATION SCIENCES

Oncospace  
Dx Rx Tx

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## Purpose/Objectives

- Size, location, and proximity of the target to critical structures influence treatment decisions.
- Surgical resection offers the only chance of cure for nonmetastatic pancreatic cancer (PC).
- We developed and validated a method to improve:
  - characterization of the location of PC
  - the treatment volume extent with respect to critical vascular structure that define surgical resectability to improve clinical predictions and decision makings.

## Materials/Methods

- Oncospace is a local learning health system that systematically captures clinical outcomes and all aspects of radiotherapy treatment plans, including overlap volume histograms (OVH) – a measure of spatial relationships between two structures (Figure 1).
- Distances between Planning Target Volume (PTV) and Organs At Risks (OARs) at 0%, 25%, 50%, 75%, 100% overlapped volume level based on OVH were computed. Normalized distance to center of kidneys (**NDCK**) was calculated to indicate tumor location and laterality (Figure 2).

$$NDCK = \frac{\min(OVH_{Lt.Kidney})}{\min(OVH_{Lt.Kidney}) + \min(OVH_{Rt.Kidney})} - 0.5$$

- PTV volume, anatomic location by ICD-9 code, Karnofsky Performance Status (KPS) and surgical outcome were queried.

- Distance to celiac axis, superior mesenteric artery (SMA), common hepatic artery (CHA) (Figure 3) and treatment volume is validated by surgical status as following by t-test.

- Borderline Resectable (**BR**) vs. Locally Advanced (**LA**)
- Locally Advanced converted to Resectable (**LA-R**) vs. Locally Advanced Unresectable (**LA-U**)

## Results

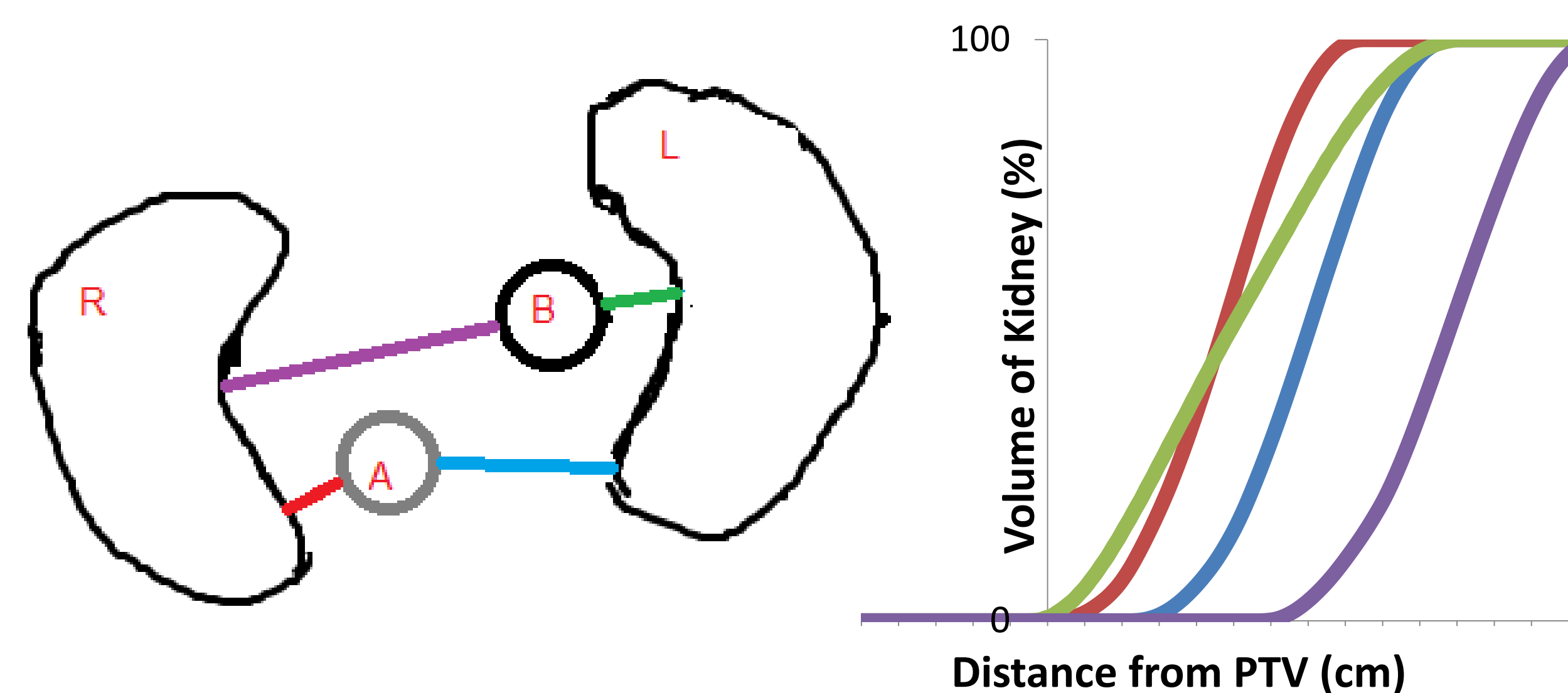


Figure 1. Display of the PTV A, B to Left and Right Kidneys (left) and graphical display of OVH (right)

- There were 205 pancreas stereotactic body radiotherapy patients treated from 2009-2015 queried.
- Location/laterality of NDCK show strong association with anatomic location (Figure 2).

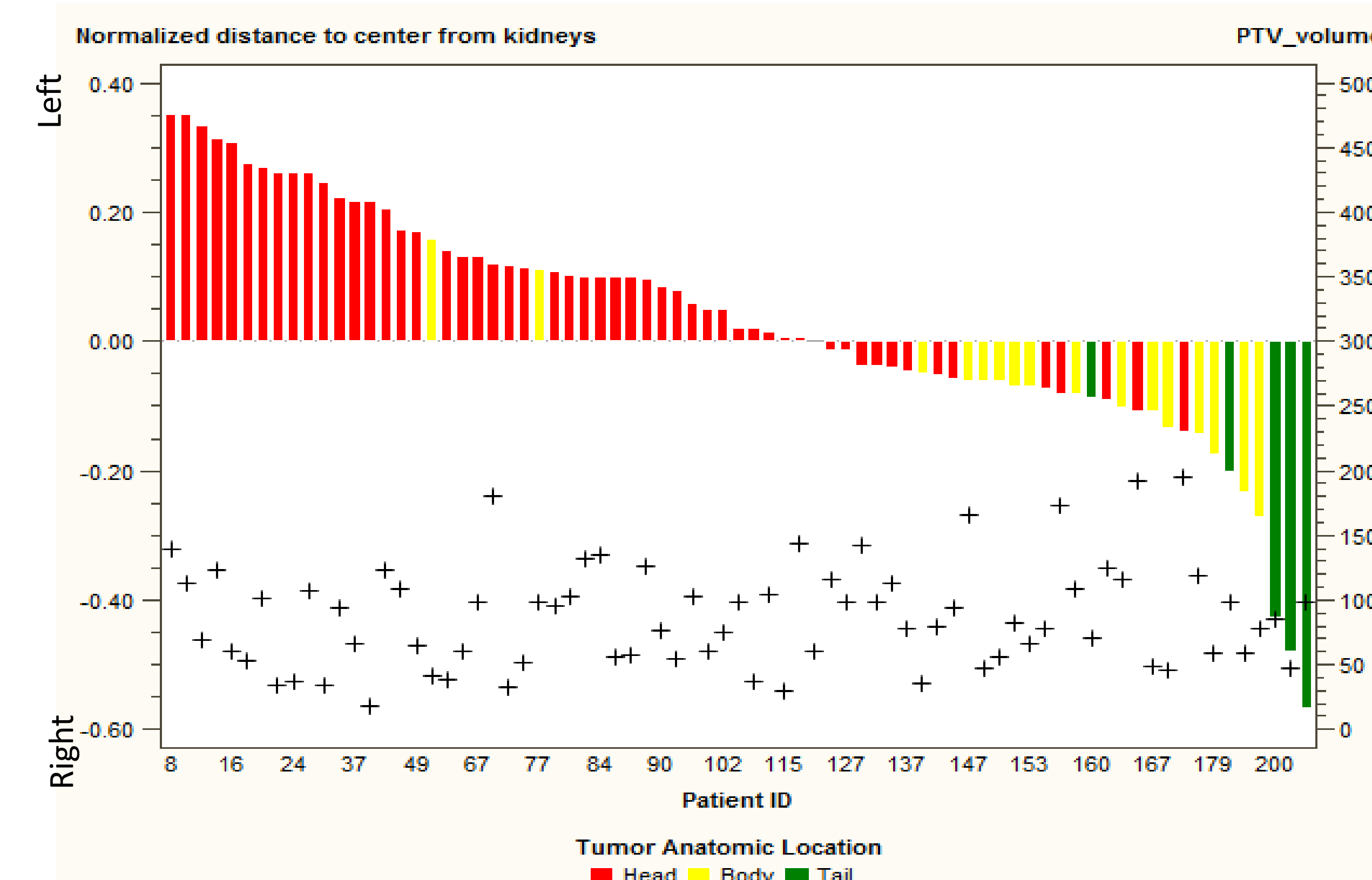


Figure 2. Relationship between normalized distance the center from the kidneys in ratio and PTV by anatomic location of the head, body and tail of the pancreatic tumor by ICD-9 with PTV volume in cc

- Compared to the LA group, the BR group showed smaller treatment volume (cc) and larger geometrical distance (cm) from closest critical arteries at 0%, 25%, 50%, 75% overlapped level (Table 1).

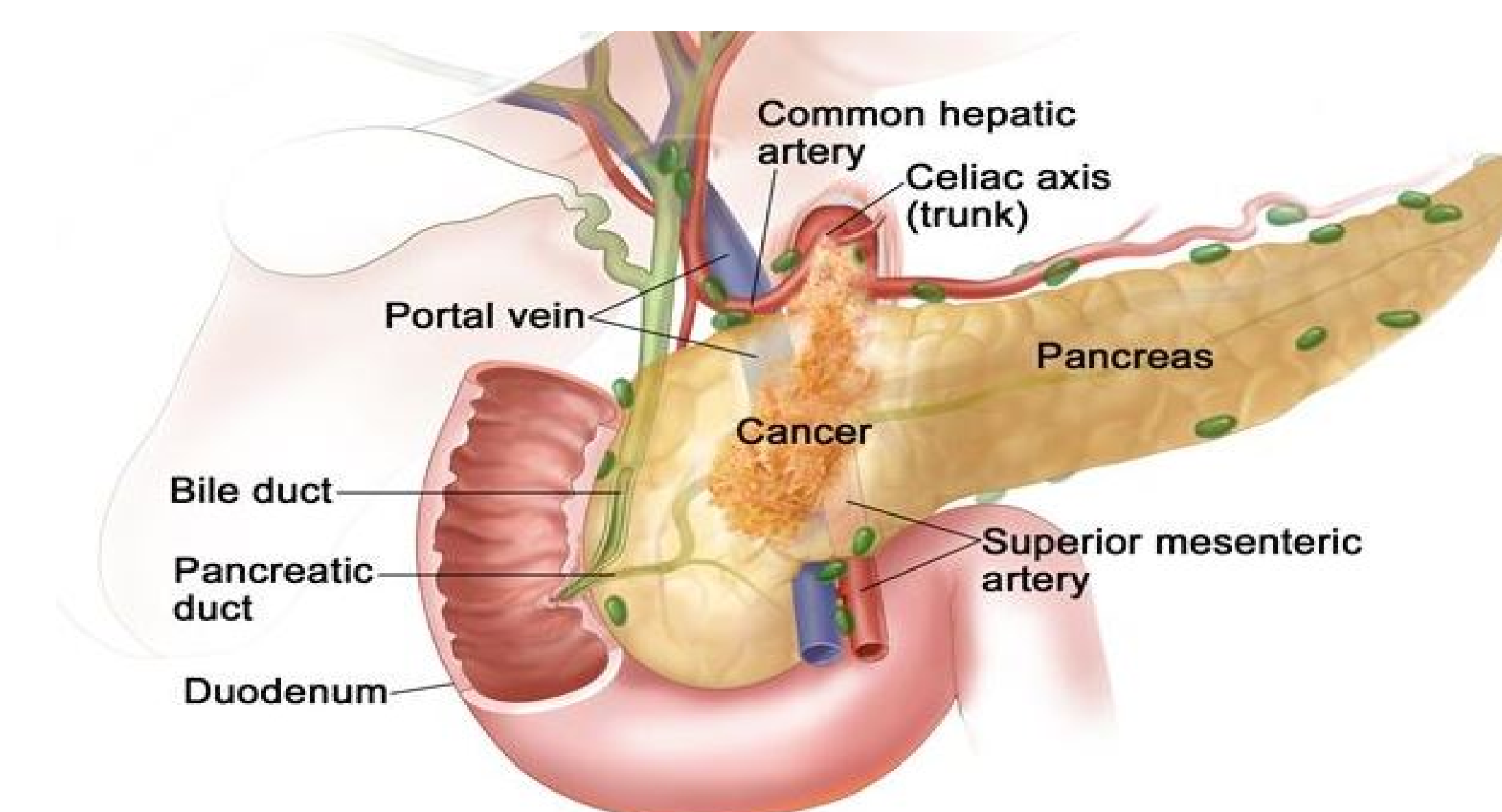


Figure 3. Pancreas and surrounding anatomy

- Distance to SMA appears to dominate the shape relationship among the three critical arteries (Table 1).
- Among the LA group, surgical candidates (LA-R) demonstrated pancreas body, tail-oriented tumor based on NDCK and smaller treatment volume (Table 2).

| Variable, mean             | LA (n=76) | BR (n=20) | P-value |
|----------------------------|-----------|-----------|---------|
| Distance_SMA_0%            | -0.8302   | -0.3216   | 0.0764  |
| Distance_SMA_25%           | -0.3739   | 0.1231    | 0.0922  |
| Distance_SMA_50%           | -0.0362   | 0.4849    | 0.0882  |
| Distance_SMA_75%           | 0.4101    | 0.9975    | 0.0805  |
| Distance_ClosestVessel_0%  | -1.0421   | -0.4121   | 0.0361* |
| Distance_ClosestVessel_25% | -0.6513   | -0.0427   | 0.0454* |
| Distance_ClosestVessel_50% | -0.3894   | 0.2739    | 0.0373* |
| Distance_ClosestVessel_75% | -0.08     | 0.5603    | 0.0238* |
| PTV volume                 | 89.2791   | 66.7585   | 0.0065* |

Table 1: Significant variables\* (distance to vessel at overlapped level in cm, and volume in cc) between LA and BR group. Non significant variables include: distance to celiac axis and CHA at all overlapped level, distance at 100% overlapped level and KPS score

| Variable, mean | LA-R (n=51) | LA-U (n=25) | P-value |
|----------------|-------------|-------------|---------|
| NDCK           | 0.0748      | -0.0723     | 0.0151* |
| PTV volume     | 98.8517     | 67.8365     | 0.0004* |

Table 2: Significant variables\* (Normalized distance to kidney in ratio, and volume in cc) between LA and BR group. Non significant variables include: distance to all vessels at all overlapped level and KPS score

## Conclusions

- Our platform enables analysis of shape/size-location relationships.
- These data suggest that PTV volume and distance between PTVs and surrounding OARs and major arteries can refine our ability for outcome predictions and decision making.
- Prediction model to support real-time clinical decision-support warrants further investigation.