



# Anatomical Variations Between Vertical and Horizontal Bolster Placement and the Implications for Percutaneous Nephrolithotomy (PCNL) Access

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## Introduction

- The ideal bolster position for prone PCNL has not been previously evaluated.
- Techniques of bolster placement vary between centers and geographic regions so we sought to evaluate the 2 most common positions: vertical and horizontal.

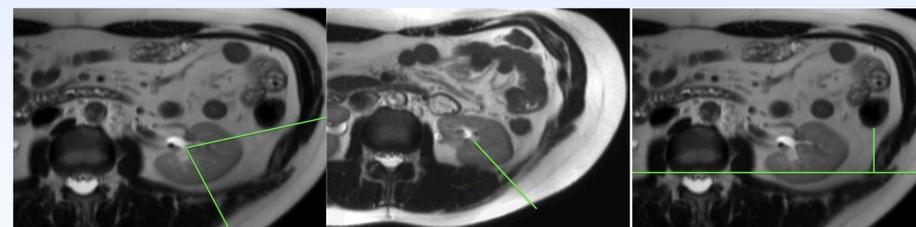
## Methods

- 10 healthy volunteers with 20 renal units prospectively underwent 3T MRI in prone position.
- Images obtained with standard foam cylindrical bolsters (26 x 6 x 6 inches) situated vertically and then horizontally
- Horizontal bolsters positioned at the xiphoid process – to support lower rib cage -- and at the pubis
- Vertical bolsters placed in standard fashion along the lateral aspects of the chest
- Equal number of healthy men and women
  - Mean age: 39.8 ± 10.6 (range 25-56)
  - Mean BMI: 25.8 ± 4.2 (range: 19.8-32.9)
- Participants asked to breath-hold in end expiration during image acquisition
- Dedicated body MRI radiologist blinded to bolster placement conducted all measurements.
- Distances of kidney upper pole to the **diaphragm** (KDD), **L1 vertebra** (KVD), and **inferior-most rib** (KRD) measured for each bolster position
- Additional measurements included:
  - Maximum access angle** (MAA, angle between lateral margin of the paraspinous muscles and posterior most aspect of liver, spleen, or colon at the hilum)
  - Nephrostomy tract length** (NTL, skin edge to the upper and lower posterior pole calyx along the infundibular axis)
  - Anterior-posterior position of colon** (AP, distance of the ipsilateral colonic flexure to the posterior vertebral body plane, at level of the renal hilum)
- The Wilcoxon signed rank test was used to compare differences.

## Results

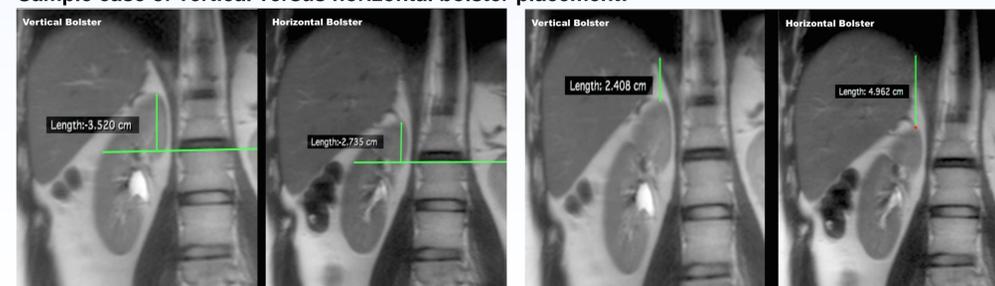
- Right and left median KDD significantly increased with horizontal bolsters (2.68 cm vs. 6.12 cm, p=0.02 and 3.54 cm vs. 5.40 cm, p=0.01, respectively).
- Right KRD significantly increased from 0.1 cm to 2.5 cm (p=0.025); the left showed an increase from 1.4 cm to 1.9 cm (p=0.123).
- Right KVD significantly increased from a median of -1.51 to 0.65 cm (p=0.007); the left KVD increased from -0.7 to 0.2 cm (p=0.059).
- No significant difference in MAA between vertical and horizontal bolsters (right kidney 48.5 degrees vs. 39.7 degrees, p=0.241; left kidney 62.2 degrees vs. 54.0 degrees, p=0.139).
- No significant difference in overall NTL between vertical and horizontal bolsters (right kidney: 7.72 vs. 7.87 cm, p=0.135; left kidney 7.63 vs. 8.03, p=0.232).
  - Greater right and left lower pole NTL with horizontal bolsters (7.55 vs. 8.29 cm, p=0.017 and 7.52 vs. 8.67, p=0.022).
- No significant change in AP position of the colon (right kidney 4.5 to 4.3 cm, p=0.753; left kidney 2.7 to 3.1 cm, p=0.139).

### Measurement techniques:



A) Maximum access angle B) Nephrostomy tract length C) Anterior-posterior colon position

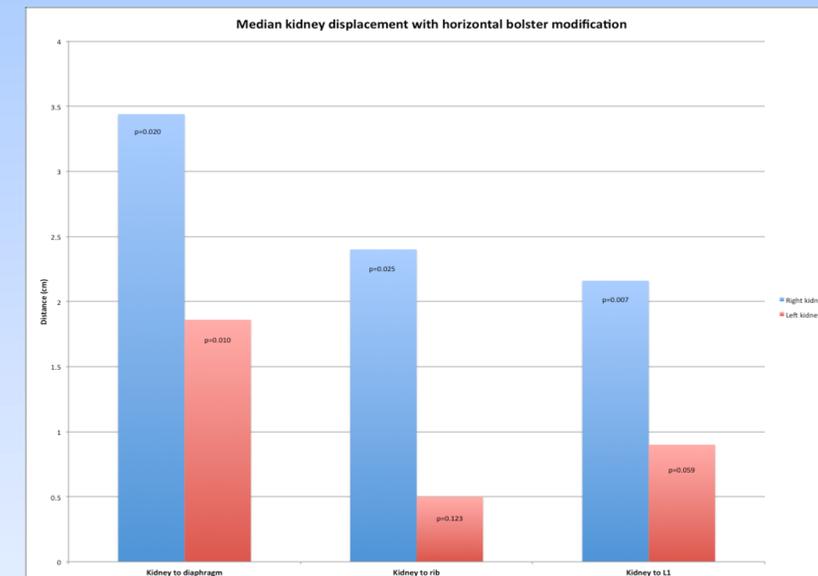
### Sample case of vertical versus horizontal bolster placement:



A) kidney to L1 vertebral distance B) kidney to diaphragm distance

## Conclusion

- Horizontal bolster placement in the prone position displaces the kidney caudally, without affecting colon position, access angle, or overall nephrostomy tract length.
- This may improve safety of PCNL by decreasing the need for supracostal access in select cases and increasing the safety of supracostal access.



### Vertical versus horizontal bolster results for nephrostomy tract length, maximum access angle, anterior-posterior colon position

	Vertical Bolsters	Horizontal Bolsters	P value
<b>Right Kidney</b>			
Overall Mean NTL	7.72 cm	7.87 cm	0.135
Upper Pole NTL	7.78 cm	7.57 cm	0.333
Lower Pole NTL	7.55 cm	8.29 cm	0.017
Maximum Access Angle	48.5°	39.7°	0.241
Anterior-Posterior Colon	4.5 cm	4.3 cm	0.753
<b>Left Kidney</b>			
Overall Mean NTL	7.63 cm	8.03 cm	0.232
Upper Pole NTL	7.70 cm	7.70 cm	0.333
Lower Pole NTL	7.52 cm	8.67 cm	0.022
Maximum Access Angle	62.2°	54.0°	0.139
Anterior-Posterior Colon	2.7 cm	3.1 cm	0.139