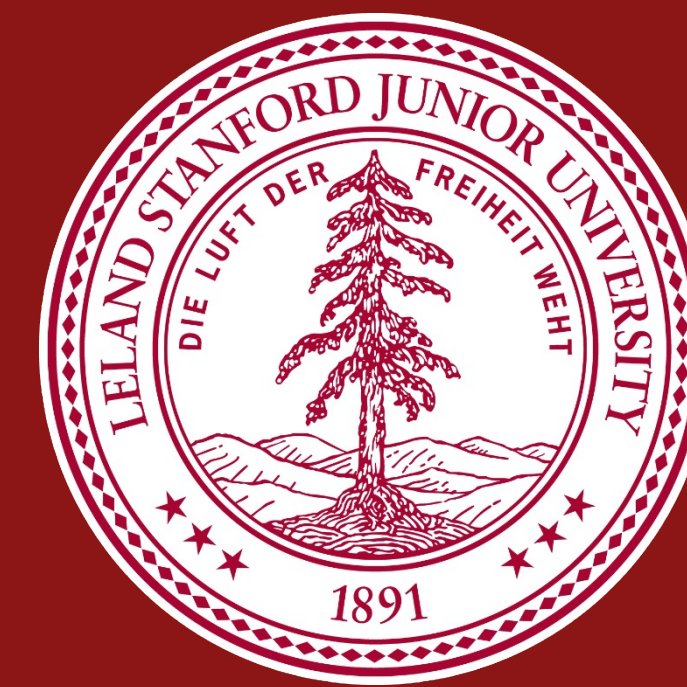




Stanford
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Correlation of CT-Guided Planning with Real-Time Thoracic Epidural Placement: A Preliminary Experience

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Introduction

- Thoracic epidurals are known to provide excellent analgesia, yet a surgically congruent placement of epidural catheters remain challenging.
- The utility of pre-procedure CT analysis for predictive and real-time guidance of placement remains underutilized.
- We investigated whether pre-procedural CT measurements could predict loss of resistance (LOR) depth and needle trajectory angles during paramedian approach.

Results

- In three patients, epidural placement parameters closely matched CT predictions.
- In two patients with deeper LOR depths, actual placement parameters matched CT predictions for one vertebral space above the intended level (Table 1).
- Proof of concept AI analysis demonstrated feasibility of predictive needle trajectory and LOR depth based on the CT scans and 3D renderings (Figures 1 and 2).

Discussion

- Pre-procedural CT analysis shows promise for predicting both thoracic epidural placement depth and optimal needle trajectory angles.
- When actual LOR depth exceeds predictions, the needle trajectory analysis can predict if the catheter may be one space above the intended level.
- This approach can be utilized to estimate the true thoracic level of placement if the depth and angle are significantly different than anticipated.
- This preliminary experience supports the potential utility of CT-guided planning and real-time angle tracking for improving thoracic epidural placement.
- Future development of AI-assisted analysis could further enhance this approach.

References



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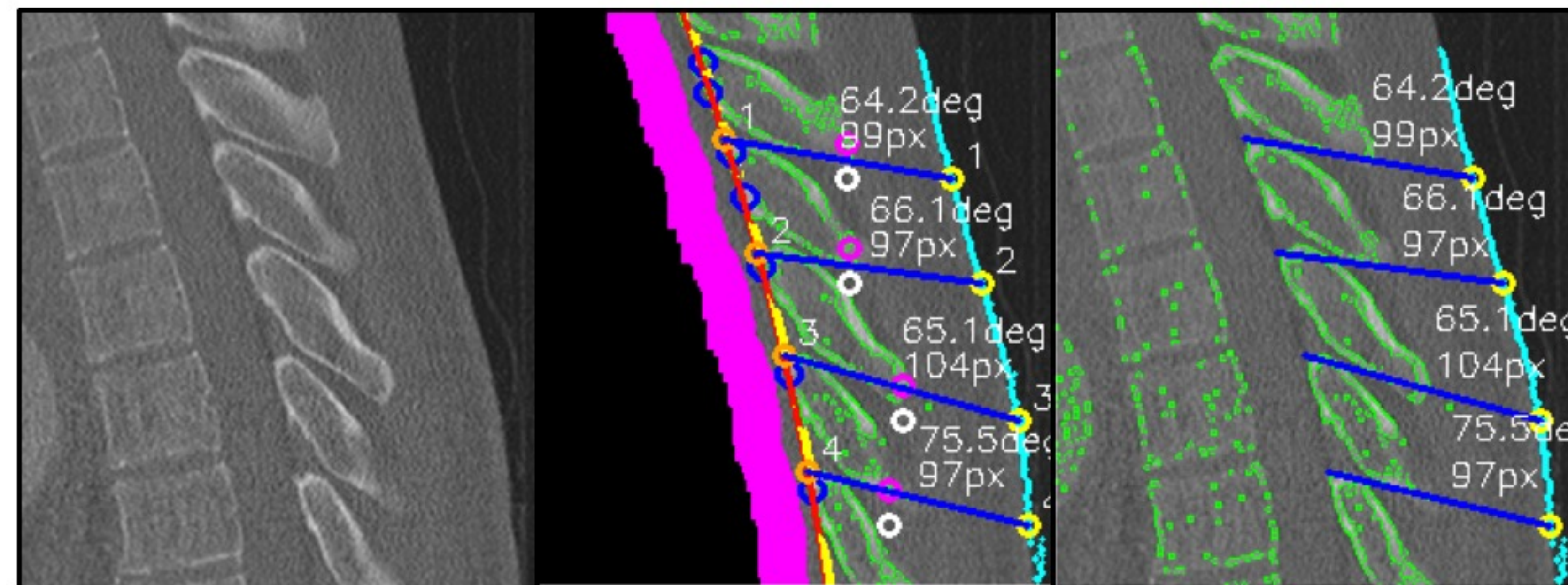


Figure 1: Software algorithm to estimate + display angle of entry and loss of resistance
left: sagittal CT scan of thoracic spine, unmodified
middle: demonstration of each step of the algorithm
right: blue lines showing 4 potential paramedian approaches, yellow circles are skin insertion points, and each blue line has the LOR (represented with px) and angle of entry

Methods

- 1) Initial CT scan review
- Load thoracic CT scan at the mid-sagittal view
 - Count vertebrae to center image at intended level

- 2) Anatomical Landmarks
- Identify skin and superior border of spinous process (SP)
 - Mark needle insertion point at the skin 1 cm inferior to SP

- 3) Measurement Collection
- Estimate LOR range & needle angles on CT scan:
 - Skin insertion to just anterior of the interlaminar space
 - Account for 15 degrees medial redirection
 - Record actual LOR and angle from epidural placement

- 4) Additional Level
- Repeat steps 1-3 for one vertebral level up from the one just measured

- 5) AI based image analysis
- Predict insertion paths and depth
 - Provide feedback on trajectory planning

Case	Intended level	Final level	CT calculated LOR range (cm)	CT calculated LOR range up one vertebral level (cm)	Actual LOR (cm)	CT estimated angle range (degrees)	CT estimated angle range up one vertebral level (degrees)	Measured angle (degrees)
1	T8-9	T8-9	4.5-5.2	NA	5	54-71	NA	55
2	T8-9	T8-9	6.1-6.3	NA	6	60-68	NA	70
3	T9-10	T8-9	4-4.5	5.9-6.9	7	(54-64)	31-39	42
4	T9-10	T8-9	4.3	5.3-5.8	6	(78-86)	42-50	52
5	T8-9	T8-9	5.6-6.1	NA	5	63-73	NA	71

Table 1: Case series data showing calculated LOR and angle from CT scan versus measured LOR and angle from epidural placement. Cases 1,2,5 only have 1 level shown since the actual placement parameters were close to the predicted values. Cases 3 and 4 have 2 levels shown since the primary intended level's predicted parameters did not match the actual placement parameters.

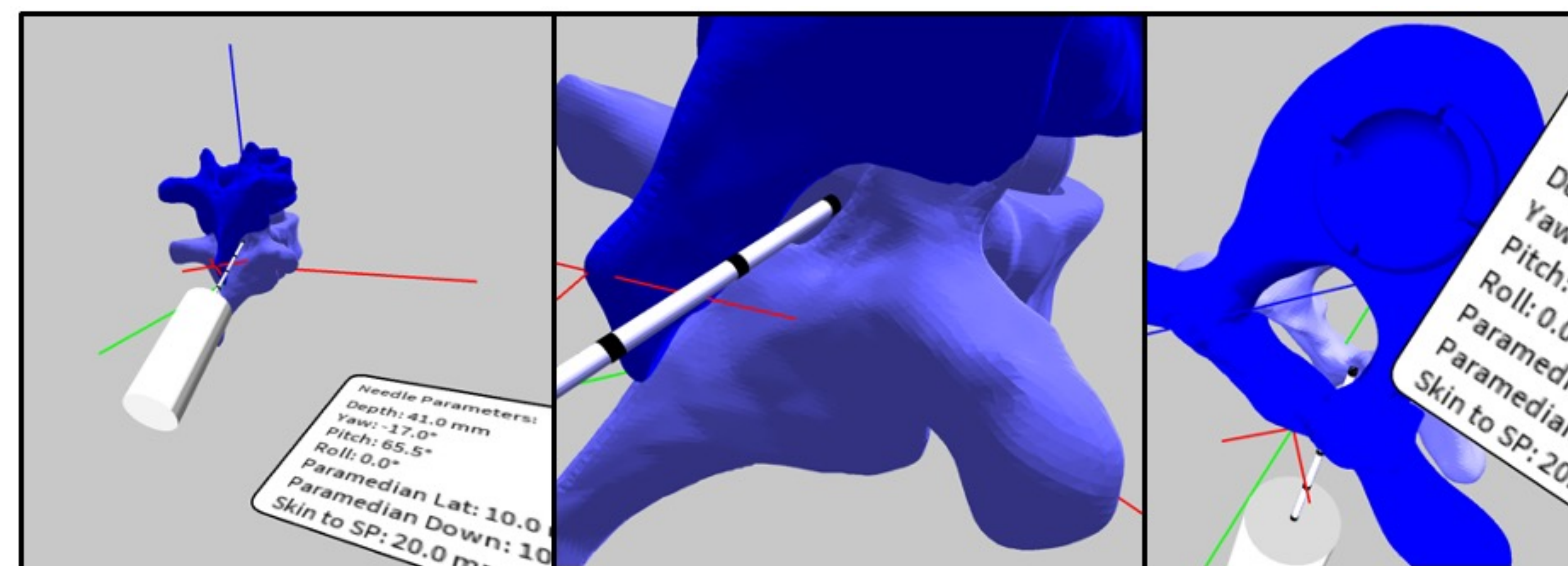


Figure 2: Custom 3D modeling software to estimate angles of entry and depth of LOR
left: 3D model of T7 and T8 with modifiable Touhy angle and depth
center: demonstration of clear passage of Tuohy through interlaminar space
right: demonstration of Touhy needle tip placement just outside of epidural space