Applications of Image-Guided Transoral Robotic Surgery for Target Localization

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Clinical Motivation

- **Transoral robotic surgery (TORS)** offers several advantages over traditional "outside-in" approaches:
  - **De-intensification of adjuvant therapy**
  - Shorter recovery times and hospital stays
  - Improved functional outcomes

- However, surgical roadblocks still exist:
  - General challenges:
    - **Intraoperative tissue deformation**
    - Deep tumor margins

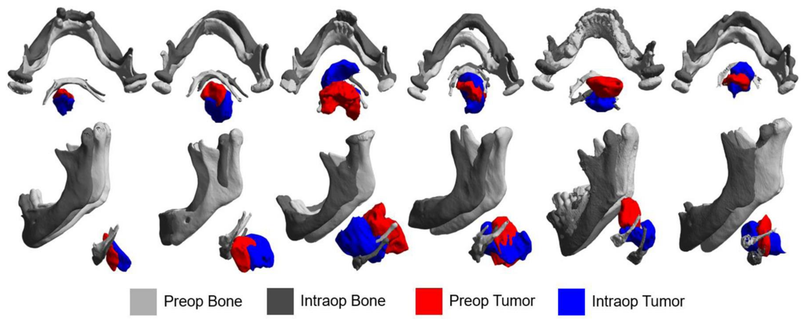


Fig. 1: Representative axial (top row) and sagittal (bottom row) views illustrating tissue deformation in six patients from a prior study performed at our institution.

  - TORS-specific challenges:
    - **Steep learning curve**
    - Lack of haptic feedback

- **Image-guided navigation (NAV) systems can potentially enhance surgical accuracy, but need to be adapted for TORS using semi-automated visualization and targeted tracking**

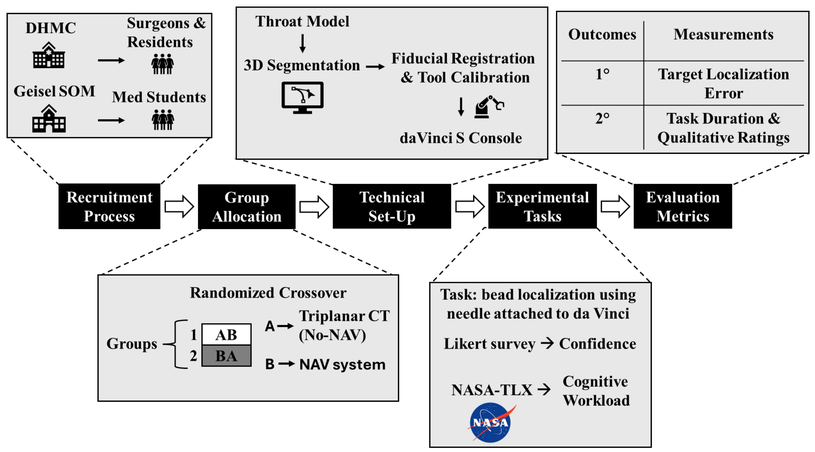
Objectives

- **Aim 1**: Design a reproducible, soft-tissue throat model for TORS simulation
- **Aim 2**: Evaluate an image-guided NAV system based on its localization accuracy, usability, and cognitive workload

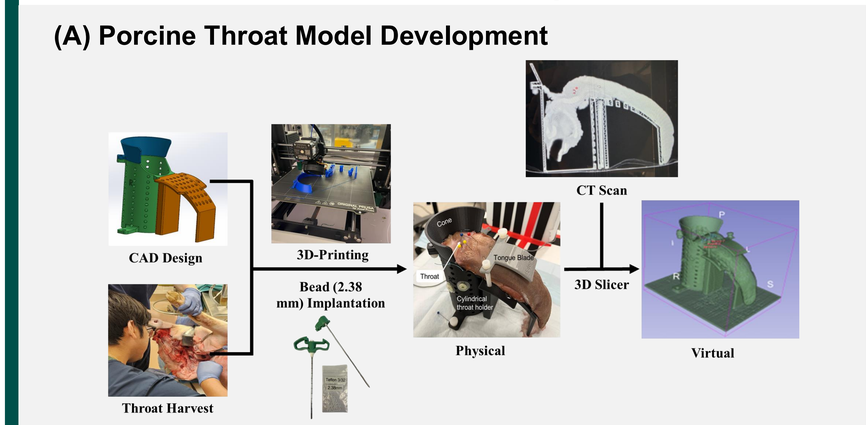
Methods

Can image-guided navigation system enhance surgical accuracy?

Study Workflow



Technical Set-Up



Results

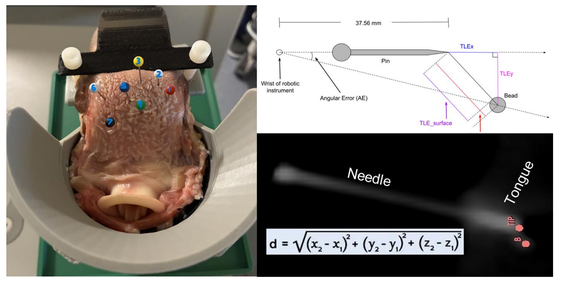
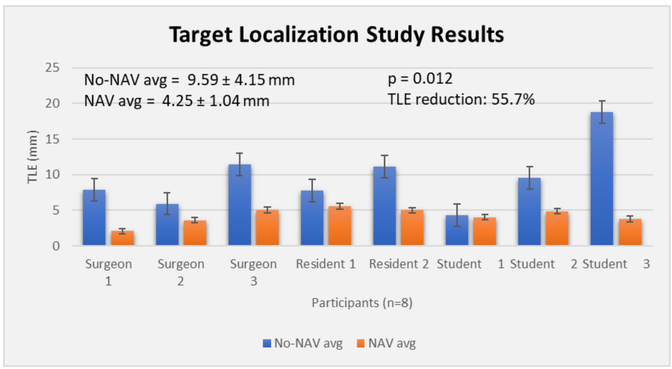


Fig. 2: Target localization error (TLE) is computed as the Euclidean distance between the 3D coordinates of the needle tip and the bead.

- **8 participants** recruited (3 ENT attendings, 2 ENT residents, and 3 medical students)

- **NAV enhances surgical accuracy (p = 0.012)**



Secondary Outcomes	No-NAV	NAV
Operator confidence		Likert rating 4.38 / 5 ± 0.48 → preferred arm
Task Duration (p = 0.24)	10.9 ± 3.9 min	12.4 ± 2.9 min
Cognitive Workload (p = 0.21)	55.9 ± 17.2	46.8 ± 10.3

Next Steps

- Implementing an **augmented reality NAV system**

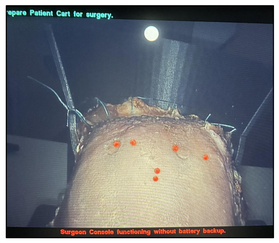


Fig. 3: Image guidance overlayed directly onto the endoscopic view.