Innovation and Research Week

שבוע חדשנות ומחקר

# Feasibility study of a bimanual haptic epidural simulator to learn loss of resistance technique

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## Background

Epidural analgesia is the most effective form of pain relief during labor yet is associated with numerous complications including accidental dural puncture and failed epidural. Anesthesiologist's experience is thought to influence success rate of epidurals and effort has been made to develop models to simulate epidural loss of resistance technique.
However most models are unable to control for interindividual variations such as depth of loss of resistance or ligamentum flavum thickness. We therefore designed a bimanual haptic simulator to train anesthesiologists and optimize epidural analgesia skill acquisition.

## Aims

1. Design a bimanual haptic simulator in order to train anesthesiologists and optimize epidural analgesia skill acquisition
2. Validation of the simulator using objective tools as well as subjective opinion of the experimenters

## Methods

We designed a bimanual epidural simulator with two Phantom Omni haptic devices: Device 1 is mounted by a Touhy needle and Device 2 is connected to a LOR syringe. To render resistive forces, we implemented the model and added variability in the thickness of the layers and their stiffness according to a weight-based estimation. We measured the movements of both haptic devices, and quantified the rate of results (success, failed epidurals and dural punctures), insertion strategies, and answers of participants to questionnaires about their perception of the realism of the simulation.

## Results

The study recruited 22 anestshesiologists with varying levels of expertise from several hospitals in Israel. The results indicated a statistically significant effect of expertise on the success rate of the procedure ($p = 0.0149$), with a clear inverse relation between the level of expertise and the occurrence of errors ($p = 0.0152$). The face validity of the simulator was demonstrated, with higher responses from the experienced group observed in most layers of the epidural region (except for the Ligamentum Flavum) when compared to the responses of the inexperienced group.

## Discussion and Conclusions

We demonstrated good construct validity by showing that the simulator can distinguish between real-life novices and experts. Good face and content validity were shown in experienced users' perception of the simulator as realistic and well-targeted. We found differences in strategies between different level anesthesiologists and suggest trainee-based instruction in advanced training stages. Moving forward, our next objective is to integrate visual virtual reality (VR) elements into the simulator. This immersive addition will provide the patient's perspective, displaying the lower back of a woman in labor, complete with accompanying sounds and movements, against the backdrop of a delivery room. Subsequently, we plan to initiate a clinical study that compares interns who undergo traditional training with those who receive simulator-based training. Our aim is to evaluate and compare the success rates and incidence of dural punctures between the two groups.