Mixed Reality Regional Anesthesia Simulator For Learning Psychomotor and Cognitive Skills Related to Thoracic Epidurals and Thoracic Paravertebral Nerve Blocks

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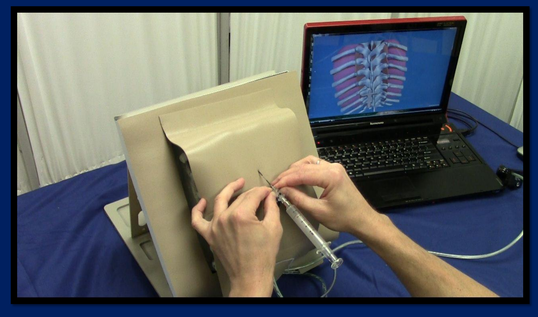
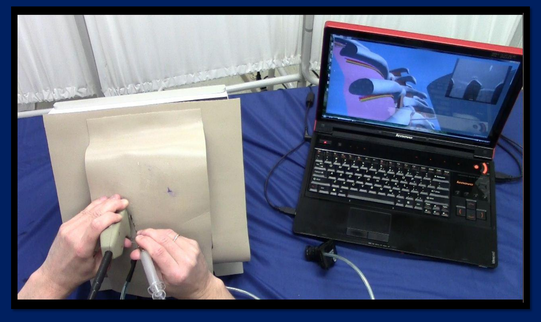
Introduction

We designed and built a mixed reality regional anesthesia simulator for learning psychomotor and cognitive skills related to thoracic epidurals and thoracic paravertebral nerve blocks. Features include: human torso (T2-T12) with physical/virtual structures, simulated physical/virtual ultrasound (US) probe, a physical Tuohy needle tracked in 3D space and its virtual counterpart, a syringe that can simulate loss of resistance, real time learner/instructor control of the viewing perspective of the virtual internal structures and a Windows laptop computer.

Methods

Using a 3D reconstruction of a human CT image, bony structures, fabricated by a 3D printer from hard material, are encased in ballistic gel with human soft tissue consistency. All relevant anatomical structures are accurately represented in 3D on the laptop screen. Needle advancement into the opaque (transparent when the physical simulated skin is removed) manikin provides appropriate tactile feedback. A tangible user interface (handheld physical toy camera) allows control of camera position and orientation for optimal visualization of the needle and anatomical structures during simulation or debriefing. A video of the mixed simulator is at http://simulation.health.ufl.edu/research/ra_sim.wmv





Description

Complications, like inability to locate the epidural space, false recognition of the epidural space, spinal cord injury, “wet tap”, and pneumothorax can be simulated. Each procedure can be recorded, automatically and objectively scored by a scoring algorithm and replayed during debriefing.

Furthermore procedures such as thoracic paravertebral block and intercostal block can be done under simulated ultrasound guidance, which is realistic, allows accurate visualization of the needle and anatomical structures, and shows fluid spread in real time. 3D reconstruction on the computer screen allows learners to visualize the ultrasound beam during manipulation of the physical simulated US probe and to develop a better understanding of 2D ultrasound image formation of 3D anatomical structures and to appreciate the limitations of ultrasound related to unfavorable angles of incidence, signal attenuation, acoustic shadowing, and other artifacts.

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