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MRI BASED PATIENT-SPECIFIC COMPUTER MODELS OF VERTEBRAE, LIGAMENT AND SOFT TISSUE WITH VARIOUS DENSITY FOR EPIDURAL NEEDLE INSERTION SIMULATION.

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Epidural simulations previously used layers of synthetic silicate materials to represent tissues. Graphical modelling has enabled visual representation of vertebrae and tissues. The accuracy with which previous simulators modelled the physical properties of tissue layer deformation, density distributions and reaction force during needle insertion has been lacking. Anatomical models are generally static, not considering individual differences between patients especially in obese. Our developed epidural simulator aimed to solve these issues. MRI scans of patients were taken after receiving epidural. The MRI and pressure measurement data was used to reconstruct a density model of the tissues, ligament and vertebrae taking into account the internal structure revealed by MRI intensities. Models were generated from MRI matching individual patients with tissue density varying throughout layers, matching the in vivo tissue. When patient MRI is not available a neural network is alternatively used to estimate the patient's ligament thicknesses with over 92% accuracy. A haptic device is incorporated with the graphics tissue model allowing anaesthetists to practice inserting a needle into the simulated epidural space. Changes in pressure, force and resistance to insertion can be felt as the needle pierces each layer of fat and ligament. The main problem with learning to perform epidural is the inability to see the needle location beneath the skin. MRI reveals the internal tissue structure so that anaesthetists can practice insertions on patient-specific models, visualising epidural space distance and needle obstructions. The developed simulator provides a realistic platform to practice and reduces risks of problems during in-vivo procedures.