ACS 2022 Surgeons and Engineers: A Dialogue on Surgical Simulation Meeting

Promoting Technology and Collaboration

Virtual Reality Surgeon Training on Retropubic Midurethral Sling Procedures

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Background: The retropubic midurethral sling is one of the most common, most effective anti-incontinence surgeries. Current technique relies on estimating angles using external anatomic landmarks, sensing subtle pressure changes through tissue, and blindly passing trocars in the neurovasculature-rich retropubic space. Even in experienced hands, this can result in a 13% complication rate. Typically, training involves apprenticeship in the operating room on live patients, or expensive cadaver labs, which are limited by distortion of anatomy after multiple passes of the trocars. Given this "blind" nature, a VR training system improves surgeon visualization acuity, allows for multiple no-risk training exercises, provides real-time feedback on the proper insertion pathway, and potentially reduces complications.

Technology Overview: We present a first prototype produced by our multidisciplinary team (medical & engineering) that introduces: (1) Virtual Reality (VR) environment for surgeon training, (2) exact 3D virtual anatomical models of each patient, and (3) haptic and visual notifications regarding the progress of the procedure. The framework consists of employing AI algorithms on anonymized patient data to model the 3D virtual anatomy of each individual patient. Having constructed the main anatomical landmarks (bladder, blood vessels, pelvic bone), we integrate the model along with a 3D design of surgical tools and Operation Room (OR) settings in the finalized VR environment. Surgeon training is based on maneuvering the haptic device handle through the virtual environment (Figure 1). Haptic and visual notifications are provided to the user depending on the divergence from the optimal tool path through the anatomy.

Potential Application in Surgical Simulation and Education: This framework is generalizable for a wide range of urogynecologic procedures, such as vaginal hysterectomies and transvaginal prolapse surgeries, since it overcomes the lack of direct visibility inherent in pelvic floor operations. Subsequent iterations of the prototype will include predictive AI-driven guidance, which further enhance the dynamic and cost-effective character of the system.

Potential Opportunities to Collaborate: This collaboration between surgeons and engineers extends naturally to other subspecialties addressing blindly passed instruments requiring haptic feedback in neurovascular-rich anatomy.

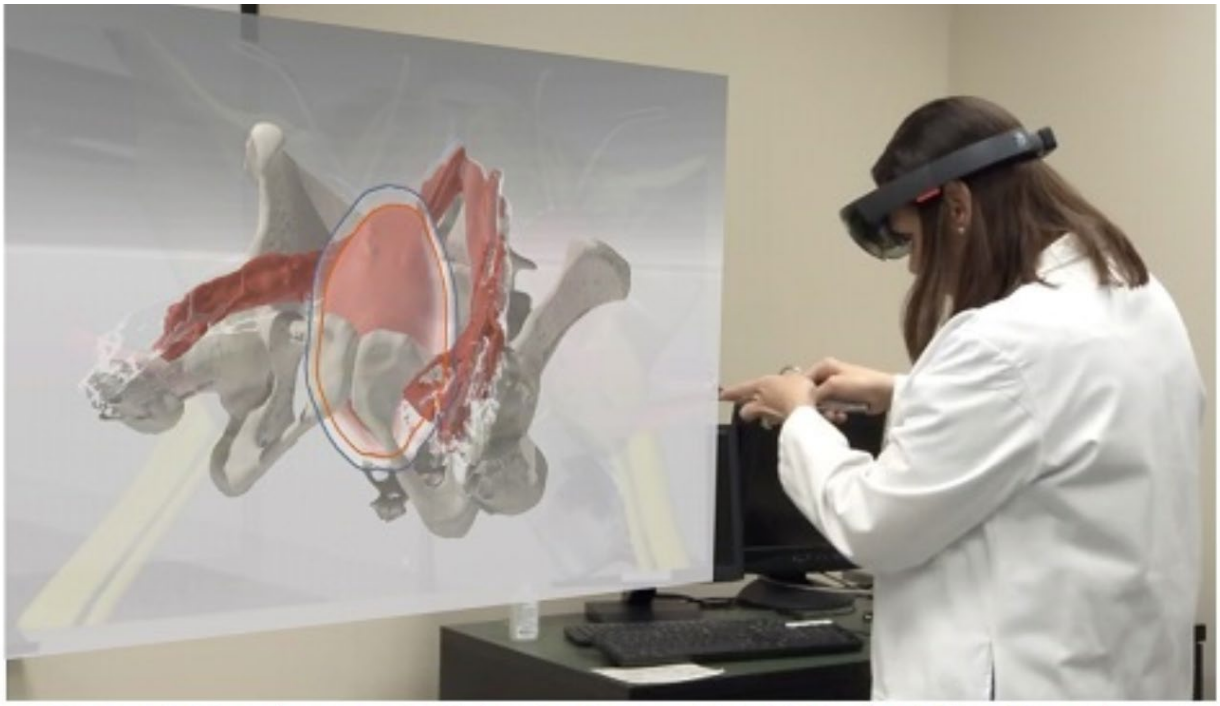

Figure 1: Virtual surgeon training for Retropubic Mid-Urethral Sling Procedures