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Promoting Technology and Collaboration

Transdisciplinary Development of a Virtual Reality Training System for Retropubic Sling Teaching

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Background: Retropubic Mid-Urethral Slings are surgically placed by estimating insertion angles using external anatomic landmarks, sensing subtle tactile changes through tissue, while passing trocars in the neurovascular-rich retropubic space. The "Blind" nature of this technique, even in experienced surgeons' hands, can result in up to 13% complication rate. Surgeons are typically trained via an apprenticeship on live patients; static models, or, if available, cadaver labs which carry expense, often require travel, time away from work, and are technically limited by the distortion of anatomy after multiple uses. To develop a new innovative training method, a transdisciplinary team of surgeons, engineers, physical therapists, and programmers was assembled within Virginia Commonwealth University. Our resulting unique Sling VR system with haptics feedback and competency scoring addresses challenges in surgeon training.

Technology Overview: Our objective was to develop a low-risk, cost-effective method to teach surgical procedures that require learning by feel and high-volume pattern recognition. An initial clear development plan was developed including required expertise, resource availability, and communication schedule. Computer scientists developed artificial intelligence algorithms for deidentified MRI and CT images to provide high accuracy of anatomy in a 3D VR model. The system detects the surgeons' relative position to the pelvis, bladder, and major blood vessels. A programmer and motor control scientist (PT) from our LEVR (Launching Excellence in Virtual Reality) center integrated high-resolution haptic and visual alerts to provide the surgeon with real-time feedback when approaching at-risk anatomy and generate a competency score. Multiple surgeon trial sessions provided feedback during the iterative development steps.

Potential Application in Surgical Simulation and Education: This will be the first non-cadaveric, non-static model available in the field. It can aid in developing trainee competency, improving patient safety and decreasing perioperative complications.

Potential Opportunities to Collaborate: Efficient communication and coordination across multiple specialties, university departments, and colleges has enabled development of an operational prototype system for demonstration and broader surgeon evaluation. The system has implications to other urogynecologic transvaginal operations and potentially additional "blind" procedures.