P-D-05

Research Abstracts

CROWNS - A Platform to Train and Assess Wire Navigation Skills in Orthopedics

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Introduction: Wire navigation is a fundamental skill in orthopedic surgery. Opportunities for deliberate practice are limited due to radiation exposure, patient safety, and OR time constraints. We developed the CROWNS (Core Requisites for Orthopedic Wire Navigation Skills) platform, designed to provide radiation-free, realistic training and objective performance assessment across common wire navigation-based procedures.

Methods: The CROWNS system incorporates sawbones models within a tissue-mimicking enclosure, infrared lights and a camera-based system, and laser-etched wires, which together with a laptop enable realistic visualization of wire navigation without radiation. Modules developed include training hip fracture, pediatric elbow fracture, and sacroiliac screw placement. Validation studies have been conducted across multiple venues (University of Iowa, University of Minnesota, Aarhus University, and national courses) to test face, construct, and transfer validity. Participants included orthopedic residents (PGY1-5), fellows, and faculty. Outcomes assessed included wire placement accuracy, fluoroscopic image use, procedure time, and composite performance scores. Resident and fellow surveys assessed perceived realism and educational value.

Results: Face validity was supported, with >90% of residents and fellows rating the simulator as beneficial and realistic. Advanced learners outperforming novices across modules provided strong evidence of construct validity. Transfer validity was confirmed in two studies: hip module training correlated with improved performance in mock OR settings (n=54), and pediatric elbow training led to measurable improvement in real OR cases compared to untrained controls (n=97). Benchmarking studies at Orthopedic Trauma Fellow Courses has provided a basis for setting expert performance thresholds, with subsequent assessments at Iowa finding 75-77% of residents met benchmarks.

Conclusions: The CROWNS platform is a validated, competency-based simulation system for wire navigation training. It improves skill acquisition, differentiates levels of expertise, and demonstrates transfer to operative performance. Its integration into residency curricula offers a scalable approach to enhance training, establish proficiency benchmarks, and ultimately improve patient safety.