Sensorized Broken Wrist Model for Teaching Casting via Simulated Fluoroscopy

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The epidemiology of distal radius fractures has been well-documented. A distal radius fracture is one of the most prevalent conditions treated in an orthopedic setting and accounts for one-sixth of the injuries treated. Traditionally, a physician's reduction technique is acquired through trial-and-error and observation of senior peers performing actual castings. Flaws in training correlate to poor outcomes in the clinical environment. Malunion is a result of improper bone realignment which necessitates further hospital visits. According to researchers at Iran University, a 23.5% malunion rate is associated with non-surgical fracture reduction. This has prompted medical education programs to pivot towards simulation-based learning. Simulation-based learning supplements the acquisition of clinical skills and provides a safe and controlled training environment for medical students. However, current models do not provide real-time feedback and require the use of fluoroscopy to determine reduction quality.

The development of a sensorized distal radius fracture model for teaching casting via simulated fluoroscopy is a novel design idea with few competitors. The only commercial product available for training medical students is the Sawbones® distal radius casting trainer. In addition, there have been several private academic models created for simulated treatment of distal radius fractures. These commercial and academic models contain a fractured radius, which trainees attempt to reduce by feel; however, users do not receive any real-time objective feedback.

The market for a sensorized casting model consists of orthopedic residency programs throughout the nation, of which there are approximately 154 according to the AAOS. There are approximately 3,300 orthopedic students, with 640 entering residency programs yearly, that require training to bridge the gap between medical school and medical practice. With exposure to clinical settings during residency declining each year, a desire for residents to gain access to real-time objective feedback during training has been growing.

Our design is a modified Sawbones® distal radius trainer. We have incorporated a number of sensors that capture and provide quantitative, real-time feedback to the trainee about their reduction quality. The novelty of our design manifests through its use of simulated fluoroscopy in conjunction with a force sensor and IMUs to capture meaningful data such as force applied and bone realignment. A custom GUI displays responsive X-ray video so that the user feels as if they are reducing the fracture under live fluoroscopy. A dynamic force indicator shows whether a participant is applying proper force to an acceptable location, as determined by expert physician data. Upon completion of casting, force and angle data pertaining to bone realignment can be graphed to show the caster how their technique varied throughout the procedure. Analysis of the collected casting data provides objective measurement of trainee competency.

This product offers improvement to the current training system by providing an effective means of teaching a novice, declaring objective competency of casting, and contributing data on appropriate reduction angles and casting forces required for satisfactory treatment of distal radius fractures. If commercialized, this design would reduce costs for both patients and practitioners, and increase overall quality of healthcare. Our device will ultimately improve the quality of training for orthopedic students, consequently lowering the prevalence of improper reductions and increasing procedure efficiency.