SIMULATION TO IMPROVE SURGICAL ARTICULAR FRACTURE REDUCTION SKILLS

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INTRODUCTION

Orthopaedic surgical skills acquisition during residency training is presently based on an apprenticeship model, with minimal practice outside of the operating room. This model does little to provide uniform training or assure technical competence. In a review of surgical errors, 63.5% of cases involved technical error and 29% included an error in judgment [1]. Both types of errors can be attributed to a lack of experience. Surgical simulation can help address shortcomings in training by ensuring residents the opportunity to (1) practice important procedures not otherwise encountered, (2) practice procedures until competency is achieved, and (3) prevent exposure of live patients to undue risk.

Surgical articular fracture reduction presents a challenging procedure involving a variety of skills needed in orthopaedic surgery. Partly for this reason, a laboratory simulation of the procedure was recently developed [2]. However, the complexity of the task makes it difficult for trainees to improve their skills working with this simulator. The goal of this study was to conduct preliminary assessments of the value of a flexible skills trainer and one-on-one coaching sessions to improve performance on the articular fracture reduction simulator.

METHODS

A simulation of the surgical reduction of a three-fragment tibial plafond fracture that has previously been described [2,3] was used to compare the performance of six first-year orthopaedic residents before (pre-test) and after (post-test) the use of a box skills trainer. A third (retention) test was performed two weeks later following a one-on-one coaching session. The simulator gives residents a 15 minute time window to reduce and fixate the fracture fragments using a standard set of surgical tools and stainless steel K-wires. The residents also use fluoroscopy to help determine the current position of the fragments. The fracture is housed in a surrogate soft tissue foot and ankle model (Sawbones Inc.). Among the changes recently introduced to the simulator, hand motion data were collected using a Polhemus G4 electromagnetic tracking system and the foot and ankle model (formerly homegrown) was produced by Sawbones Inc. and molded directly into the soft tissue model (Fig 1).

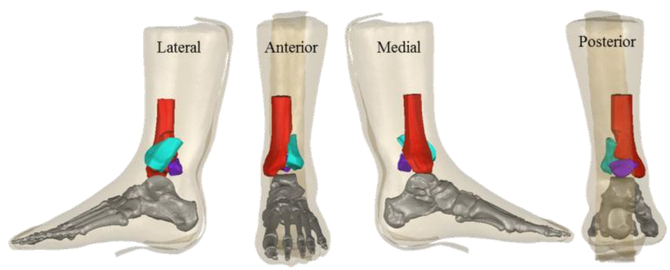

Figure 1: The foot and ankle fracture model used in the simulation is shown schematically in its soft tissue housing.

Data collected and analyzed following the simulation include the number of discrete hand motions and cumulative hand distance traveled, the number of fluoroscopy images (radiation exposure), and an objective structured scoring of performance (OSATS) done by an expert. Multiple angles of video were recorded, including a head-mounted camera (Go Pro Hero3) and multiple wide view angles.

The skills trainer consisted of two video cameras mounted on an aluminum frame. The cameras view a workspace from orthogonal positions: one from 1.5’ above, the second points toward the participant from a position approximately 1.5’ behind the workspace. A screen between the workspace and the participant obstructs the direct view of hand motions in the workspace. This requires the participant to rely on the camera views visible on a monitor placed conveniently nearby to navigate the 3D environment. Several tasks performed in the workspace (described in separate abstract) are used to exercise the trainees’ skills.

The video camera views obtained during the original fracture reduction simulation were edited together with the fluoroscopy images and were used in coaching the residents. The one-on-one coaching session consisted of a traumatologist viewing the videos with the resident in order to discuss surgical technique, proper use of tools (including fluoroscopy), and any other issue or questions that the resident may have had regarding the fracture reduction.

RESULTS AND DISCUSSION

The number of hand motions and distance traveled during the procedure became slightly less variable with each successive trial (Fig. 2), but the

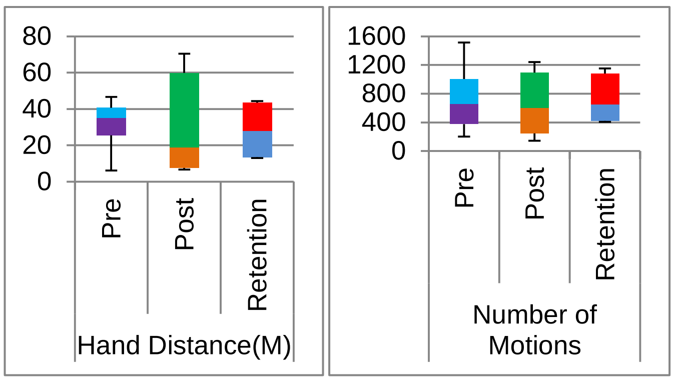

Figure 2: Left- box plot of distance in meters of hand travel during reduction **Right**-box plot of number of discrete hand motions during reduction.

change was not significant (Table 1). The difference in the use of fluoroscopy was significant between the pre-test & retention test and the post-test and

Table 1: Student T-Test significance values for comparison between the three trials (significant results are highlighted.

	mAs	# of images	Distance (m)	# of motions	OSATS
Pre-Post	0.68	0.97	0.88	0.74	0.03
Pre-Ret	0.03	0.04	0.43	0.18	0.01
Post-Ret	0.01	0.01	0.64	0.86	0.14

retention test (Fig. 3). Since the session with the traumatologist occurred immediately prior to the retention test, this would indicate that the one-on-one coaching session had a positive effect on use of fluoroscopy. Higher OSATS scores of performance on the post-test simulation compared to the pre-test

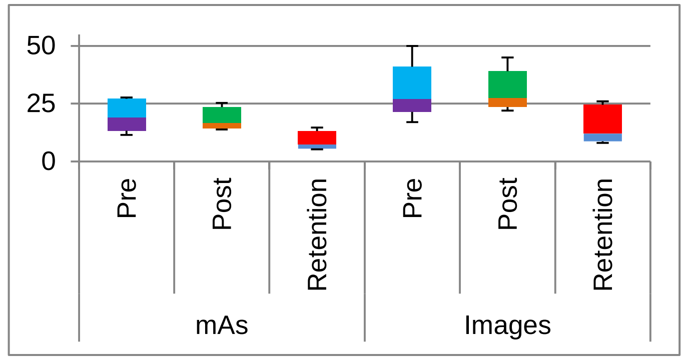

Figure 3: box plot of fluoroscopic data; on left radiation dose in mAs and on right number of images obtained.

suggests that time spent on the box skills trainer led to improved performance. Further performance improvements, as indicated by elevated OSATS scores, followed the one-on-one coaching. This also implies that coaching influenced performance.

CONCLUSIONS

Improvement shown by the residents both in their reduced use of fluoroscopy and improved OSATS scoring showed that the box skills trainer and the coaching provided by a senior traumatologist can be useful in resident education. We believe that this will lead to better trained surgeons; which will improve patient safety and patient outcomes.

REFERENCES

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