Comparing Skill Acquisition and Validity of Immersive Virtual Reality to Cadaver Laboratory Sessions in Training for Reverse Total Shoulder Arthroplasty

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INTRODUCTION: In the current landscape of surgical training, resident and fellow education typically combines supervised surgery in the operating room with didactic lectures, technique videos and technique guides, sawbones models, cadaver dissections, skills labs, and variable fidelity surgical simulators. However, due to the COVID-19 pandemic, reductions in residency work hour limits, and a continued emphasis on patient safety, surgical trainees have had reduced opportunities to refine their skills in the operating room. The emergence of immersive virtual reality (iVR) may afford surgical trainees the opportunity to practice their skills at their convenience without risk of harm to patients, nor operating room and laboratory and cadaver costs. Though surgical simulators have been shown to be effective compared to traditional lectures and videos, iVR has not been directly compared to cadaveric lab training, the accepted gold standard. Our aim is to study skill acquisition for augmented baseplate insertion during reverse total shoulder arthroplasty (rTSA) among junior-level orthopedic surgery residents using these two training methods.

METHODS: This study is a randomized, intervention-controlled clinical trial of junior orthopedic surgery residents post graduate year (PGY) 1-3, from a single training program, to determine the effectiveness of iVR compared to cadaveric laboratory training in surgical skill acquisition for reverse total shoulder arthroplasty with augmented baseplate implantation. After a brief lecture and technique video demonstrating key steps of augmented baseplate insertion, participants were asked to complete a brief survey of demographic information as well as their experience with rTSA and iVR. Participants were then randomized to training with either iVR, or a laboratory session with cadaveric shoulder specimens. Participants were allowed 1 hour to practice the procedure with their assigned training method, then assessed by a blinded evaluator using validated competency checklists (OSATS, GRS) during cadaveric baseplate insertion. Following the final assessment, participants completed a survey regarding the realism and utility of their assigned training tool and sentiments toward iVR in orthopedic surgery education. Continuous variables were analyzed using the unpaired t-test while categorical variables were analyzed using chi-squared test.

RESULTS:

9 junior residents (four PGY1, one PGY2, four PGY3) were enrolled in this study and randomized to training with either immersive virtual reality (n=4) or cadaver lab training (n=5). There were no statistically significant differences in demographic data, prior experience with reverse total shoulder arthroplasty, nor prior use of iVR ($p>0.05$). There was no statistically significant difference in total OSATS score (average iVR score 16.5, cadaver 17.6, $p=0.49$), mean GRS scores (iVR 4.5625, cadaver 4.525, $p=0.92$), nor time to completion of the assessment (average iVR 546 seconds, cadaver 614 seconds, $p=0.71$). Average cost of iVR hardware and a 1-year software license with unlimited access to a variety of surgical modules was $4900, while the average cost of a single cadaver lab training was $1268.20 per resident (with the assumption each resident receives their own cadaver and implants/instruments may be reused at least twice).

DISCUSSION AND CONCLUSION:

Junior residents display similar skill acquisition when training with iVR or fresh-frozen cadaver methods. Unlike cadaver labs, iVR allows trainees to repeat steps until achieving mastery, provides objective feedback metrics for the procedure performed, and has significant cost saving potential. Though additional research into this field is needed, iVR may provide an important tool in surgical education, particularly in resource-poor areas or for those procedures for which cadaveric specimens may be too costly or infeasible to obtain.