Validity Assessment of a 3D Printed Arthroscopic Shoulder Simulator: An Experimental Evaluation of Construct Validity and Educational Value

Patrick Allan Massey, Wayne Andrew Scalisi, Shane Barton, Giovanni Francesco Solitro[1]
[1]Louisiana State University Health Shreveport

INTRODUCTION:

Adoption of arthroscopic shoulder simulator in training programs is currently limited by the costs of existing solutions ($1,000 to $30,000) and their geographical availability. We have developed a 3D printed anatomic shoulder simulator that is low cost and deployable worldwide since it relies on common fused deposition modeling (FDM) printing technology. The purpose of this study was to evaluate the educational validity of a novel 3D printed arthroscopic shoulder simulator (3D-PASS) in relation to a widely adopted and commercially available shoulder simulator (CASS).

METHODS:

This study was a prospective randomized control trial approved by the local Institutional Review Board (IRB). Twenty subjects were recruited for 2 groups: 10 Medical Students and 10 Expert Surgeons. Medical students were 3rd or 4th year medical students who had completed surgical rotations. Expert Surgeons were orthopaedic surgery attendings who have completed a sports medicine or shoulder and elbow fellowship or who have completed at least 250 shoulder arthroscopic procedures. Each subject was randomized to perform arthroscopic tasks on the 3D-PASS or on the CASS. After randomization there were 5 medical students for the 3D-PASS and 5 medical students for the CASS groups and 5 expert surgeons for the 3D-PASS and 5 expert surgeons in the CASS group. All subjects completed a timed assessment of arthroscopic tasks on their designated shoulder simulator. The four arthroscopic tasks included probing different locations, inserting a suture anchor into the greater tuberosity, pulling sutures through portals, and measuring anatomy. All of the subjects completed a shoulder anatomy test before and after the given tasks as well as a questionnaire.

Educational value was determined by anatomy test scores before and after performing the simulation tasks while construct validity was determined by measuring the differences in time to completion of the tasks between the two groups based on experience. A Student 2 sample t-test was used to compare numerical data between two groups.

RESULTS:

On average, the medical student group took 729 seconds to complete the simulation tasks on the CASS versus 385 seconds on the 3D-PASS (p=.01, see fig 1). The expert surgeon group took 295 seconds versus 248 seconds to complete the arthroscopic tasks on the CASS versus 3D-PASS, respectively (p=.51). The medical student group had longer time to completion of the arthroscopic tasks than the expert surgeon group on both the CASS (p=.003) and 3D-PASS (p=.046).

There was a moderate negative correlation between the number of shoulder arthroscopies a user had performed and the amount of time to completion of the simulation tasks on both the CASS (r=-.60) and 3D-PASS (r=-.43). Subjects improved on their anatomy test from a 62% to a 80% (p=.022) after performing the 4 tasks on the CASS and from 62% to 84 % on the 3D-PASS (p=.049, see fig 2).

Additionally, the expert surgeons rated the 3D-PASS as more portable, and more likely to improve suture management skills than the CASS. (p=.004 and p=.04 respectively).

DISCUSSION AND CONCLUSION: The 3D printed arthroscopic shoulder simulator demonstrated construct validity and educational value comparable to a commercially available shoulder simulator. Additionally, medical students were able to complete arthroscopic tasks faster with the 3D printed shoulder simulator compared to the commercial simulator.