Arthroscopic Shoulder Surgical Simulation Training Curriculum: Transfer Reliability and Maintenance of Skill Over Time

John C. Dunn, MD,* Philip J. Belmont, MD,* Joseph Lanzi, MD,* Kevin Martin, DO,† Julia Bader, PhD,* Brett Owens, MD,‡ and Brian R. Waterman, MD*

*Department of Orthopaedic Surgery, William Beaumont Army Medical Center, Fort Bliss, Texas; †Department of Orthopaedic Surgery, Evans Army Community Hospital, Fort Carson, Colorado; and ‡Department of Orthopaedic Surgery, Keller Army Community Hospital, West Point, New York

BACKGROUND: Surgical education is evolving as work hour constraints limit the exposure of residents to the operating room. Potential consequences may include erosion of resident education and decreased quality of patient care. Surgical simulation training has become a focus of study in an effort to counter these challenges. Previous studies have validated the use of arthroscopic surgical simulation programs both in vitro and in vivo. However, no study has examined if the gains made by residents after a simulation program are retained after a period away from training.

METHODS: In all, 17 orthopedic surgery residents were randomized into simulation or standard practice groups. All subjects were oriented to the arthroscopic simulator, a 14-point anatomic checklist, and Arthroscopic Surgery Skill Evaluation Tool (ASSET). The experimental group received 1 hour of simulation training whereas the control group had no additional training. All subjects performed a recorded, diagnostic arthroscopy intraoperatively. These videos were scored by 2 blinded, fellowship-trained orthopedic surgeons and outcome measures were compared within and between the groups. After 1 year in which neither group had exposure to surgical simulation training, all residents were retested intraoperatively and scored in the exact same fashion. Individual surgical case logs were reviewed and surgical case volume was documented.

RESULTS: There was no difference between the 2 groups after initial simulation testing and there was no correlation between case volume and initial scores. After training, the simulation group improved as compared with baseline in mean ASSET ($p = 0.023$) and mean time to completion ($p = 0.01$). After 1 year, there was no difference between the groups in any outcome measurements.

CONCLUSION: Although individual technical skills can be cultivated with surgical simulation training, these advancements can be lost without continued education. It is imperative that residency programs implement a simulation curriculum and continue to train throughout the academic year. (J Surg Ed 72:1118-1123. Published by Elsevier Inc on behalf of the Association of Program Directors in Surgery)

KEY WORDS: simulation, surgical training, transfer validity, shoulder, arthroscopy

COMPETENCIES: Practice-Based Learning and Improvement, Patient Care, Medical Knowledge

INTRODUCTION

Surgery training programs have recently been rapidly transformed in compliance with mandates from the Accreditation Council for Graduate Medical Education (ACGME).[1,2] These changes include maintaining a case log with specific case minimums, surgical skill training, and strict work hour restrictions. These changes have decreased the case volume for general surgery trainees.[3] In addition, residents are expected to master swiftly evolving evidence-based literature and complex surgical procedures.[4] The combination of these factors has strained the quality of resident surgical education, which directly affects patient care and safety.[5-8] To combat these trends, surgical simulation has become a focus of study. General surgery residency programs have pioneered the use of simulation, the use of which has been supported by randomized controlled trials.[9-14]

Surgical simulation has also gained in popularity in orthopedic training programs. Arthroscopic simulation studies have been conducted on shoulder,[15-17] knee,[18] and

Correspondence: Inquiries to Brian R. Waterman, MD, Department of Orthopaedic Surgery and Rehabilitation, William Beaumont Army Medical Center, 5005 N. Piedras St., Fort Bliss, TX 79920; e-mail: dunnjohnc@gmail.com

1931-7204/$30.00
http://dx.doi.org/10.1016/j.jsurg.2015.06.021

hip models.[19] Numerous studies have affirmed the validity of simulation[10,15-18,20-22] and improvements in surgical skill[16,23,24] among orthopedic residents. At our institution, simulation training has demonstrated transfer validity between the simulator and operating room.[16] In the present analysis, we sought to determine if a simulation training curriculum improves live performance in the operating room and if these gains can be maintained over time.

METHODS

Participants

Before study commencement, Institutional Review Board Approval was obtained. In all, 17 orthopedic surgery residents, from all postgraduate training levels, voluntarily enrolled in October 2012. No resident had formal arthroscopic simulation training before the study. Resident year, arthroscopic case log volume, and demographic information were recorded. Each resident undergoes case log evaluation by the program director every quarter, to ensure accuracy. All residents regularly undergo evaluation by senior staff of arthroscopic video, which is routinely recorded during cases.

Study Design

A single-blinded, prospective randomized controlled trial was conducted. In all, 2 heterogeneous groups were randomized into either a control or experimental group. The control group would receive no simulation training whereas the experimental group would undergo an arthroscopic simulation training program. Throughout the course of the study, all residents continued with their respective surgical rotations and case logs were updated accordingly. At the beginning of the study, all residents were introduced to a 14-point diagnostic shoulder arthroscopy checklist (Fig.). In addition, a sample video of an expert arthroscopist performing the checklist was shown. All residents were given a primer on the simulator.

1. Inspect and probe long head of the biceps tendon
2. Pull biceps from the intertubercular groove into the joint
3. Inspect the biceps sling
4. Inspect and probe the superior labrum
5. Inspect and probe the glenoid articular surface
6. Inspect and probe the humeral head articular surface
7. Inspect the articular the surface of the supraspinatus
8. Inspect the articular surface of the infraspinatus
9. Inspect the posterior humeral head and bare area
10. Inspect the capsular attachment to the humerus (HAGL)
11. Inspect the inferior pouch of the humerus
12. Inspect and probe the posterior labrum
13. Inspect and probe the anterior labrum
14. Inspect the subscapularis recess and insertion

FIGURE. The 14-point anatomic checklist.

Simulator Training

Every resident received a basic introduction to the ARTHRO VR simulator (Simbionix, Cleveland, OH). This simulator is designed to closely approximate in vivo experience with haptic feedback.[25] Using a blue-sphere design[15] to score performance, users are able to manipulate tissue, while being scored in a precise manner. Objective simulator measurements in our simulation curriculum included camera distance traveled (in millimeters), probe distance traveled (in millimeters), and time to completion (in seconds).

The group randomized to simulation training received 1 hour (four 15-minute one-on-one sessions with an experienced arthroscopist) of additional training over a 90-day period. Training focused on diagnostic arthroscopy and specifically on triangulation, efficiency, and psychomotor coordination. The goal was to complete 12 to 15 diagnostic examinations each session, or 50 for the complete curriculum. Increments of 50 arthroscopic cases have been shown to increase simulation scoring.[16] The control group did not use the simulator after initial orientation.

Arthroscopic Testing

All of the residents then completed initial recorded testing with a senior staff arthroscopist in the beach chair position, with a 30° arthroscope, and a high-definition arthroscopic camera (Stryker Inc.; Kalamazoo, MI). The senior staff arthroscopist was blinded to the resident's participation in training. Senior staff would make the necessary portals, and advance the camera and probe into the glenohumeral joint, at which point the resident would begin the test. No additional assistance was given. Testing was terminated if it was unsafe for the patient or if the resident could not finish the examination. Videos were recorded and scored by 2 blinded, fellowship-trained orthopedic surgeons.[26] The expert evaluators used the Arthroscopic Surgery Skill Evaluation Tool (ASSET) to score each video. ASSET is a valid assessment for scoring quality with satisfactory interobserver and test-retest reliability during arthroscopy.[27] In addition to overall ASSET scores, ASSET safety score, time to completion, and number of checklist points achieved were recorded.

After initial testing, the simulation group received training, whereas the control group did not. After 3 months, all residents were retested, *in vivo*, in the same manner, and videos were rescored. For the following 1 year, no resident enrolled in the study used the arthroscopic simulator. All residents continued their respective rotations and case log volume was recorded. At this point, all 17 residents were retested and scored, in the same manner.

Statistical Analysis

Means and standard deviations were calculated for continuous data whereas frequencies and proportions were calculated for