Orthopaedics & Traumatology: Surgery & Research 103 (2017) 483–488

Available online at
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EM|consulte
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Original article

Learning the skills needed to perform shoulder arthroscopy by simulation

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ARTICLE INFO

Article history:
Received 23 September 2016
Accepted 21 February 2017

Keywords:
Simulation
Shoulder arthroscopy
Skills
Teaching

ABSTRACT

Introduction: Simulation for arthroscopy helps surgical trainees develop their surgery skills in a safe environment. This teaching technique has become more widespread in recent years because of the need to provide surgeons in training with an alternative to the current methods. We hypothesized that a resident in surgery could acquire the skills needed to perform arthroscopic shoulder surgery by working on a simulator.

Material and methods: The study was conducted over a 4-month period from June to September 2016. All the surgeons and residents in our department participated in the study. We recorded each participant's age, sex, dominant hand, and video gaming experience. We used the Arthro Mentor^{TM} simulator from Simbionix (now 3D Systems). Testing was carried out at the start and end of training to evaluate the participant's skills and their progression. The changes were evaluated statistically.

Results: Fourteen surgeons were included in the study. They were split into two groups: controls and residents. There was a statistically significant improvement in the intern group between the overall pre-test score and the overall post-test score. There was no significant improvement in the overall score of the control group between the pre-test and post-test.

Discussion: For surgeons in training, shoulder arthroscopy simulation helps them acquire the skills needed to perform arthroscopy such as hand-eye coordination, triangulation and the ability to work in three-dimensions based on two-dimensional visual information. We believe that the benefit of simulation resides in learning the skills needed to perform a surgical procedure, not in learning the procedure itself.

Level of evidence: III–case-control study.

1. Introduction

Shoulder arthroscopy is said to be a demanding technique that can bring on complications due to poor knowledge of the surgical technique [1]. Castagana et al. believe that learning shoulder arthroscopy first requires a good knowledge of anatomy, biomechanics and shoulder pathology leading to a rational approach to the proposed treatment [1]. Once these concepts have been acquired, learning of the arthroscopic technique can start: observation, cadaver practice, simulator practice, guided and controlled progression in operating room [1]. Simulation for arthroscopic training helps surgical trainees develop their surgery skills in a safe environment [2]. This teaching technique has become more widespread in recent years given the need of providing surgeons in training an alternative to the current methods [3,4]. The traditional or mentoring model has certain limitations that have become more pronounced because of our society's evolution [2,5]. The number of working hours is now controlled, limiting the access to operating room to surgeons in training. The on-call period and safety breaks strongly affect the presence of these surgeons in the care environment [5,6].

Hence, there is an increasing need to provide training alternatives to allow tomorrow's surgeons to remain competitive and in particular, learn both standard surgery and ultra-specialized surgical techniques [6]. Simulation has a natural role in this context. It provides teaching opportunities developed in the aviation industry, where it has been proven. This method also provides an opportunity to evaluate the trainee objectively. Three recent systematic reviews validate use of simulation for professional arthroscopy training [5–7]. However, these authors concluded that new studies are needed to show the knowledge is maintained over time and in particular, that it is transferred during actual surgical procedures. From our perspective, the relevance of a surgical simulation program rests in learning the automatic reflexes needed to correctly perform a surgical procedure in the operating room.

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http://dx.doi.org/10.1016/j.otsr.2017.02.008
1877-0568/

Fig. 1. Arthromentor–shoulder module (arthromentor module book).

We hypothesized that a surgeon in training could improve the skills needed to perform arthroscopic shoulder surgery by working on a simulator. The primary objective was to evaluate the ability for progression of surgery residents using exercises on a simulator. The secondary objective was to show that a resident could reach the same performance level as an experienced surgeon on a simulator.

2. Materials and methods

2.1. Participants

The study was conducted over a 4-month period from June to September 2016 in our orthopedic and trauma surgery department. All of the department's surgeons and residents participated in the study. We recorded each participant's age, sex, dominant hand, and video gaming experience.

2.2. Simulator and training methods

We used the Arthro Mentor^{TM} simulator from Simbionix (now 3D Systems) (Fig. 1). This simulator combines fiberglass/polyurethane anatomical models (shoulder, knee and hip) with 3D images and haptic sensation. This simulator uses didactic sequences of training tasks that increase in difficulty to help the surgeon practice arthroscopic maneuvers, explore normal and diseased joints, and carry out repair procedures by arthroscopy.

First, each participate performed a module called "basic tasks". This module consists of 22 exercises that allow the user to acquire the basic principles of arthroscopy. Once this module had been completed, all the participants did a pre-test before moving on to the simulator's more advance training modules. This pre-test consisted of two exercises that best represented arthroscopic exploration in a human shoulder. The first exercise, called "joint", consisted of exploring the glenohumeral joint. The second exercise, called "acromion", consisted of exploring the subacromial space. These two exercises were performed with only the trainer present. A computerized report of each participant's performance on each test was generated. This report provided information on:

- distance covered by the camera (out of 10 points);
- distance covered by the probe (out of 10 points);
- errors made with the camera (out of 10 points);
- errors made with the probe (out of 10 points);
- time required for the exercise (out of 10 points);
- overall score (out of 10 points).

Once this pre-test had been completed, the participants had free access to the simulator and to all of its diagnostic and treatment functions (except for the two pre-test exercises, so as to not bias the final outcome). All participants committed to doing 1 hour of training on the simulator each week for 12 weeks.

After the 12th week, the participants performed a post-test assessment. Each participant did the same exercises as in the pre-test in the presence of the trainer. A new report was generated by the computer that assessed the participant's progression and compared it to the control group.

2.3. Statistical methods

Results of the quantitative variables are given a mean ± standard deviation, minimum, maximum and median values; those of qualitative variables are expressed as counts and percentages. The normality of the distribution of the quantitative variables was checked with the Shapiro-Wilk test. Comparison of qualitative variables (sex, dominant hand, video gaming experience) between the two groups (residents, controls) was performed with the Chi^2 test or Fisher's exact test, depending on the applicability of the tests used. Distributions of the quantitative variables were compared with the non-parametric Mann-Whitney test for non-paired groups because the data was not normally distributed. A significance threshold of 0.05 was chosen for all the statistical testing. SAS software used was (version 9.1.3, SAS Institute, Cary, NC, USA).

3. Results

3.1. Epidemiological data

Fourteen surgeons were included in the study: five senior surgeons who had in-depth experience in shoulder arthroscopy and nine residents in orthopedic and trauma surgery. Two groups were made:

- control group consisting of the surgeons experienced in arthroscopy (five participants);
- intern group consisting of the residents in our department (nine participants) with two in their 10th semester, two in their 8th semester, two in their 6th semester, one in their 4th semester, and one in their 2nd semester.

The average age of the participants was 30 years (27–37). Of the 14 participants, there were 11 men (78%). Most of the participants were right-handed (12 of 14, 86%). None of the participants had video gaming experience.

The two groups were comparable in terms of sex and handedness (P = 0.2 and 0.6, respectively). The participants in the control group were older than the ones in the intern group (34 vs 28 years, P = 0.04).