Pre-course cognitive training using a smartphone application in orthopaedic intern surgical skills “boot camps”

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ABSTRACT

Background: We evaluated a cognitive task analysis–based application, Touch Surgery.

Methods: Orthopaedic surgery interns completed a simulated ankle open reduction and internal fixation and a lag screw fixation before starting the boot camp. Surveys were administered before the simulation and after the boot camp.

Results: Fourteen of 19 interns completed the study. Ten interns thought the application improved their baseline understanding. Nine thought the application accelerated the learning process. Eight thought the application made the procedures easier to learn.

Conclusions: Touch Surgery enhanced the surgical skills curriculum, was well-received, and has the potential to supplement training of interns.

1. Introduction

Teaching surgical competence can be complex and time-intensive. Although most surgical training in the United States is delivered through an apprenticeship approach, orthopaedic surgical interns are provided with 1 month of motor-skills training to introduce the requisite skills before training in a clinical setting. The prevailing approach to surgical training has been technical-skills focused; however, there is a growing movement in favor of cognitive task analysis (CTA)–based training.¹ CTA breaks a procedure into its cognitive steps, with particular focus on decision-making, which is especially important during the transfer of “automated” knowledge (i.e., skills that are used without conscious effort because of repeated practice) from expert to novice surgeons.¹

Cognition is the first stage of learning complex procedures, as described by the Fitts-Posner 3-stage theory of motor-skill acquisition.² As trainees conclude the cognitive stage, they understand the procedure and can explain how it is performed. In the second stage, they progress through the integration stage, incorporating their understanding with appropriate motor behavior. During this stage, trainees must still think about the steps of the procedure, but they become more fluid in their performance over time. In the third stage, when trainees enter the automation stage, they begin to perform tasks with greater speed, efficiency, and precision.

The efficacy of CTA-based training has been shown in the surgical

research^{3–5} for various specialties. Touch Surgery (Kinosis Ltd., London, UK) is a smartphone application developed for CTA-based surgical training. Its step-by-step surgical guide is supplemented by simulated operations on an interactive 3-dimensional virtual “patient.” Touch-screen interaction is required to progress through the learning mode, and answering multiple-choice questions is required to progress through the testing mode. Touch Surgery has shown construct, face, and content validity.⁵

The purpose of this study was to assess CTA-based training using the Touch Surgery application to augment the early technical-skills development of orthopaedic surgery interns during their month of dedicated motor-skills training. We evaluated whether cognitive task analysis improved surgical interns’ perceived (1) baseline understanding of the surgical procedures, (2) rate of development of surgical motor skills, and (3) ease of learning of surgical motor skills.

2. Methods

2.1. Participants

Participants were orthopaedic surgery interns from our institution’s residency program, as well as those from 3 other regional residency programs in 2015, and 5 other regional residency programs in 2016. Participants attended a 4-week orthopaedic surgery motor-skills “boot camp,” which is held annually in October at a single site. The

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curriculum focuses on clinical conditions and their treatments (Electronic Supplementary material) and consists of didactic training and hands-on workshops delivered during half-day sessions.

All interns who enrolled in the boot camp in 2015 (18 interns) and 2016 (26 interns) were invited to participate in the study. A recruitment e-mail was sent 2 weeks before the start of boot camp. Although attendance and completion of the boot camp was mandatory for all interns, participation in the current study was voluntary.

2.2. Intervention

Participants performed a simulated ankle open reduction and internal fixation and a lag screw fixation using the Touch Surgery application. Touch Surgery is an interactive software application offering a step-by-step guide to orthopedic operations using an interactive, 3-dimensional virtual “patient.” First, in the application’s learning mode, trainees were guided through an interactive simulation of the procedure. Then, in the testing mode, trainees answered multiple-choice questions to gauge their retention of key content. Participants completed both simulations in both modes. The passing score was set at 70%, and all participants were required to pass the simulation, though repeated attempts were allowed, if necessary.

2.3. Data collection

The recruitment email contained a pre-simulation survey that asked participants for their age, sex, and whether they had any prior experience with the Touch Surgery application. A post-course survey was e-mailed to participants after completion of the boot camp and asked the following yes/no questions: (1) Do you feel using Touch Surgery prior to the workshops improved your baseline understanding of the procedures? (2) Do you feel using Touch Surgery prior to the workshops sped up your learning of the procedures? (3) Do you feel that learning procedures you have covered on Touch Surgery was easier than procedures you have not covered on Touch Surgery?

2.4. Blinding

The course organizers and educators were blinded to which interns had enrolled in the study and completed the simulation exercises.

2.5. Ethics

Ethics approval was granted through the local institutional review board.

3. Results

Of the 44 interns who attended the boot camps, 19 enrolled in the study by completing the pre-simulation survey, and 14 completed the study. All participants were attending the boot camp for the first time. The mean age of participants was 29 years (range, 25–35 years), and 13 of 14 participants were men. Six participants had used the Touch Surgery application before the start of the study.

Ten of the 14 participants believed that using the Touch Surgery application before boot camp improved their baseline understanding of the procedures. Nine of 14 participants believed that using the Touch Surgery application accelerated their learning of how to perform the procedures. Eight of 14 participants thought that the Touch Surgery application made the procedures easier to learn compared with other procedures in the surgical motor-skills curriculum.

4. Discussion

The use of CTA-based training before attending an orthopaedic surgical motor-skills boot camp was well-received by most of the

participating interns. Most participants believed that the use of CTA through the Touch Surgery smartphone application (1) improved their baseline understanding of the procedures they were planning to learn, (2) accelerated their rate of learning, and (3) made the procedures covered by the Touch Surgery application easier to learn than those that were not.

This study is limited by several factors. First, there was a small number of participants. Although anecdotal feedback indicated that the CTA-based training accelerated the learning experience, the current analysis was limited to those interested in participating in the study. Second, this study was not designed to assess whether skills were acquired or whether they improved, but rather whether the participants perceived that CTA-based training was helpful in acquiring them. Third, the metrics we used are subject to bias, because interns who find greater utility in smartphone applications may have been more willing to participate in the study. However, the use of smartphone applications is nearly universal in the daily life of most surgical trainees.⁶

Participants who used the Touch Surgery application before the surgical workshop improved their baseline understanding of surgical procedures. Simulation tools such as Touch Surgery allow residents to rehearse the steps involved in procedures and to receive objective performance assessment before further development in a clinical practice or surgical motor-skills curriculum.⁷ Previous studies have confirmed this notion and demonstrated that CTA-based methods improve knowledge capture in various surgical procedures, including performing a femoral artery shunt.⁸

The rate of developing surgical motor skills was accelerated through the use of CTA-based training. Accelerating trainees’ advancement through the cognitive phase of learning allows them to progress more quickly to the integration stage of surgical learning, when they acquire the requisite procedural skills during boot camp, in line with the Fitts-Posner 3-stage theory of motor-skill acquisition.² The CTA-based exercises allow for development of surgical skills beyond task-oriented technical proficiency.

Finally, our results show the use of Touch Surgery improved the ease of learning surgical motor skills. Simulations tools such as Touch Surgery promote cognitive rehearsal, which makes learning new surgical procedures easier. Studies have reported reductions in patient complications and length of hospital stay after the implementation of simulation-based training.⁹

5. Conclusion

This study suggests that pre-course CTA-based training improved interns’ baseline understanding, accelerated their rate of learning, and made it easier to learn new procedures. CTA-based training before the boot camp allowed interns to progress through the cognitive phase of learning more quickly, allowing them to progress more quickly to the integration and automation of surgical learning. However, future analysis with randomization of participants to CTA-based training or standard approaches may clarify which interns benefit the most and determine the magnitude of improvement by measuring the speed, efficiency, and precision of performing surgical tasks.

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Conflict of interest

Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

Author contributions

Substantial contributions to conception and design (AL, DL), acquisition of data (IH), or analysis (IH) and interpretation (AL, IH, DL) of data; drafting (AL, IH) the article or revising it critically (DL) for important intellectual content; final approval of the version to be published (AL, IH, DL).

Ethical review committee statement

Ethics approval was granted through the local IRB. Study approval: IRB00083348.

Location statement

This research was performed at the Johns Hopkins University School of Medicine.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the

online version, at doi:<https://doi.org/10.1016/j.jor.2018.03.038>.

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