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Training effect of using Touch Surgery™ for intramedullary femoral nailing

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ABSTRACT

Background: Simulation in orthopaedic training is becoming increasingly popular and has been widely used in formal curricula. However, these resources are expensive and not easily accessible to every trainee. Other means of disseminating surgical education through virtual reality (VR) multimedia can act as useful adjunct to traditional methods of teaching. One validated VR platform is Touch Surgery, a cognitive task simulation and rehearsal app.

Objectives: The primary objective of this study was to identify the training effect of Touch Surgery intramedullary femoral nailing (IFN) modules using objective performance metrics over six consecutive attempts. Secondary objectives consisted of validated multiple choice questions (MCQ) testing before the first (pre) and after the sixth (post) attempts.

Methods: 27 medical undergraduates were recruited to complete the decision-making process six consecutive times for four modules on the procedural steps of IFN. The modules consisted of (i) preparing the patient and equipment, (ii) femoral canal preparation, (iii) nail insertion and proximal locking, and (iv) distal locking and closure. Real-time objective performance metrics were obtained, stored electronically and analysed using the median and Bonett–Price 95% confidence intervals from the participants' attempts to assess training effect. Significance was calculated using the Mann–Whitney U test for independent data whilst the Wilcoxon signed ranked test was used for paired data. Significance was set as 2-tailed p-value <0.05.

Results: Median performance scores per attempt for all four modules demonstrated a significant improvement ranging from 58 to 115%. Scoring variability and distribution was reduced and more predictable per attempt. Logarithmic learning curves elicited strong positive correlations between the number of attempts and scoring. Mean scores for pre and post-study MCQs tests significantly improved from 83 to 94% in all modules.

Conclusion: IFN modules on Touch Surgery app demonstrated a significant training effect with practice. Novices demonstrated cognitive competencies to ensure patient safety prior to operating. The app is an effective adjunct to traditional learning methods and has the potential for curricular implementation.

Introduction

Perceptions towards surgical simulation by residents is predominantly positive with most residents appreciating that simulation-based training is essential and should be mandatory in current residency programmes [1–3]. Simulation offers the opportunity to train without risk to patient safety and at a pace comfortable for the learner. This is becoming increasingly important as we now have a greater emphasis on patient safety and safer training for residents [4] at a time of diminishing surgical training hours in North America and Europe [5,6]. Surgical training is moving away from mass exposure with random learning opportunities towards a focused curriculum as targeted training and deliberate practice trumps number of hours spent in the operating room [4,7]. Junior trainees are not expected to make conscious decisions about procedural steps that propagate the omission in the transferability of knowledge from experts to trainees [8]. The huge discrepancy of training opportunities may be assisted with other accessible media.

Touch Surgery is a gratis smartphone-based surgical simulator that uses cognitive task analysis (CTA) to deconstruct surgical

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procedures into key steps and operative decisions. These steps and decisions are combined with surgical animations to create an interactive and immersive virtual reality (VR) cognitive task simulation and rehearsal (CTSR) tool.

Simulation in trauma is becoming more topical with time due to its increasing global burden. One of the commonest trauma scenarios faced by orthopaedic surgeons is femoral fractures. Both can be definitively managed with closed reduction on the traction table and internal fixation using an intramedullary femoral nail (IFN). Total incident rate for femoral shaft fractures is 10 per 100,000 person-years and the incident rate ratio between men to women is 0.9 with an increasing prevalence [10,11]. Touch Surgery has demonstrated construct, face and content validation of IFN modules in a previous study comparing novices and expert [9].

Objectives

The primary objective was identifying a training effect of Touch Surgery IFN modules using objective performance metrics over six consecutive attempts. Secondary objectives consisted of validated objective multiple choice questions (MCQ) testing before the first (pre) and after the sixth (post) attempts.

Methods

Touch Surgery application

Touch Surgery offers an immersive and interactive VR platform freely accessible on mobile smart devices including iOS and Android interfaces. The app delivers a step-by-step manual to complete orthopaedic operations as well as other common surgical procedures. Test modules depend on completing manual steps (e.g. drilling, reaming, incising and screwdriving, etc.) The other component is assessing decision-making with single best answer (SBA) questions (out of four options) in each step of the operation. The IFN procedure was authored by the consultant surgeons at the MSk Lab at Imperial College London, UK, and developed at Touch Surgery Labs. Participants used the app pre-loaded on a Samsung tablet (Samsung, Seoul, South Korea). The procedure was divided into four separate modules consisting of the following:

(i) patient positioning and preparation,
(ii) femoral canal preparation,
(iii) proximal locking,
(iv) distal locking and closure.

Study participants

27 participants from Imperial College London were randomly recruited during their Orthopaedic attachment in March–April 2015. Each student on the attachment was offered a unique numerical identifier and was selected from a random number generator on Microsoft Excel software (Microsoft, New York, USA). Inclusion criteria included medical undergraduates, over the age of 18, and naïve to both Touch Surgery simulation and IFN procedures. Exclusion criteria included using Touch Surgery or assisting in IFN prior to study participation.

Data collection

The participants visited the lab and followed a rigid flow of instructions (Fig. 1) to ensure a standardised experience for one hour. Scores were stored online in real-time and retrieved on an encrypted lab server for analysis. All participants completed the exercises under supervision by an independent surgeon. Points were scored from making correct decisions, appropriate swipe interactions and from the time taken to complete each step. The app calculated total scores as a percentage and no negative marking was used.

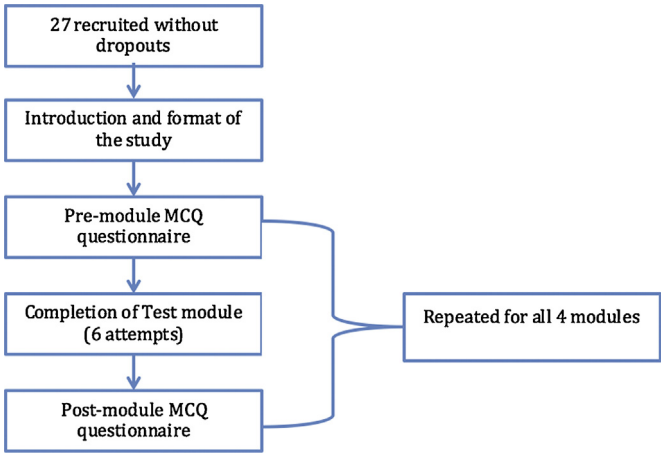

Fig. 1. Flow chart for study participants.

Study questionnaire

The MCQ test assessed the principal learning objectives from each of the four simulated modules. No MCQ were duplicated from the single best answers within the app. The participants completed the MCQs prior to the first attempt and then again after their sixth (last) attempt. The MCQ test was initially validated by ten orthopaedic surgeons deemed as the expert cohort who could perform IFN independently.

Data analysis

Median scores and 95% Bonett–Price confidence intervals were calculated for each attempt before being tabulated and plotted using logarithmic learning curves [12]. A 2-tailed paired student t-test test was used to assess statistical significance between pre and post-study MCQ scores for the medical undergraduates. A 2-tailed independent Student's *t*-test was then utilised to observe for significance between medical undergraduates and orthopaedic surgeons. A result was considered statistically significant when a two-tailed p-value < 0.05.

Results

Demographics

27 participants were initially recruited to the study without any drop-outs.

The median age of the novice group was 21 years of age with 59% males. The median completed years of undergraduate study was 3 years. 10 orthopaedic surgeons were recruited from the surgical training circuit to validate the MCQ test. The median age of the surgeons was 33 years and 100% males.

Performance scores

Median performance scores per attempt for all four modules were outlined in Table 1 and Fig. 2.

There was a significant improvement of scores per module between 58 and 115% with less scoring variability and distribution per attempt. Mean scores for pre and post-study MCQs were