Use of the Bon*e*doc DHS simulator by fifth year medical students: A pilot study

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To date virtual reality simulations of operative procedures have been extensively tested and utilised by advanced surgical trainees. The increasing number of medical students has meant that the amount of exposure to surgical procedures is reducing, and direct involvement of the medical student within those procedures is decreasing. The Bon*e*doc DHS Simulator for fixing hip fractures was trialled within the orthopaedic attachment. An online questionnaire was completed by 31 fifth year medical students, the control group of 17 students had no exposure to the simulator, and 14 students had access to the simulator. Despite similar operative exposure, the intervention group scored significantly higher on understanding key aspects of hip fracture. The simulator did not in itself stimulate interest in orthopaedics (3 of 14 students). Unfortunately tight security on hospital computers restricted students' use of the simulator. Twenty-four hour access to the simulator was deemed important (9 students agreed, 0 disagreed, 5 unanswered).

Keywords: Surgical simulation, virtual reality, undergraduate medical education

Introduction

Simulation is a generic term that refers to the artificial representation of a real world process to achieve educational goals via experiential learning. This term encompasses a wide range of clinical simulators from part-task trainers, virtual reality simulations to computer-controlled mannequins. Virtual Reality (VR) simulations are innovations in which a computer display simulates the physical world, and affords the possibility of recording performance more objectively than possible in the real world.

The dawn of modern simulator training can be traced back to the first flight simulator developed by Edward Link to train pilots in the 1920s (Link Flight Trainer 2000). Applications of simulation technology in medicine, however, are less frequent than in the aviation industry and have only emerged in the last two decades. The specialties of anaesthetics, cardiology, critical care and surgery have led the way in using simulators for teaching clinical skills however it is only recently that the implications of using simulators in medical education have been considered.

With the reduction of working hours, surgical education is being driven from an apprentice style to a curriculum based model. Reduced work hours have been correlated with improved examination scores in basic surgical education (Barden et al, 2002), however this may in part reflect clarification of the curriculum, and reduced hours dictate less exposure to the operating theatre environment (Whang et al, 2003). The use of virtual reality provides a new opportunity in the area of simulation of surgical skills using computers for training and evaluation. Simulation offers students the opportunity to gain knowledge and assess skills through repeated practice within a safe environment. The majority of existing simulators utilising virtual reality are designed for practising general surgical procedures, in particular laparoscopic surgery.

Hip fracture is one of the most common fractures in the elderly patient in New Zealand. The number of hip fractures is projected to increase further as the percentage of people over the age of 65 increases to an estimated 23% of population in 2021 (Dunstan 2005). Approximately one patient per day will be admitted to Dunedin Hospital with a hip fracture and around half of these fractures will be fixed with either Cannulated Hip Screws or a Dynamic Hip Screw and Plate system (DHS). The remainder of the fractures are treated by arthroplasty (Hip replacement). Therefore this is a common orthopaedic surgical procedure that most undergraduate students have the opportunity to observe and if fortunate assist in surgery during their orthopaedic attachment.

The Bon*e*doc DHS Simulator is a non-haptic virtual simulation of the Dynamic Hip Screw and plate fixation procedure for treating fractured hips. This simulator was written using Virtual Reality Markup Language (VRML) by one of the authors and has been previously validated (Blyth et al, 2007). The simulator is web browser based and designed to run on the standard computers found within the hospital environment.

This study seeks to evaluate the suitability of virtual reality simulation as a teaching tool in undergraduate surgical education. The study has three main objectives: firstly to investigate whether the use of the Bon*e*doc simulator improves student understanding of a common orthopaedic condition and its treatment, secondly to assess student perspectives on the acceptability of the Bon*e*doc as part of their ward attachment and finally to assess whether exposure to the simulator stimulated their interest in orthopaedics as a possible future career.

Methodology

Subjects

The study participants were 33 Year 5 medical students at the Dunedin School of Medicine (DSM), New Zealand undertaking their seven-week orthopaedic attachment. This attachment includes tutorials, attending ward rounds, outpatient clinics, admitting patients, and going to the operating room with their surgical team. At the end of the attachment students undergo a combined written and oral examination. This assessment was completely separate from the current study. The participants were divided into two; a target group composed of 16 students who in addition to the normal attachment were allowed access to the Bon*e*doc simulator. The control group of 17 students had no exposure to the simulator.

Simulator

The Bon*e*doc DHS simulator uses a virtual reality interface to allow users to practice the important decision making aspects of the procedure for fixing a hip fracture. The simulator runs in Internet Explorer (Microsoft Corp, USA) using the Octaga player (Octaga AS, Norway) plug-in. The simulator is designed to enable access either over the internet or on a standalone computer. The simulator incorporates all relevant tasks to pinning of a hip fracture, from fracture reduction (Fig 1, 2), incision (Fig 3) through to placement of cortical screws under virtual x-ray guidance (Fig 4). At the conclusion of the operation the student is given a virtual score card evaluating performance with respect to how well they reduced the fracture, how accurately they placed the screw, how well they utilised the x-ray machine, how long the incision was and the time to complete the surgery.

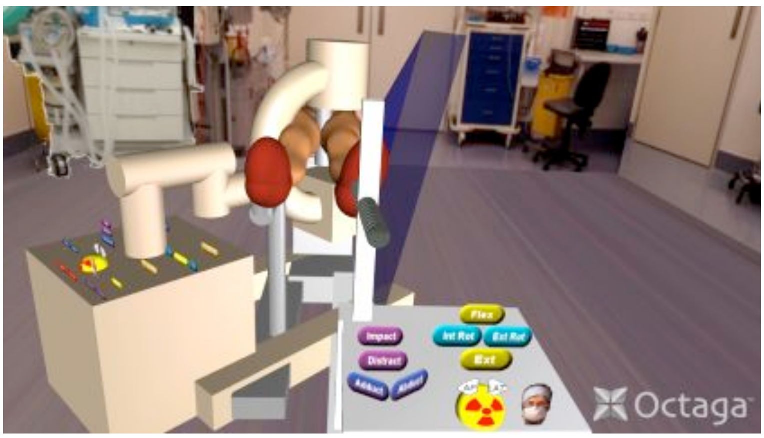

Figure 1: The virtual operating room showing the traction console

Figure 2: A real operating room showing the x-ray machine

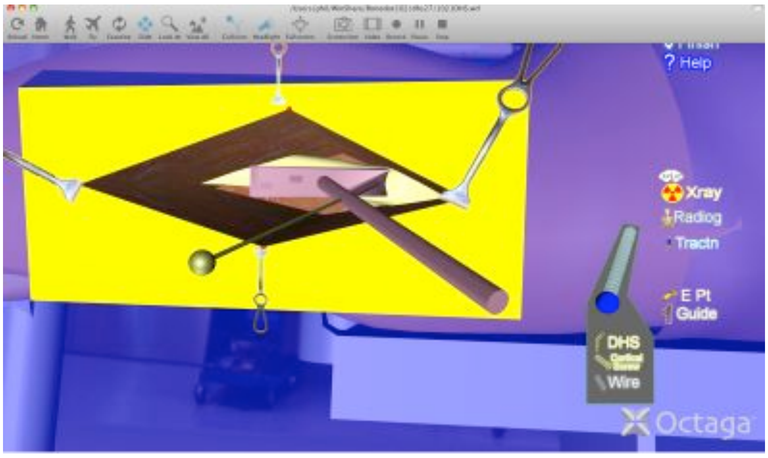

Figure 3: The surgical view showing the lateral thigh

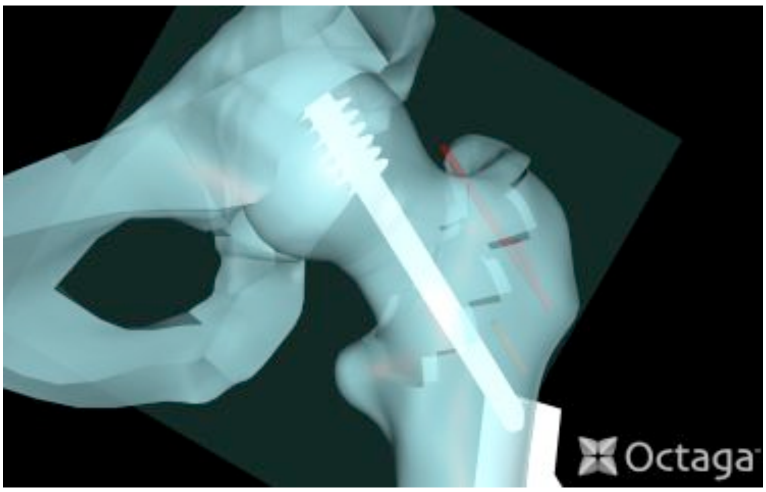

Figure 4: A virtual x-ray showing the definitive screw, and previous guide-wire attempts.

Study protocol

All participants gave written informed consent prior to participation. Each participant in the target group was provided with a USB flash drive containing the Bon*e*doc programme. This enabled the student to access the programme from any computer. Students were guided through their first operation by the investigators. An investigator was available on call to provide help for students using the simulator.

The simulator programme collected performance data each time a participant completed an operation. This data was not utilised for the purpose of this study. There was no requirement for the participants to complete any number of virtual procedures.

At the conclusion of the study both groups of participants were required to complete an online survey. All data collected was coded with each student being assigned a unique identifier code.

Survey design

A 25 item structured online survey using the online survey software *SurveyMonkey* (http://www.surveymonkey.com/) was developed for this project. The survey was divided into four sections: Demographics, Computer and Operative Exposure, Procedural Knowledge and Feedback on the simulator. Computer and Operative exposure information was sought to ascertain bias within the groups, as performance in the knowledge components would be influenced by their attitude to career pathways, and their exposure on the attachment.

A combination of multiple choice options, images and free text box replies were utilised. The control group who did not use the simulator were instructed not to complete the last section of the survey.

Results

Demographics

The response rate from the 17 control group members was 100 % and from the target group was 87.5% (14/16). All students were aged less than 30 years, with the majority being aged between 20-25yrs (14/17 controls and 12/14 target group). All students, bar one in the target group, accessed the internet daily via broadband.

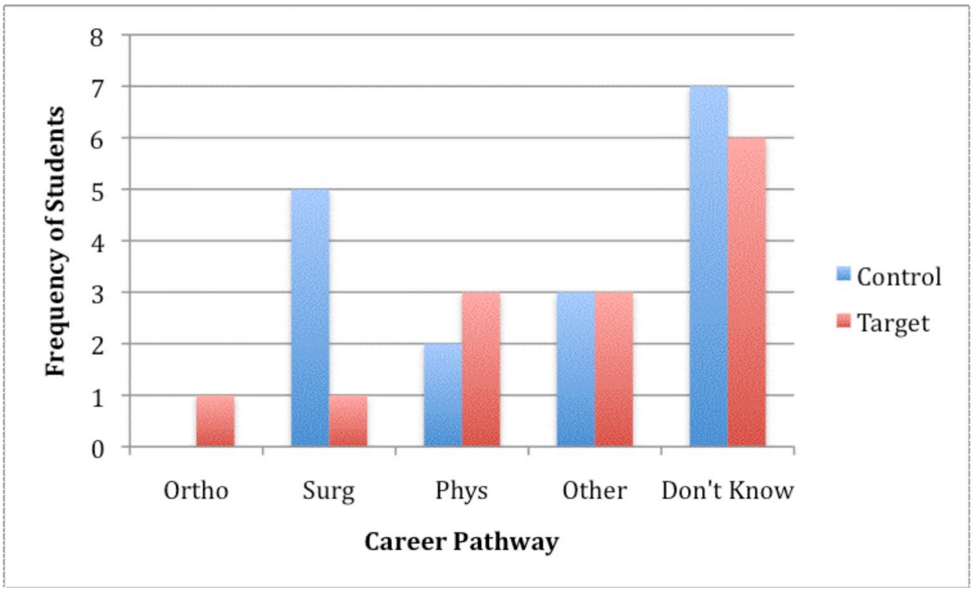

Figure 5: Column graph showing students future career aspirations

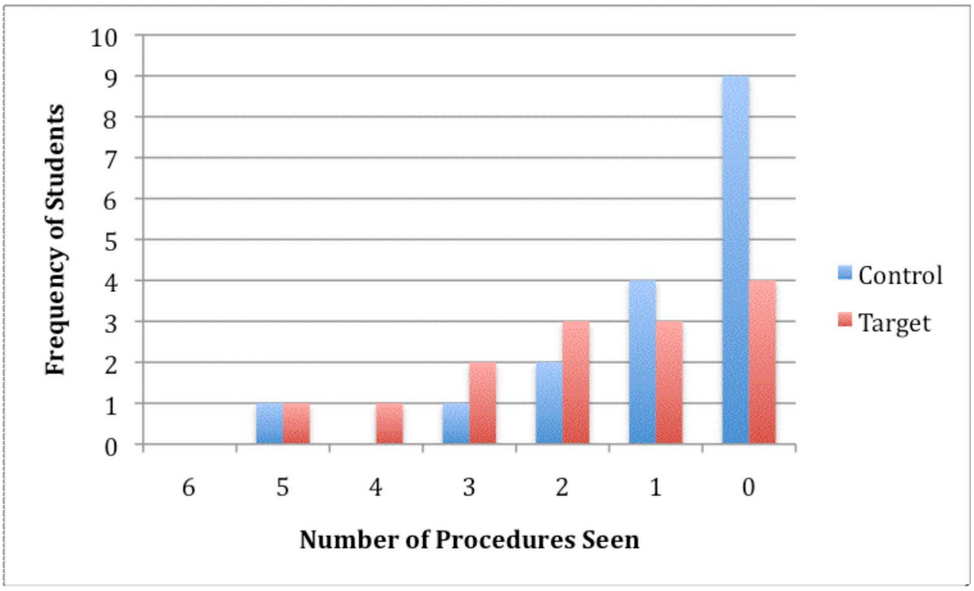

Figure 6: Column graph showing students exposure to the real operation

Hip fracture knowledge

Of the 6 questions covering aspects of hip fracture diagnosis and management, only the question related specifically to the position of the screw within the femoral head was answered correctly more commonly by the target group (p=0.003). Despite a trend towards more correct answers within the target group, the composite scores between groups were not statistically significant.

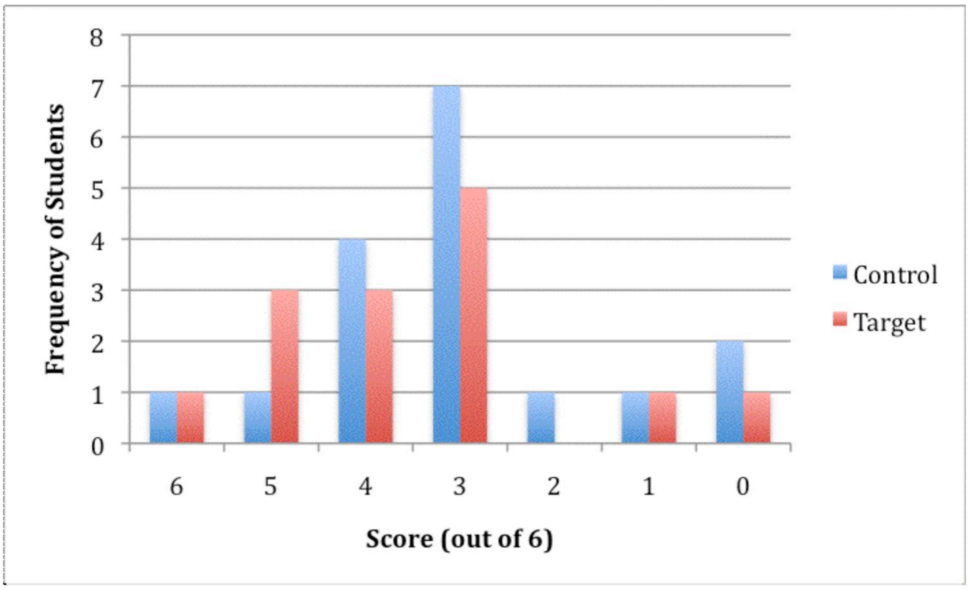

Figure 7: Composite scores for the 6 knowledge type questions

Simulator feedback

This section was only answered by the target group who used the simulator. Only 8 of 14 target group students utilised the simulator during their attachment, the most common reason cited by the 6 non-users was access to computers with suitable security access. All students who had used the simulator felt that it should be available all hours of the day. The most useful aspect of the simulator cited was understanding what was happening in the surgical procedure.

Three students felt the simulator stimulated their interest in orthopaedics, five did not feel it stimulated their interest, and 3 were unsure. Summary free text quotes include “Thanks for introducing me with this tool...it is awesome even though i can't make full use of it.” and “Sorry I didnt (sic) let you guys know that I couldn't access the programme earlier! But from just watching it seems really useful”.

Discussion

The purpose of this pilot study was to assess the suitability of the Bon*e*doc simulator as a teaching tool in undergraduate surgical education. The outcomes measured included objective questions related to knowledge about a condition that the students should understand, student’s attitudes towards the simulator, whether the simulator enhanced their orthopaedic attachment and their assessment of the simulators usefulness for their education.

The projected workforce numbers within the surgical specialties is predicted to drop significantly. One of the methods to avoid this decline is to attract more medical students into surgery, as it has been shown that this early exposure can be a deciding factor (Ek et al 2005). Within the study population a large number of students indicated that they had no firm commitment to a particular career pathway (Figure 5). It was proposed that through VR simulation medical students could be exposed to some of the complexities of an operative situation, and gain a better understanding of the challenges and rewards of operative choices. Three of 14 students felt the simulator stimulated their interest in orthopaedics; these students had indicated no preference for a future career pathway. The target group also attended more hip surgery (Figure 6), which may reflect the simulator or study itself stimulated the student’s interest. Within this survey, free text responses certainly showed the simulator helped the students to understand these aspects. This understanding did not necessarily translate into influencing the students into a career in orthopaedics, however the numbers are small and factors such as a strong predilection to a non-surgical career could influence this.

The results show that students in the target group exposed to the Bon*e*doc DHS simulator generally scored higher in the orthopaedic knowledge component of the survey in comparison to students in the control group, though there was slightly higher exposure to real world operations by the target group (Figure 6). Questions concerning knowledge were pitched at the level expected of the medical students. These questions were general in nature, such as basic fracture patterns and methods of treatment which junior emergency department house officers or general practitioner would be expected to know. However apart from the question specifically related to the procedure in question these results were not statistically significant. Student perspectives on simulator interface were generally positive despite the numerous barriers to using the simulator.

There were significant barriers to access of the simulator, and the significant number of students who did not access the simulator reflects this. Within the local hospital there are high security restrictions, and thus despite supplying students with USB flash drives, on multiple occasions the students were not able to access the simulator within the hospital. Disappointingly this was not discovered until late in the trial, and since then a computer with the appropriate security permissions has been set up for the next group of students.

The simulator was not part of the formal curriculum of the orthopaedic attachment, and this has been shown to affect engagement by students with eLearning projects (Kneebone 2003). Within our cohort this was detailed in free text responses as a lack of time to use the simulator, and the fact that students chose not to access the simulator at home. However it is important that the ability of a simulator to produce outcomes aligned with the objectives of the curriculum is displayed before altering the curriculum. Within this study this ability was seen in part as the study group had significantly better results with respect to their knowledge.

In conclusion this pilot study has shown that despite significant barriers to use of a simulator, students on their orthopaedic attachment scored higher on a knowledge test when exposed to a simulator. In addition the simulator allows all students to experience a relatively common procedure, which should, but is not always part of their attachment. The simulator stimulated an interest in orthopaedics in some students, and given the large number of students who are undecided about their future careers, the simulator may have a positive effect in the future on the number of trainees applying for orthopaedics.

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