Computer assisted orthopedic training system for fracture fixation

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Background: Surgical training has been greatly affected by the challenges of reduced training opportunities, shortened working hours, and financial pressures. There is an increased need for the use of training system in developing psychomotor skills of the surgical trainee. Simulation environment can provide a friendlier and less hazardous environment for learning surgical skills. Simulations are used to augment training in the operating room and trainees acquire their skills in a “non-threatening and unhurried environment”. Learning in the operating theatre provides little opportunity for practice and reflection, and this is one of the strongest stimuli for taking training in surgical skills into non-OR environments. Task simulations possess the potential to structure the learning of technical skills aimed at ensuring a smooth escalation in task complexity leading to the performance of procedures in the operating theatre.

Aims: To develop the training system for fracture fixation and validate its effectiveness in a cohort of junior orthopaedic trainees

Training System: Computer navigated training system uses the two sets of images from the C-arm while the registration phantom is placed in the fluoroscopic imaging space which permits determination of the position of the X-ray source and the image plane which then guides the trainee to navigate the surgical instruments into the three-dimensional space. No further c-arm exposures are taken during the entire procedure.

Material and Methods: The study was designed to include junior orthopaedic trainees from the local hospital. All the junior surgical trainees who had not done any dynamic hip screw fixation and had no previous exposure to COAS training system were included in the study.

The trainees were randomly divided into two groups.

Group 1: Initial part of the study involved the use of conventional CAOS system to train this group of orthopaedic trainees. This group was trained using the CAOSs system in the development of 3-D orientation using a 2-D image for the dynamic hip screw insertion.

Group 2: This group would have no exposure to such training.

The Control group was made of equal number of trained orthopaedic surgeons who routinely fix these fractures so that the scoring system can be validated and the two groups can be compared to the control group.

The two groups are also compared for the difference of exposures required to perform the task and amount of time required to finish the task.

Scoring System: The ability for precision, three-dimensional navigation and processing of virtual information to help in hand eye co-ordination has never been used as a formal training tool. The assessment of such skills demands a scoring system, which can be reproducible as well as validated. We
devised our own scoring system based on using task analysis; this included time difference between each exposure, the change in 3-D coordinates with each exposure, total number of exposures to finish the task.

**Results:** The results were analyzed using a statistical application SPSS version 16 and tested for the statistical difference in the improvement of the mental navigation of instruments after training with the CAOSs. The trainees were assessed based on the time consumed along with the number of images taken to complete the DHS guide wire placement and also the accuracy of the procedure. The assessors had no prior knowledge of the prior training of the residents assessed the results and thus were blinded when assessing the scores.

**Demographics:** Twelve subjects (aged 23-34 years) who satisfied the inclusion criteria and agreed to participate were included in the study. There were ten males and two females. All were junior orthopaedic trainees.

**Scores:** There was a significant decrease in all the parameters in the first group (training) compared to group 2.

The number of exposures was 10.1 (mean) in the training group for guide wire placement compared to 37.4 (mean) in the second group.

There was an overall decrease in all the parameters and the mean score increased from 36.7 to 73.1 in the training group and this was statistically significant using chi square test (p-value 0.03).

There was a gradual improvement of the scores when the trainees were routinely practising on the training system.

**Discussion:** This paper highlights that simulation is effective in reducing the time to gain a certain level of surgical skills of junior orthopaedic trainees for fracture fixation. The trainee is involved in multiple steps, including three-dimensional navigation using two dimensional fluoroscopy images. The improvement in the scores in the training group shows the useful of this system as an important training tool(8). The scoring system was used to try and give participants formative feedback on their performance. This system helps trainee practice these complex fractures in relatively stress free environment without any additional X-ray exposures. This is utmost importance where more and more junior trainees are spending less time in theatre and have less exposure to hands on training by senior surgeons in theatre. The system provides results and scores with which the surgeon and trainee can readily identify and improve on sub tasks within the particular surgery.

The authors understand that the number of the subjects in our study is low but it still demonstrates that as our simulation system improves the accuracy and timing in junior orthopaedic trainees. Authors are working on further trials using distal locking of femoral nails and cannulated screws as a template.

The system in its present format uses generic anatomical data on an artificial bone but the system is being further developed to include patient specific data and x-rays and the system is also tried on fixing difficult scenarios such as elbow and pelvic fractures.

**Conclusion:** Computer navigated training system appears to be a good training tool for young orthopaedic trainees. This system can be used to augment training in the operating room and trainees acquire their skills in a “non-threatening and unhurried environment”. The system has the potential to be used in various other orthopaedic procedures for learning of technical skills in a manner aimed at ensuring a smooth escalation in task complexity leading to the better performance of procedures in the operating theatre.