Validation Studies-Abstracts

3DSYSTEMS

ARTHRO Mentor™

List of abstracts

Virtual Reality Simulation for Shoulder Arthroscopy: A Three-Year Follow-up Study of Individual Skill Progression

George Pappas, MD, PhD, Andreas H. Gomoll, MD, Brian Forsythe, MD, and Jon J.P. Warner, MD (Harvard Shoulder Service, Brigham and Women's Hospital and Massachusetts General Hospital)

Previous studies have demonstrated a correlation between surgical experience and performance on a virtual reality arthroscopy simulator but only provided single time point evaluations. Additional longitudinal studies are necessary to confirm the validity of virtual reality simulation before these teaching aids can be more fully recommended for surgical education. We hypothesized that subjects would demonstrate improved performance on shoulder arthroscopy simulator retesting several years after an initial baseline evaluation, commensurate with their advanced surgical experience.

After gaining further arthroscopic experience, 10 orthopaedic residents underwent retesting three years after initial evaluation on a Procedicus virtual reality shoulder arthroscopy simulator. Using a paired t test, simulator parameters were compared in each subject before and after additional arthroscopic experience. Subjects were evaluated for time to completion, number of probe collisions with the tissues, average probe velocity, and distance traveled with the tip of the simulated probe compared to an optimal computer-determined distance. In addition, to evaluate consistency of simulator performance, results were compared to historical controls of equal experience.

Subjects significantly improved their performance on simulator retesting three years after initial evaluation. Scores improved significantly ($P < 0.02$ for all) in the 4 simulator parameters: completion time (–51%), probe collisions (–29%), average velocity, (122%), and distance traveled (–32%). With the exception of probe velocity, there were no significant differences between the performance of this group and that of a historical group with equal experience, suggesting that groups with similar arthroscopic experience demonstrate equivalent scores on the simulator. Thus it may eventually be possible to establish simulator benchmarks to indicate likely arthroscopic skill. These results further validate the use of surgical simulation as an important tool for the evaluation of surgical skills.

Does Perception of Usefulness of Arthroscopic Simulators Differ with Levels of Experience?

Gabrielle J. M. Tuijthof PhD, P. Visser MD, Inger N. Sierevelt MSc, C. Niek Van Dijk MD, PhD, Gino M. M. J. Kerkhoffs MD, PhD

2010

Abstract

Background:

Some commercial simulators are available for training basic arthroscopic skills. However, it is unclear if these simulators allow training for their intended purposes and whether the perception of usefulness relates to level of experience.

Questions/purposes:

We addressed the following questions: (1) Do commercial simulators have construct (times to perform tasks) and face validity (realism), and (2) is the perception of usefulness (educational value and userfriendliness) related to level of experience?

Methods:

We evaluated two commercially available virtual reality simulators (Simulators A and B) and recruited 11 and nine novices (no arthroscopies), four and four intermediates (one to 59 arthroscopies), and seven and nine experts ([60 arthroscopies) to test the devices. To assess construct validity, we recorded the median time per experience group for each of five repetitions of one identical navigation task. To assess face validity, we used a questionnaire to judge up to three simulator characteristic tasks; the questionnaire asked about the realism, perception of educational value, and perception of user-friendliness.

Results:

We observed partial construct validity for Simulators A and B and considered face validity satisfactory for both simulators for simulating the outer appearance and human joint, but barely satisfactory for the instruments. Simulators A and B had equal educational value according to the participants. User-friendliness was judged better for Simulator B although both were graded satisfactory. The perception of usefulness did not differ with level of experience.

Conclusions:

Our observations suggest training on either simulator is reasonable preparation for real-life arthroscopy, although there is room for improvement for both simulators.

Clinical Relevance:

These simulators provide training in surgical skills without compromising patient safety.

A Global Approach to the Design and Evaluation of Virtual Reality Medical Simulators

Sofia Bayona, Universidad Rey Juan Carlos Mostoles, Madrid, Spain
Jose Manuel Fernandez-Arroyo, Hospital Severo Ochoa Leganes, Madrid, Spain
Pilar Bayona, Instituto de Psicologia Integral, Salud y Coaching, Avanza Madrid, Spain
Isaac Martin, Universidad Rey Juan Carlos Mostoles, Madrid, Spain
2011

VR Simulators are a powerful alternative to traditional educational techniques in many domains; and in particular, in surgery. Although they offer new possibilities for learning, training and assessment, they still found difficult to be accepted and integrated into hospitals.

In this paper, we explain what we consider to be the keys to create successful VR simulators, and we present two methodologies: one for guiding the design of simulators, and another for evaluating their validity.

Research on VR surgical simulators should be interdisciplinary. It involves medicine, educational psychology, computer science, and engineering. Optimal interdisciplinary communication is difficult, and most projects in surgical simulation are strongly influenced by the engineering perspective, with little or no contributions from the others. This unbalance often leads to a premature end of the project or to simulators which are less practical for surgeons.

A design methodology should guide the process of creating a VR simulator. A thorough description of the problem, of the simulator's role, and an exhaustive task analysis will lead to the requirements specification. For the technical implementation, decisions will be taken related to the hardware interface and the interaction that users will have with the virtual world; which will determine collision detection and response algorithms, and the behaviour of the 3D models. In addition to the technical testing, we need to prove the validity of the simulator and consequently we need to design and register measures about users' performance.

We explain a methodology to evaluate the validity (face, content, and criterion-related validity), reliability and transfer of skills from a VR simulator to the real environment in a structure and rigorous way. Following this methodology, an evaluation experiment involving 19 orthopaedic doctors using a VR arthroscopy simulator was carried out. Results prove face and content validities and inform about which factors and measures are considered important for arthroscopic surgery.

In order to consolidate the research results, we encourage the establishment of an intersectorial consortium with agents from the academic, healthcare and industrial sectors to ensure the long-term sustainability of research lines, additional funding, and to guarantee that simulators, once validated, can be widely available in hospitals.

This paper presents a global approach including relevant guidelines and methodologies for designing and evaluating VR simulators. It can provide a solid structure for other researchers when facing those processes and contribute to the successful integration of VR simulators within the educational curriculum.

Increased Training Correlates with Performance on a Virtual Reality Simulator for Shoulder Arthroscopy

Michael Angeline, Sherwin Ho (University of Chicago Medical Center, USA) 2009

Abstract

Purpose:

The aim of this study was to examine if increased training on a virtual reality simulator correlates with improved performance.

Conclusions

Results:

Comparison of initial and final performance results for the three benchmark training exercises:

- Statistically significant improvement in: ($p<0.04$ for all)
  - Completion time (-45%)
  - Distance traveled (-42%)
  - Probe collisions (-46%).
- No statistical difference in average probe velocity.
- Increased training correlates with improved simulator performance.
- This study provides further validation of the utility of surgical simulators in orthopaedic residency training.
- Simulators can be used as a mechanism to document competency for the ACGME requirements.
- Additional studies are needed to further confirm the transfer of simulator-based skills to the clinical setting.

A New Assessment Methodology for Virtual Reality Surgical Simulators

Sofía Bayona, Pilar Bayona, Luis Pastor (Univ. Rey Juan Carlos, Madrid, Spain)
José Manuel Fernández Fernández-Arroyo (H. Severo Ochoa, Madrid, Spain)
2009

Abstract
This paper presents an assessment methodology to validate surgical simulators which will help researchers in avoiding most common errors by providing a complete structured guide.

The methodology organizes the questions depending on the validities they are related to, helping in objectives' definition and consistent hypothesis formulation. We will define the study depending on its purpose, time course and the study factor assignment, taking into account legal and ethical issues and choosing the population and sample size. If it is an experimental study, we will determine if there exist a control group and the operational definition of variables. We will avoid extraneous variables and make our study blind, establishing the final evaluation procedure, and stipulating actuation and observation protocols. A feasibility study will be performed before executing the pilot and final studies in which we will analyse the data as indicated by the statistical plan, obtaining our results and conclusions. We provide an example, applying the assessment methodology step by step to the evaluation of a virtual reality arthroscopy simulator with haptic feedback. Finally, possible experiments are proposed as well as a conscientious study of different alternatives for the final evaluation procedure, and an extended proposal of surgical competence assessment measures.

Preliminary Report of Shoulder Arthroscopic Virtual Reality Training System

Hiroshi Noguchi (Mito Red Cross Hospital, Japan)
Mastaka Sakane Naoyuki Ochiai (Univ. Tsukuba, Japan)
2009

Abstract

Purpose:

It takes a long time to master technique of shoulder arthroscopy. We introduced shoulder-virtual-reality-arthroscopic trainer (VRAT): INSIGHT*-Arthroscopy. The purpose of this study was to evaluate whether arthroscopic experience and knowledge of anatomy reflected on the results of VRAT or not, and evaluate the learning effect.

Materials:

Twelve medical students, 6 residents,
6 shouder surgeons.

Methods:

Time for deleting 11balls (if the ball was touched by probe during 2 seconds, the ball disappeared) in glenohumeral joint was measured 5 times. Data was statistically compared by Fisher's-PLSD-test. Statistical significance was set at 5%.

Result:

The initial time of shoulder surgeons, residents, and medical students were 211sec, 595 sec, 495sec, the shortest times were 87sec, 157sec, 156sec, and average times were 134sec, 293sec, 278sec, respectively. All the times of shoulder surgeons were shorter than those of residents and medical students, significantly. No significant difference between residents an medical students was found. Among all groups, the shortest times were shorter than the initial times, significantly. Shortening rate (longest time-shortest time/longest time) of shoulder surgeons, residents, and medical students were 56%, 67%, and 69%, and no significant difference among the 3 groups was found.

Discussion:

The results of shoulder surgeons may reflect hand-eye-coordination, obliquescope-technique based on experience of shoulder-arthroscopy. Because performance on VRTA correlated with surgical experience. VRTA may be useful for evaluation of arthroscopic technique. Because the results of residents, who knew anatomy better than medical students, were similar to those of medical students, the task in this study may not be enough to assess anatomical knowledge. Although all groups obtained learning effect, we want to know the longevity of learning effect. The results implicated VRAT had the validity for arthroscopic training. In the future, we hope the training with VRAT will contribute to the upbringing of the specialist of shoulder arthroscopic surgery from a younger age.

* Product name changed to ARTHRO Mentor

Performance on Shoulder Arthroscopy Simulator Correlates with Cadaver Performance and Experience

CPT Kevin D. Martin, DO (William Beaumont Army Medical Center, El Paso, TX,USA) LTC Philip J. Belmont Jr., MD, MAJ Brett D. Owens, MD, MAJ Mike Todd (Keller Army Hospital, West Point, NY, USA)

2009

Abstract

To establish construct validity using an arthroscopic shoulder simulator, differentiating expert arthroscopists from novice, with further clinical correlation added from a cadaveric model. While previous work using shoulder arthroscopy simulators have correlated performance with experience level, there is little data supporting the transfer of performance to surgical skill. Our goal was to evaluate the correlation of simulator performance with shoulder arthroscopy in a cadaver model.

Methods:

We tested 22 subjects (17 resident, 5 attending) on the time required to complete an arthroscopy shoulder simulator testing module designed to mimic the simulator testing procedure. Time to completion was recorded for 3 iterations. Experience level was determined by residency level with interns classified as PGY_1, chief residents as PGY-5, attending as PGY-6, and sports fellowship trained surgeons as PGY-7. Pearson correlation testing was performed between PGY level and mean time performance on each module as well as between the simulator and cadaveric modules for the 14 individuals with complete data on both.

Results:

Mean completion time performance on the simulator module inversely correlated with experience level (r=-0.90). Similarly, mean completion time performance on the cadaveric module inversely correlated with experience level (r=-0.97).
There was also high correlation between the performance on the arthroscopy simulator with performance on the cadaver arthroscopy (r=0.87).

Conclusions

Surgeon performance on a shoulder arthroscopy simulator strongly correlates with experience level as well as performance on a cadaveric module. This data supports continued use of arthroscopy simulators in orthopaedic resident training.

Assessment Study of insight ARTHRO VR®* Arthroscopy Virtual Training Simulator: Face, Content and Construct Validities

Sofía Bayona, Isaac Martín (Univ. Rey Juan Carlos, Madrid, Spain)
José Manuel Fernández Fernández-Arroyo (H. Severo Ochoa, Madrid, Spain)
Pilar Bayona (National Board of Physichologists, Madrid, Spain)
2008

Abstract
The aims of this study were to test the face, content, and construct validities of a virtual reality haptic arthroscopy simulator and to validate four assessment hypothesis. The participants in our study were 94 arthroscopists attending an international conference on arthroscopy. The interviewed surgeons had been performing arthroscopies for a mean of 8.71 years (r = 6.94 years). We explained the operation, functionality, instructions for use, and the exercises provided by the simulator. They performed a trial exercise and then an exercise in which performance was recorded. After having using it, the arthroscopists answered a questionnaire. The simulator was classified as one of the best training methods (over phantoms), and obtained a mark of 7.10 out of 10 as an evaluation tool. The simulator was considered more useful for inexperienced surgeons than for surgeons with experience (mean difference 1.88 out of 10, P value\0.001). The participants valued the simulator at 8.24 as a tool for learning skills, its fidelity at 7.41, the quality of the platform at 7.54, and the content of the exercises at 7.09. It obtained a global score of 7.82. Of the subjects, 30.8% said they would practise with the simulator more than 6 h per week. Of the surgeons, 89.4% affirmed that they would recommend the simulator to their colleagues. The data gathered support the first three hypotheses, as well as face and content validities. Results show statistically significant differences between experts and novices, thus supporting the construct validity, but studies with a larger sample must be carried out to verify this. We propose concrete solutions and an equation to calculate economy of movement. Analogously, we analyze competence measurements and propose an equation to provide a single measurement that contains them all and that, according to the surgeons' criteria, is as reliable as the judgment of experts observing the performance of an apprentice.

Conclusions
Taking into account the results described in the previous sections, we make the following conclusions about the hypotheses posed in the introduction:

1. Regarding the hypotheses: "Surgeons will consider the virtual-reality haptic simulator as a useful tool to learn arthroscopy techniques," the mean score was 8.24 out of 10, with a 95% CI of 7.77–8.71; that is, 87.3% of the 94 surveyed surgeons gave a score of 7 or more for the utility of the simulator, so we can consider this hypothesis as valid in the light of our results.

2. Concerning the hypothesis: "Arthroscopists will positively value the simulator, its quality, its realism, and the exercises provided," we have studied each aspect separately. As mentioned, we obtained means of 7.54 out of 10 for quality, 7.41 regarding realism, and 7.09 concerning the variety of the provided exercises. These results, together with the fact that we obtained a global mark for the haptic simulator of 7.82, lead us to validate that hypothesis.

3. The third hypothesis was: "The experts will consider that the system will be able to measure the level of skills in arthroscopic techniques." The results were positive, with the simulator obtaining a mean score of 7.10 (r = 0.15) with a 95% CI of 6.79–7.40.

4. With the aim of studying the hypothesis: "The virtual reality haptic simulator will be able to differentiate between the performance of non-expert and expert arthroscopists," we developed the work described in the section "Construct validity." The data seem to indicate that there is a relationship between the level of experience and the final score that the simulator assigns to each subject after performing the exercise on the haptic arthroscopy simulator. However, a larger sample is needed to increase the reliability of the results, so this hypothesis cannot yet be completely validated. Work must still be done to conclude about our fourth hypothesis; we plan to do this following the methodology proposed in Bayona S (2007)

* Product name changed to ARTHRO Mentor

(Metodologías de aprendizaje y evaluación para simuladores quirúrgicos de Realidad Virtual. Aplicación en simuladores artroscópicos (Dissertation). Escuela Técnica Superior de Ingeniería Informática. Universidad Rey Juan Carlos. Madrid. Spain.) So far, we have validated the simulator's face and content validities. We have also started experiments to prove the construct validity and proposed some studies with our simulator to verify concurrent and predictive validities. Consequently, it is necessary to continue on this track before been able to validate the hypothesis that "training with the simulator as an additional tool to the traditional training methods will improve the learning curve of an apprentice surgeon," which is one of the main goals of the simulator.

Use of the Haptic Force Feedback Virtual Reality Simulator as a Training Tool in Shoulder Arthroscopy

Jai Relwani, Omar Haddo, Tirtza Even, Stephen Copeland (Institute Reading Shoulder Unit, UK), José Manuel Fernández Fernández-Arroyo (Hospital Severo Ochoa, Madrid, Spain) Ofer Levy (Berkshire Independent Hospital Reading (Capio) UK)
2008

Abstract
Shoulder arthroscopy requires the surgeon to acquire certain psychomotor skills which entails a significant learning curve. With the current limitation on available training time in the hospital (MMC and European working time directive), it is essential to develop alternate methods of teaching which would significantly aid the acquisition of these skills with accuracy, thereby reducing the learning curve while operating on a patient.

We present a shoulder arthroscopy training system with virtual reality images and force biofeedback that replicates accurately the forces (soft tissue tension and the feel of the tissues) and anatomy to be negotiated by a trainee during shoulder arthroscopy. The simulator allows the user to visualize the shoulder joint with a high degree of fidelity and to handle the instruments as they would in the operating theatre. This integrated with the force feedback system enables the user to 'feel the anatomy and pathology' during the interventional procedure as in the real situation.

Trainees were tested on their virtual arthroscopy skills prior to simulator use. They were then taken through a set of exercises developed to improve their hand eye coordination specifically for shoulder arthroscopy. Variables were measured before and after training to detect any difference in performance. There was a significant difference in the variables measuring the learning curve before and after the simulator training with substantial improvement of performance. The VR arthroscopic simulator provides an unlimited resource for training and provides an excellent teaching tool and quantitative skill assessment tool.

Validation of a Virtual Reality Arthroscopic Shoulder Simulator

Lennard Funk, Aisha Awan, Maulik Gandhi (Sports Medicine Clinic – Manchester,UK) 2007

Abstract
Computer simulation is used for skills training in many areas of industry, with the most advanced being in flight simulation. Simulators for arthroscopic surgery have been developed and are commercially available, but not yet validated.

Purpose:
Validation of the Insight virtual reality shoulder simulator* against an established shoulder arthroscopy model.

Methods:
85 medical students with no experience of shoulder arthroscopy performed tasks (navigation, triangulation and instrumentation) on validated dry-joint shoulder arthroscopy model (Alex, Sawbones). Similar tasks (navigation and triangulation) were then performed on the Insight shoulder simulator*. Results were compared.

Results:
Mean times to complete navigation, triangulation and instrumentation tests on the Alex model were 60.34s (sd=35.6), 52.65s (sd=22.0) and 107.7s (sd=102.7) respectively. Mean times to complete navigation and triangulation on the Insight* were 110.9s (sd=54.1) and 154.4s (sd=91.1). Regression analysis was performed between the different tests. Strong correlation was found between triangulation on the Alex and Insight* ($p=0.013$). The correlation between navigation on the two models failed to reach significance ($p=0.082$). There was no correlation between the instrumentation task on the Alex and either of the Insight* tests.

Conclusions
Despite current limitations the Insight virtual reality surgical simulator* has significant potential for surgical training. The advantage offered by surgical simulators over closed box models is that they can be used repeatedly and can present a variety of situations and anatomic variants. They include inbuilt training modules, requiring less trainer input and focused, systematic and controlled training can be accessed without risk to the patient.

* Product name changed to ARTHRO Mentor

Virtual Reality Arthroscopic Simulator - The Future Arthroscopic Training

Ofer Levy (Berkshire Independent Hospital Reading (Capio), UK) ,Sunil Sharma (Royal College of Surgeons, Glasgow & Edinburgh, UK), José Manuel Fernández Fernández-Arroyo (H. Severo Ochoa, Madrid, Spain)

2007

Abstract

Modern minimally invasive surgery with arthroscopic surgical techniques demand high level of skills especially with regard to triangulation in space as well as working within a particular joint while observing the images (often in different orientation) on a separate screen. The learning curve to obtain these skills is very long and steep. It may take several years of training to learn and accomplish proficiency in these techniques.

Current teaching techniques involve traditional apprenticeship with many hours/years of assisting senior surgeons, learning on plastic models (rarely mimicking the 'real' life), participating in courses with workshops practising on human cadavers and eventually 'learning' on real patients.

There are obviously difficulties with these methods of teaching and training as resources are limited.

Utilising the Virtual Reality (VR) capabilities with tactile feedback within an arthroscopic simulator may overcome these difficulties and improve the ability to teach and train surgeons in performing these complex arthroscopic procedures without risking any live patients.

The VR arthroscopic simulator provides an unlimited resource for training, readily available to all. Surgeons can practice on these simulators for unlimited times until they achieve good enough skills to enable them to perform these procedures safely on patients.

Trainees' arthroscopic skills improvement can be measured by setting a series of increasingly complex exercises that the trainees should perform. The simulator programme will grant them points for quality of performance as well as for speed, avoiding unnecessary movements, etc. Trainers can assess quantitatively the skills achieved by the trainees and certify them to perform these procedures using objective criteria.

We report series of assessments on groups of surgeons of different skill level prior to and following the VR simulator practice.

Shoulder Arthroscopy Training System with Force Feedback

Sofía Bayona, Marcos García, César Mendoza (Univ. Rey Juan Carlos, Madrid, Spain)
José Manuel Fernández Fernández-Arroyo (H. Severo Ochoa, Madrid, Spain)
2006

Abstract
Arthroscopy decreases soft tissue disruption which leads to less pain and less chance for infection, but implies a high difficulty of performance and requires the surgeon to acquire psychomotor skills which are essential to become proficient.

In this paper, we present a shoulder arthroscopy training system with force feedback. The first problem faced by the future surgeon is triangulation. Mastering this technique requires considerable practice and eye-hand coordination. The simulator allows the user to visualize with a high degree of fidelity the shoulder joint and to handle the instrumental as it would occur in the operating theatre. Additionally, it offers the possibility of having a panoramic view to orientate the apprentice in the first learning phases. Moreover, to increase realism, the system integrates a force feedback system which enables the user to feel the anatomy during the intervention.

An Apt Solution

Maulik J Ghandi (Royal Albert Edward Infirmary, Lancashire, UK)
Lennard Funk (Hope Hospital, Salford, UK)
2006

Abstract
Arthroscopy is a type of minimal access surgery with benefits such as reduced morbidity, better cosmetic results, and faster recovery. The challenges of arthroscopy differ to that of open surgery. This includes the ability to appreciate the difference of looking at a two dimensional screen, operating with 'reversed movements', and reduced tactile feedback. It is likely other factors are significant. Even the ability to reconstruct 3-D images from pictures varies with age and cultural background.

It has been reported that a junior surgeon has to perform at least 50 procedures to master shoulder arthroscopy and that expert performance in skills takes approximately 10 years to achieve. Prior to any surgical experience, the current selection process for orthopaedic training posts relies on a combination of CV, interview, and referees' points. This has previously been shown to correlate poorly with surgical skills measured subjectively.

The need for surgical aptitude testing was recognised in the Netherlands but has been dropped due to the lack of specificity to surgery.

Aptitude testing can be used as a form of selection to differentiate individuals. This test is advantageous in situations where the actual task to be done has extreme implications if not performed correctly, or the training for the task is time-consuming and expensive. For example, simulators have long been used to identify potential pilots.

Various training options are currently available for trainees. These vary from the use of cadavers to virtual reality training models. Such tools may also be helpful in evaluating the progress of current surgical trainees. Operating on live patients would be one of the final stages of training.

Recently, an international workshop was set up with specific objectives to develop a core curriculum for objective assessment of surgical skills. It was clear that this assessment would be one small measure to support the overall competence. A simple, cost-effective system of identifying which individuals have the desired skill levels could help selection of surgical trainees. Such identification of individuals will allow a more tailored training approach. This would allow extra training to be given to those who do not quickly develop the skills required for arthroscopy until they reach the 'criterion level'. This criterion level has been suggested as the mean performance of experienced surgeons on that particular
task.

Scoring well in any assessment tool that requires a one off performance does not necessarily predict potential learning. It may be that individuals have already reached their maximum learning potential for any of the skills tested by the tool, and thus have minimal capacity to improve, yet they show up as 'more trainable' compared to the other participants.

In summary, there is no scientific basis for selecting trainees from their CV, interview, or referees' report which would indicate their potential performance at arthroscopy. Aptitude testing may help in conducting a more objective selection of the candidates ready for arthroscopy from those who require longer training simulator.

Proyecto Sara (Simulador artroscopicopico Avanzado). Simuladores en la Formacion y Docencia de la Cirugia Artroscopica de Hombro Mediante Tecnicas de Realidad Virtual

Fernández Fernández-Arroyo, JM (H. Severo Ochoa, Madrid, Spain), Espadero Guillermo, JM, Bayona Beriso, S, García Lorenzo, M, Toharía Rabasco P (Univ. Rey Juan Carlos, Madrid, Spain)

2005

Abstract

Los avances tecnológicos de la Ingeniería Informática han permitido que la simulación de situaciones sea una realidad en nuestro entorno, siendo sus aplicaciones cada vez más amplias, empleándose técnicas de Realidad Virtual en el campo de la Medicina, tanto en la enseñanza anatómica como en el entrenamiento quirúrgico. Hace unos años formamos un grupo de trabajo multidisciplinario e interinstitucional, con el propósito de diseñar un 'entrenador' para cirugía artroscópica de hombro basado en técnicas de Realidad Virtual. Se expone la dificultad de la enseñanza así como el estado actual de dicho proyecto, que partió inicialmente de los datos anatómicos óseos del Proyecto Humano Visible, trabajando actualmente a partir de la digitalización en 3D de piezas anatómicas propias. Posteriormente estos datos se modelizan mediante mallas de puntos a las que se añaden estructuras tendinosas y ligamentosas mediante programas de diseño de gráficos 3D. La visualización de los modelos óseos se realiza a través de un dispositivo háptico (que está basado en un VLI® adaptado a nuestras necesidades), mediante la modificación de sus manipuladores de tal forma que se logra simular una cámara artroscópica y un palpador. Mediante el manejo de este instrumental logramos actual sobre esta imagen virtual, realizando unos ejercicios específicos de dificultad progresiva y con la posibilidad de su repetición, facilitando el aprendizaje de la navegación y triangulación artroscópica, sin problemas de tiempo ni de paciencia, tan usuales en la enseñanza tradicional.

New technologies in particular virtual reality will have major impact on health care in the next decade. Virtual reality applications are being used in teaching and surgical training. A successful medical simulator or surgical system based on virtual reality is development for a team of specialist who work based in information of the Visual Human project with software digital 3D design. The developers claimed that, with a special helmet equipped with head tracking devices and 3D displays, it is possible to create an illusion for the wearer that he or she was present in such an environment. There is a significant benefit associated with a focused, clinically based trauma management course for senior medical students. Students overwhelmingly felt the trauma simulator was effective for their trauma teaching, and improved their overall confidence in clinical trauma scenarios.

The Financial Impact of Teaching Surgical Residents in the Operating Room

M. Bridges, M.L. Diamond (University of Tennessee Medical Center-Knoxville, Tennessee, USA) 1999

Abstract

Background:

There have been no published data regarding the cost of training surgical residents in the operating room.

Methods:

At the University of Tennessee Medical Center-Knoxville, in addition to residentperformed teaching cases, some cases are performed without the assistance of residents by the same faculty.

Results:

Sixty-two case categories involving 14,452 cases were compared for operative times alone. In 46 case categories (10,787 procedures), resident operative times were longer than faculty alone. In 16 case categories, resident operating times were shorter than faculty times. The net incremental operative time cost was 2,050 hours between July 1993 and March 1997. Assuming 4 years of operative training for 11 graduating chief residents, the cost per graduating resident was $47,970.

Conclusions

Extrapolated to a national annual cost for the 1,014 general surgery residents who completed training in the 1997 academic year, the annual cost of training residents in the operating room is $53 million. This high monetary cost suggests the need for digital skills, selection criteria, the development of training curriculum and resource facilities, the preoperating room need for suturing and stapling techniques, and perhaps the acquisition of virtual surgery training modules.

Shoulder Arthroscopy Simulator Performance Correlates with Resident and Shoulder Arthroscopy Experience

Kevin D. Martin, DO, Kenneth Cameron, PhD, MPH, ATC, Philip J. Belmont Jr., MD, Andrew Schoenfeld, MD, and Brett D. Owens, MD

2012

Abstract

Background:

The technical skills required to perform arthroscopy are multifaceted and require supervised training and repetition. Obtaining this basic arthroscopic skill set can be costly and time-consuming. Simulation may represent a viable training source for basic arthroscopic skills. Our goal was to evaluate the correlation between timed task performance on an arthroscopic shoulder simulator and both resident experience and shoulder arthroscopy experience.

Methods:

Twenty-seven residents were voluntarily recruited from an orthopaedic residency program. Each subject was tested annually for three consecutive years on an arthroscopic shoulder simulator and objectively scored on time to completion of a standardized object localization task. Each subject's total number of shoulder arthroscopies, all arthroscopies, and cases were calculated according to postgraduate year from their Accreditation Council for Graduate Medical Education (ACGME) case log. Generalized estimating equation multivariate regression analysis was performed to determine the correlation between simulation performance and total numbers of shoulder arthroscopies, all arthroscopies, and cases.

Results:

Univariate analyses revealed that postgraduate year, total number of shoulder arthroscopies, total number of arthroscopies of any joint, and total number of surgical cases performed during residency training prior to testing were associated with the mean time required to complete the simulator task. The number of prior shoulder arthroscopies performed ($r = 0.55$) and postgraduate year in training ($r = 0.60$) correlated most strongly with simulator basic task performance. In the multivariate analysis, the number of prior shoulder arthroscopies and postgraduate year remained independent predictors of faster completion of the simulator task. For every additional postgraduate year, there was a sixteen-second improvement in the time required to complete the simulator task ($p < 0.005$). Similarly, after controlling for the influence of postgraduate year, there was a twelve-second decrease in the time to complete the simulator task for every additional fifty shoulder arthroscopies performed during residency training ($p < 0.008$).

Conclusions

These results showed a significant relationship between performance of basic arthroscopic tasks in a simulator model and the number of shoulder arthroscopies performed. The data confirmed our hypothesis that simulator performance is representative of both resident experience and shoulder arthroscopy experience.

Clinical Relevance:

This study suggests that greater resident clinical experience and shoulder arthroscopy experience are both reflected in improved performance of basic tasks on a shoulder simulator. These findings warrant further investigation to determine if training on a validated arthroscopic shoulder simulator would improve clinical arthroscopic skills.

Arthroscopic Basic Task Performance in Shoulder Simulator Model Correlates with Similar Task Performance in Cadavers

Kevin D. Martin, DO, Philip J. Belmont Jr., MD, Andrew J. Schoenfeld, MD, Michael Todd, DO, Kenneth L. Cameron, PhD, ATC, and Brett D. Owens, MD
Investigation performed at William Beaumont Army Medical Center, El Paso, Texas
2011

Abstract

Background:

Attainment of the technical skill necessary to safely perform arthroscopic procedures requires the instruction of orthopaedic surgery residents in basic arthroscopic skills. Although previous studies involving shoulder arthroscopy simulators have demonstrated a correlation between task performance and the level of prior arthroscopic experience, data demonstrating the correlation of simulator performance with arthroscopic skill in a surgical setting are scarce. Our goal was to evaluate the correlation between timed task performance in an arthroscopic shoulder simulator and timed task performance in a cadaveric shoulder arthroscopy model.

Methods:

Subjects were recruited from among residents and attending surgeons in an orthopaedic surgery residency program. Each subject was tested on an arthroscopic shoulder simulator and objectively scored on the basis of the time taken to complete a standardized object selection program. After an interval of at least two weeks, each subject was then tested on a cadaveric shoulder arthroscopy model designed to replicate the shoulder arthroscopy simulator testing protocol, and the time to completion was again recorded. Both testing protocols involved the simple task of placing a probe on a series of assigned locations in the glenohumeral joint. Spearman rank correlation analysis was performed, and regression analysis was used to determine the predictive ability of the simulator score.

Results:

The performance time on the simulation program was strongly correlated with the performance time on the cadaveric model ($r = 0.736$, $p < 0.001$). The time required to complete the simulator task was a significant predictor of the time required to complete the cadaveric task ($t = 4.48$, $p < 0.001$).

Conclusions

These results demonstrated a strong correlation between performance of basic arthroscopic tasks in a simulator model and performance of the same tasks in a cadaveric model.

Clinical Relevance:

This study suggests that performance of basic arthroscopic tasks in a simulator environment may be indicative of performance of similar arthroscopic tasks in a surgical setting. This work supports the continued study of arthroscopy simulators as a potentially beneficial educational tool.