



CUTTING-EDGE VIRTUAL SIMULATIONS SET TO REVOLUTIONISE KEYHOLE SURGERY TRAINING

Training times in increasingly popular keyhole surgery techniques could be dramatically reduced thanks to an innovative 3D computer simulation program from British software developer, Primal Pictures. The company is creating a virtual surgery program that allows trainees to rehearse keyhole surgical procedures in three dimensions on a normal PC – training them faster and increasing their competence levels.

“Minimal access surgery is becoming widely accepted and is now considered a core skill in surgical training – particularly in orthopaedics,” explains Dr. Vassilios Hurmusiadis, project co-ordinator and chief investigator at Primal Pictures. “However, until now, the technique has been difficult to teach and many surgeons have had to rely on their brain’s ability to manipulate images and the opportunity to learn through experience in the operating theatre.”

The Virtual Anatomy Trainer for Minimal Access Surgery (VATMAS) will provide a solution to the difficulties associated with teaching the cognitive aspects of training. The project will develop software that will enable surgeons to familiarise themselves with the inverted, distorted and unusual views of anatomy seen through an arthroscope or keyhole camera. Surgical trainees will also be able to use the three-dimensional computer game-type simulation to ‘try out’ methods and understand how and where to insert tools for a successful procedure.

VATMAS will use a combination of MRI data and real-time images from arthroscopies. The project will develop the world’s first simulation that can run on a PC or laptop and be used for revision or additional study outside of the operating theatre or training room.

The project will be funded by the Technology Strategy Board and developed in conjunction with the Royal College of Surgeons of England (RCSE) and the Division of Imaging Sciences, King’s College London. The consortium has been awarded a substantial government grant that will enable it to carry out research and development on this groundbreaking project.

“Trainees at RCSE attend an initial two-day course about the general principles of endoscopic surgery,” explains Kevin Sherman, RCSE course tutor and consultant to VATMAS. “They have the opportunity to practise on a physical model – usually a plastic knee – and with the aid of a camera and monitor; they are able to see the interior of the knee containing small components that they can practise on. The difficulty lies in teaching the brain to process information that the eyes are seeing rotated through 90 degrees or more – you could be moving your hand to the left and seeing it move up or down on the screen. It is this concept of training the brain to work differently that can defeat surgeons and that’s why the VATMAS project is so important.

“When we began to discuss the project, we felt that the key skills that needed to be taught to trainees were those of visualisation and recognition. We wanted to be able to show trainees what the anatomy would look like through the lens and teach them how to reach different areas of the joint. This cognitive training is what is unique about VATMAS as it currently can only be taught through actual operative experience.”

Traditionally, trainees learn anatomy by looking at cadavers or anatomical images. If there is no virtual simulator available, they then train directly on patients. “This is one of the biggest problems with training in endoscopic procedures,” comments Vassilios. “Trainee surgeons are supervised, but gain their experience by working on patients and often don’t understand the anatomy well enough. Haptic simulators are used by some training establishments to develop dexterous hand-eye coordination skills in endoscopic surgeons. However, these are very expensive and therefore not widely available. Where they are available, access is likely to be limited due to the number of trainees wishing to use a single machine.”

Unlike in general surgery, orthopaedic surgery often involves looking around and behind a bony structure, making recognition and the ‘translation of images’ even more complicated as the camera will not be ‘looking’ straight-ahead in the first place. The use of a wide angle lens can also confuse surgeons when objects appear magnified or smaller than expected. “An arthroscope will look to the side, usually at a 30 degree angle from the direction of the instrument,” explains Kevin. “The surgeon has to move the instrument and rotate the camera separately to expand their field of view and turn the image the correct way up to correspond with the way they are working.

“A surgeon will turn the camera to obtain an anatomical view of a knee, for example, even if the knee is actually on its side – he works with the view from the camera, rather than what his logical brain might expect. It’s really important to be able to process what you have seen, as when you are exploring a joint with this method, it can be difficult to know if you have covered all areas.”

So it isn’t surprising that some doctors struggle with this procedure. “You really do need to have the ability to visualise something and to manipulate images in your brain. You also have to be able to work without seeing what your hands are doing and you need a very sound knowledge of the anatomy inside a joint which is one of the reasons why many orthopaedic surgeons now specialise either in particular areas of the body, or particular procedures.”

VATMAS will provide three-dimensional images of all the anatomy and anatomical relationships of a real knee from the point of view of the arthroscope. It will include scenarios and demonstrations of the structure of the knee and the direction of the instruments inserted. It will also cover operative techniques – what instruments to use and where to put them.

“The project will focus on the visual and cognitive understanding of the sequence of actions to be taken in an arthroscopic surgical procedure,” continues Vassilios. “It will provide views that trainees have never before had access to away from a real body and will show them how to work with the anatomy to achieve their objective. Our aim is to create an innovative, accessible tool for learning that will run on a laptop or PC. It will add the cognitive layer that trainees can practise before they lay their hands on haptic simulators or a real patient – it will give them the opportunity to really get to grips with the structures and orientation away from the classroom or operating theatre and will give them a valuable head-start.”

Initially, Kevin’s role on the project is to work with Primal and Kings to provide the specification of what is required for both teaching and performing arthroscopic procedures. Once the project is underway, he will work with other orthopaedic surgeons to develop learning scenarios and an evaluation programme for the product.

“Because VATMAS is computer-based it will give teachers the opportunity to present scenarios and discuss ways to deal with them – something that is not so easy to do with plastic models,” he explains. “The interactivity will allow trainees to see and understand the importance of ensuring that their

instruments are inserted in the correct place. By selecting different options, they will be able to understand why something will or won't work in a given scenario.

“As a result of being able to practise independently with the software, trainees will be ready to perform real operations earlier. This could potentially increase expertise in the technique overall and will almost certainly mean that surgeons will be ready to train in advanced skills sooner than they would have been otherwise.”

In fact, according to Kevin the project could take up to three months off a typical six-month MAS training schedule and this is another major factor that favours the development of this project. “Because of the European Working Time Directive, the hours that surgeons are allowed to work have been substantially reduced,” he explains. “It is therefore extremely important that trainees are able to make maximum use of their training time and that this training is as efficient as possible. VATMAS will eliminate the very early, slow phase of learning and enable surgeons to go straight into the faster phase. They will have covered the early, cognitive stage using the software and will be able to focus on their haptic skills once they enter the operating theatre, without having to learn the basics ‘on the job’. In addition, those who find visualising more difficult will be able to perfect their technique by spending extra time working independently on their cognitive skills with the software.”

As a tutor and future end-user, Kevin welcomes this innovation as it means that he will be able to spend less time teaching the basics and more time focusing on advanced skills training. In terms of operating theatre usage, it's also good news as hospitals want trainees to work reasonably fast to ensure that they are able to treat the large number of patients on their operating lists.

“Endoscopic surgery is currently taught the same way all over the world. This project is very positive for everyone involved and promises to revolutionise the way the procedure is taught,” he comments. “The combination of virtual endoscopy and interactive assessment provided by the software will lead to more surgeons being trained more effectively - substantially reducing current MAS training time. We are all very excited about it and delighted to be involved.”

If you would like more information on this project, please contact Laurie Wiseman at Primal Pictures on +44 (0) 207 637 1010.

Keyhole surgery – the history

“Minimal access surgery or endoscopic surgery – otherwise known as keyhole surgery - is defined as a procedure where the surgeon works within the cavities of the body, such as the joints, using optical instruments to visualise the interior. It was first pioneered in the 1920's,” explains Kevin Sherman. “The technique did not gain popularity because arthroscope design was too limited at the time. The ‘modern’ arthroscope was pioneered by Watanabe in Japan in the 1960's, although it still required the surgeon to ‘look through it’ and it wasn't until the development of the chip camera that the procedure became more popular and easier to teach.”

Endoscopic surgery became popular in orthopaedics in the 1970s. Use of the procedure in wider surgical procedures followed later on. Initially, without the aid of a monitor to display what could be seen by the surgeon, the procedure was predominantly ‘self-taught’ through direct experience of operating on patients. Surgeons worked with an eyepiece attached to the instrument, looking down it as they worked, and trainee surgeons would begin by observing at intervals, gradually taking on more of the actual operation under a consultant's supervision.

Keyhole surgery has had a big impact in orthopaedics – particularly with the knee and shoulder - due to quicker recovery times and reduced pain. Most procedures on joints these days are carried out using arthroscopic techniques. Thus the procedure is considered as a core skill for orthopaedic surgeons, as well as for general surgeons, and trainees will normally begin to learn this procedure within three to four years of qualifying. Kevin estimates that the number of arthroscopies performed in the UK each year is 80,000 to 90,000 and it is now the most common operative procedure.

Extracting the data for VATMAS

Professor Tobias Schaeffter of the Imaging Sciences division, Kings College London (KCL) will be responsible for extracting the data required for VATMAS. “We will use unique tracking technology that provides high-resolution arthroscopy images alongside high-quality 3-D MRI data of the knee,” he explains.

Professor Schaeffter and his team at KCL will scan a number of patients and a range of knee pathologies. The team will also scan knee pathology in movement – where the knee is moved and placed at different angles and then scanned to generate kinetic models of the joint. This data will then be supplied to the team at Primal to create the 3-D reconstructions. The computer graphics team will develop a virtual endoscopy prototype which will in turn be passed back to KCL for validation.

The end result will show real arthroscopy images side by side with computer generated images, so that the end-user will get to see and study the actual view that is seen by the surgeon.

For more information on King’s College London Imaging Sciences, please visit:
www.kcl.ac.uk/schools/medicine/research/imaging/

About Kevin Sherman

Kevin Sherman is a consultant orthopaedic surgeon in the Hull and East Yorkshire Hospitals NHS Trust. He is seconded for sessional work at the RCSE for an average of one day per week as the Charnley/Stryker Orthopaedic Tutor.

Kevin mainly teaches the training grades, but also runs some advanced courses for consultant orthopaedic surgeons.

For more information on RCSE, please visit: www.rcseng.ac.uk