Patient specific instrumentation and robotic total shoulder arthroplasty

Introduction
The use of ‘robotics’ in surgery began as long ago as the 1980s. It initially saw predominant use in laparoscopic surgery. The ‘Da Vinci’ system is the most up-to-date version of this and is in widespread use, particularly in radical prostatectomy. In this system the laparoscopic instruments are attached to a robot and the surgeon operates the robot by the means of a computer console.

The use of robotic surgery in orthopaedics has taken a different form. Malpositioning is a major cause of aseptic loosening after arthroplasty. Computers have been used to help aid with the precision placement of implants to improve long term outcomes after arthroplasty.

It is predicted that the global surgical robotic market will be worth 5 billion USD over the next 5 year period.

Robotics in knee and hip arthroplasty
Most published series have 90% rate of acceptable component alignment without either robotic or computer guidance ('eyeballing'). Numerous strategies have been used to eliminate the 10% which are inadequately positioned.

Navigation
At the time of arthroplasty anatomical landmarks are fed back to a computer. The computer uses these landmarks to build a picture of the desired bone resection required. The cuts are then made by the surgeon and their accuracy is checked by the computer.

Patient specific cutting blocks
Cross sectional imaging is used to create a 3D model of the joint. Custom made cutting jigs are then manufactured to fit over the patients’ bone. The surgeon then makes the cuts through the jigs.

Navigation with robotics
A cross sectional model of the joint is created on the computer and the desired cuts are planned on the computer pre-operatively. Anatomical landmarks are then fed back to the computer at the time of surgery. A surgeon controlled robotic arm makes the cuts. The robot prevents the surgeon from cutting outside of the planned areas.

Robotics in shoulder arthroplasty
Glenoid component alignment and fixation can be problematic in shoulder arthroplasty. There is often congenital or pathological loss of bone stock in the glenoid. This can make it difficult to achieve a well fixed component. Additionally the orientation of the socket may be abnormal. During shoulder arthroplasty the surgeon only sees a front on view of the glenoid and therefore it is difficult to gauge its orientation.

The critical step is to position a guide wire in the ideal location to correct any bone deficiency and to prepare the bone bed in which to fix the glenoid prosthesis. Similarly to hip and knee arthroplasty computer based strategies are now available to help the shoulder surgeon.

Patient specific drill guides
A 3D model of the glenoid can be made on a computer and used to create custom made patient specific drill guides that are contoured to the glenoid and have a drill hole down which the guide wire is placed. In this way all the preparation and planning is done prior to surgery. This technique has been utilised for the last 2-3 years.

Navigation
An alternative is to map out the shape of the glenoid at the time of surgery using a computer. Then the guidewire can be positioned based on the computer image that has been produced. This technique is quite new and has recently been publicised in the national press.

It would seem unlikely that in the absence of any major glenoid bone defect or malorientation that the use of robotics / navigation in shoulder arthroplasty would lead to a significant clinical benefit. However if the glenoid is deficient or malaligned then the use of patient specific drill guides or navigation may be beneficial. As always it will be hard to demonstrate a major clinical significance because the results after shoulder arthroplasty are already very good.