Guest editorial

Robotic surgery in hip and knee arthroplasty

An unproved improvement

About 100 robotic systems for orthopedic surgery have now become more widely available in Europe, mainly in Germany, during the past few years. Most systems are bought as an investment for surgeons and hospitals trying to lure patients to a competitive health care service. The patients believe that the machines in this service are reliable, but not the surgeons, and they are attracted by the most sophisticated techniques.

In the last issues of *Acta,* articles by Thomsen et al. (2002) and Nogler et al. (2001a, b) discuss orthopedic robotic surgery critically. In this issue of *Acta,* still another article is published, and its title, “No functional impairment after Robodoc total hip arthroplasty” (Bach et al. 2002), makes one wonder about modern high-tech technology.

Interest in computer- and robotic-assisted surgery has increased markedly during the late 1990s. These methods have been used for many years in industry, but have only recently attracted the medical profession. The complexity of computer-assisted surgery, in which robotic surgery is the most advanced type, has required joint efforts in the fields of medicine, computer and robotic science, and engineering. This technology was first developed on a larger scale for neurosurgery, ENT and other specialities. In orthopedics, the Robodoc system has been used to prepare the femur component during hip arthroplasty, it was introduced in the beginning of the 1990s and has since been improved (Boerner et al. 1997).

Great interest and enormous resources have been expended on this high-tech procedure during the last decade and several meetings (Computer-assisted Orthopedic Surgery—CAOS) on this topic have been arranged in USA and Europe. However, no real breakthrough has occurred; many systems are sold, especially in Germany, but they are seldom used.

Depending on how sophisticated and surgeon substituting the systems are, they can be divided in passive, semiactive and active robotic systems. Some engineers think they can perform better surgery with these techniques than the surgeons of today.

Several complex steps are needed to achieve the full potential of these image-guided 3-D technologies. In most systems, these steps include preoperative planning after a smaller operation—i.e., inserting bone markers or screws for optimization of the 3-D systems (Nogler et al. 2001). Future systems will probably avoid this procedure by using surface registration of the anatomical landmarks of interest. The patient must also be investigated by CT or MRI to record the 3-D coordinates. After this, preoperative surgical planning on the computer, using the CT or MRI information, can be done. At surgery, 3-D planning and the surgical environment, including the robotic system, must be tracked, using the preoperatively implanted bone markers or screws for calibrating the preoperative and operative 3-D systems together for optimization of the surgical planning. At surgery, safety aspects include active feedback systems. During this active period, the 3D planning images should be related to the patient in the operating room, tracking the anatomic structures of interest to the surgical tools. The human and computer interfaces should be cooperating, using and presenting the preoperative and perioperative data to the surgeon (DiGoya et al. 1998)

Ideally, these new techniques should result in a more accurate and, hopefully, less invasive surgery with a shorter operating time and fewer complications.

However, these systems have not yet been fully evaluated. They have been shown to work in some situations, but even at inventor clinics, they frequently turn to the "dark corner". The reason is that many systems are still too troublesome to use, the need for extra technicians during the planning and more frequently during surgery is a problem. No data have shown that the clinical results are better, except for the placement of pedicle screws in spinal surgery (Laine et al. 1997). At present, longer operation time, additional surgical intervention and complications are the most negative effects of these techniques. The cost-effective problems have not been analyzed (Maniadakis and Gray 2000). The whole procedure with more intense preoperative planning, including additional CT or MRI, with or without preoperative implanting of markers for tracking the system to the patient, must be considered. The problem with accuracy when connecting the various 3-D systems has not been in focus and is no better than several millimeter.

The safety of these tools should be studied to avoid, for example blow-out of the trochanteric region (which I have seen at demonstration of the system). The occurrence of more pain (Nogler et al. 2001a), longer time for rehabilitation and other complications related to wider incisions and supplementary surgery must be analyzed.

The large additional costs must be justified by improved results. However, this is almost impossible to show since thousands of cases need to be studied adequately.

It is of note that Thomsen et al. (2002) found that the surgical preparation with the ABG prosthesis were slightly worse using the robotic system than with the hand-broaching technique. This prosthesis performed better than most non-cemented prostheses in the Nordic national hip registers (Malchau et al. 2000, Poulakka et al. 2001).

The computer and robot technique is demanding and should be used only in specialized centers. It does not compensate for lack of surgical skill and routine.

A less demanding part of the robotic and computer-assisted techniques, the navigation, allows the surgeon to place the surgical tools accurately for preoperative planning or directly during surgery, using an optimization of anatomical landmarks. Although this is interesting, the considerable additional costs must be considered.

I think these techniques deserve attention, they have a potential in research and development and can be regarded as a tool that will teach us more about the precise prosthetic position as related to the anatomy. The ability to measure and document the exact prosthetic and anatomical positions deserves attention. Its potential use as an improved educational tool should be considered.

One concern is the quick and extensive commercial distribution of these techniques—an unproved improvement.

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