COMPUTER ASSISTED SURGERY (CAS OR NAVIGATION)

CAS is a form of robotic surgery in its second coming. The first incarnation of robotics in orthopaedic surgery was in the form of the ill-fated “Robodoc”. Robodoc actually did the surgery (in this case total hip repalacement) with some guidance from the surgeon and a preoperative CT scan. Robodoc was quite good at knowing where it was with respect to key skeletal landmarks but needed large incisions for access, had no idea when to stop pushing and so fractured a lot of femurs and was spectacularly expensive. Only three units were sold. All were in Germany and were mothballed very quickly. The other problem with Robodoc was that surgeons were not accepting of the technology. They didn’t trust it and were not happy with the machine holding the tools.

Robotics re-emerged a little over ten years ago as Computer Assisted Surgery (CAS) or otherwise called Navigation. CAS is a form of robotics that acts as a guide to the surgeon. All the surgery and decision making is done by the surgeon. The robotic instruments provide information that aids the surgeon in sizing, positioning, tensioning and aligning depending on what surgery is being done. CAS is a very powerful tool that is readily applied to total knee replacement (TKR), unicompartmental knee replacement (UKR), and osteotomy (HTO) surgery. Most systems have been developed around a total knee replacement model but are easily adaptable to other situations. CAS adds some time and expense to surgery (about 10 minutes to a TKR). CAS begins with a process called registration that involves teaching the computer about the knee. At the end of registration the computer knows the mechanical axes of the entire limb and the surface anatomy of the joint. A virtual model of the knee is produced using a morphing programme. The accuracy of the morphed model is validated as being accurate. How much information can be extracted from the system depends on the amount and quality of input into the system during registration. In its most basic form CAS can help align the initial two bony cuts in a TKR. Taken to its limit however CAS can size implants, position in all six degrees of freedom can be adjusted, ligamentous envelopes in various positions can be measured and the position of implants virtually adjusted to optimize the fit of these implants within the ligamentous envelope. Once a virtual plan is finalized the TKR is executed and CAS used to check the accuracy of each step. The end result is a TKR that is optimally positioned relative to the native anatomy and ligaments that it works with. TKRs that are executed using the full extent of what CAS has to offer have the potential to feel less like a prosthesis and more like something that belongs in the knee.

CAS is an invaluable tool in other surgery where small changes in position and alignment make big differences to outcomes. UKR and HTO are two examples of such. UKR is technically very unforgiving. If the prosthetic joint line on the replaced side does not match very closely the native joint line on the unreplaced side a kinematic conflict that affects the quality and extent of movement results. CAS allows accurate joint line reconstruction in all 6 degrees of freedom, it allows quantification and accurate reconstruction of the limits of the ligamentous envelope and as with TKR there is the potential for the implant to feel less like a prosthesis and more like something that belongs in the knee. This is particualry so with UKR given that the ACL is retained and the potential for normal kinematics is very real. CAS is equally applicable to HTO. The target alignment for a successful HTO has a very narrow range and prior to CAS this involved the surgeon having a great eye and a few pretty rough checks. CAS has turned HTO from art to science and particularly when combined with a medial opening wedge technique allows very accurate alignment and more predictable results.

Dr McEwen does all TKR, UKR and HTO surgery using CAS to the limits of what the system can provide.

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