PATIENT SPECIFIC INSTRUMENTATION AND SHAPEMATCHING

Patient specific instrumentation (PSI) is recent development in total knee replacement (TKR) surgery. All the major prosthesis manufacturers have PSI technology that can be used with their implants. All PSI works by creating patient specific cutting blocks (jigs that are placed of the ends of the femur and tibia) from a preoperative MRI or CT scan. The scan is sent digitally to the manufacturer in the United States. The manufacturer emails a preoperative plan to the surgeon. The surgeon can make minor adjustments to the plan and once the surgeon approves the plan the PSI cutting blocks are manufactured and sent to the hospital. The initial bony cuts of the TKR are used making these jigs and all subsequent work is referenced from the initial bony cuts.

PSI, like all new technology has its pros and cons. The advantages of PSI relate to the speed of the surgery. Many steps in the standard surgical workflow are eliminated. Whether or not PSI produces a better TKR is an entirely different question. For PSI to have any chance of improving TKR the cutting blocks need to be an accurate representation of any one patient's anatomy, positioning of the blocks needs to be reproducible (same position every time) and positioning of the blocks needs to be accurate (not just same position every time but the right position every time). Unfortunately for most PSI systems evidence regarding their reproducibility and accuracy is at best unconvincing and compared to the incredibly powerful tool that is computer assisted surgery (CAS), PSI robs the surgeon of the ability to adjust implant the best match the ligamentous envelope in which it must function. At this point in time CAS remains the gold standard.

Shapematching is a very specific type of PSI that can be used only in conjuction with the Stryker Triathlon TKR (The TKR used by Dr McEwen). Shapematching differs fundamentally from other PSI systems and in fact from CAS. All TKR technology including CAS has as its primary mechanical objective a neutral mechanical axis and a perpendicular joint line. The means that the line along which weight passes through the femur (the mechanical axis) is colinear (along the same line) with the line along which weight passes through the tibia and that the prosthetic joint line is set at right angles to the mechanical axis. This arrangement minimizes shearing loads and spreads compressive loads evenly across the plastic bearing of the TKR and with earlier TKRs was shown to be an important factor in maximizing the useful lifespan of a TKR. However, this arrangement does not reproduce any one person's native prearthritic anatomy which is the anatomy the knee ligaments are positioned to work with. Most people do not have a neutral mechanical axis or a perpendicular joint line. Therefore it follows that if the more the neutral and perpendicular arrangement differs from a person's prearthritic anatomy the more the joint line of the TKR conflicts with the native ligaments. Shapematching is a new PSI technology that ignores mechanical axis and joint line and positions the TKR around the native prearthritic centre of rotation of the knee therefore matching the TKR to the native anatomy. This is known as kinematic alignment. Shapematching, like all new technologies has its pros and cons. It has the potential to allow more physiologic knee function particularly in deep flexion and as with other PSIs will reduce operative time. However, it is unknown at this point in time whether kinematic alignment will negatively affect the longevity of the plastic bearing of the TKR. Based on available evidence however, it is likely that for most people kinematic alignment will fall within the range of tolerance of a modern TKR bearing. As with all PSIs the surgeon can reject the plan if the kinematic alignment coordinates are unacceptable.

Shapematching is not available for general use in Australia. Dr McEwen is one of five surgeons in Australia with access to the technology. This access is part of a multicentre prospective study that is assessing the reproducibility, accuracy and clinical outcomes of Shapematch TKRs. The results of this study are so far very promising. The results will be presented at meetings the world over in the next year or so and submitted for publication in peer reviewed journals.

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