# clinical update

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## inside

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# Computer Assisted Total Joint Replacement Provides Saint Alphonsus Patients with Excellent Outcomes

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**IN JUNE OF 2005, THE SAINT ALPHONSUS ORTHOPAEDIC INSTITUTE BEGAN PROVIDING COMPUTER ASSISTED TOTAL JOINT REPLACEMENT SERVICES.**

Several surgeons and implant vendors have come on board, and now this technology is available to many more total hip and knee patients. Computer guidance combined with minimally invasive surgery, the Saint Alphonsus Joint Camp, and dedicated physicians, nurses and therapists, provide our patients with the greatest likelihood of an excellent outcome.

## HISTORY OF COMPUTER ASSISTED ORTHOPAEDIC SURGERY (CAOS)

CAOS evolved from the original computer guided surgical procedures involving intracranial and head and neck surgery. In these procedures, CT scan data of the operative site is fed into the operative computer system. Intraoperative guidance is then provided to the surgeons via an optical recognition system. The precision of the computer in these high-risk areas provided increased accuracy and margin of safety. BrainLab, formed in 1989, was the pioneer of this technology.

Early total joint applications required a similar CT scan of the hip or knee be performed preoperatively. This data was then used by the computer to guide bone cuts and implant positioning. This entire process is considered image-guided computer navigation, requiring preoperative images be used by the computer.

## STATE-OF-THE-ART COMPUTER ASSISTED ORTHOPAEDIC SURGERY

The current computer systems used in orthopedics do not use preoperative images to guide hip and knee replacements and are referred to as image-less computer navigation. A more cost effective approach has been to develop an intraoperative digitization of skeletal landmarks and perform the surgery in relationship to those landmarks.

For knees, the hip center of rotation, distal femoral surface anatomy, proximal tibial surface anatomy, and center of ankle are digitally recreated within the computer during a 10-minute registration process. For hips, the anterior pelvic plane, center of acetabulum, leg length and femoral offset are registered into the computer. The most common optical system uses reflective spheres attached to small pins drilled into the femur and tibia for total knees, and into the iliac wing for total hips. In addition, the instruments used to position the cutting blocks and other surgical equipment are also mounted with these same spheres so they can be "visualized" and tracked by the computer.
The computer monitor provides real time reporting of instrument placement, thus improving the surgeon's decision-making ability. Finally, each cut can be verified for accuracy after the completion of the cut and fine-tuned to the desired precision. In knees, the critical step of balancing the soft tissue envelope is improved by quantifying joint range of motion and laxity.

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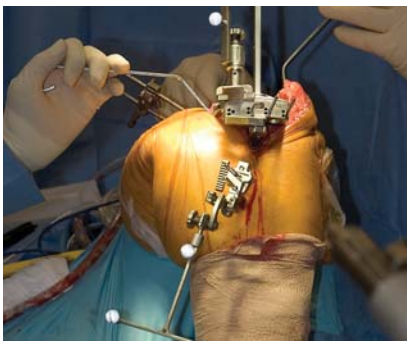

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## BENEFITS OF CAOS IN TOTAL JOINT REPLACEMENTS

The goal of CAOS in hip and knee replacement surgery is to eliminate the short-term failures that occasionally occur using standard techniques. These are usually due to the malpositioned implants, inaccurate sizing of the implants, unbalanced soft tissues, and the lack of bone growth in the noncemented implants. CAOS can affect the first three of these. "At present, most anthroplasty surgeons rely on either the naked eye or alignment jigs to align prosthetic components," stated Jeffry Menzner, surgeon Saint Alphonsus Orthopaedic Institute. The current standard instruments for total joint replacement have remained essentially unchanged for the last 20-25 years. Minimally invasive surgery has been accomplished typically by simply downsizing these same instruments. The success of total hip and knee replacement using these instruments has been very good. Implanting hip and knee prostheses is a mechanical engineering feat. The computer is a much better ruler than anything developed to date. Each implant, the femoral and tibial component for total knees, and the acetabular and femoral component for total hips has to be positioned taking into account 6 degrees of freedom. Small malpositions in any one of these 6 variables for each implant can have an effect on joint function, stability, and longevity. Although surgeons examine these variables intraoperatively with standard instruments, errors in cutting block placement can be expected. Errors beyond 3 degrees can lead to early failure.

***The computer is a much better ruler than anything developed to date.***

The computer can allow us to reproducibly position the cutting blocks to an accuracy of 0.5 degrees and 0.5 mm. In addition, making the bone cut with an oscillating saw blade can add several millimeters and degrees of variability. Our ability to then check the cuts for accuracy is very limited with standard instrumentation. Now, however, this technology allows us to check the accuracy of our cuts and fine-tune them to these new levels of accuracy.

Finally, during the last step, prosthesis implantation, the computer allows us to make very accurate measurements of important parameters and make adjustments as necessary. Sophisticated software packages provide direct measurements regarding soft tissue balancing in total knee replacement, as well. Whether the computer is used for hips or knees, these implants should have a more "natural" feel as they will be positioned correct anatomically, they should be less "clunky", and should have a longer working life for the patient due to diminished wear.

In addition, the occasional implant positioned outside the normal operating window or outlier, will be minimized, leading to less short-term failures.

## SCIENTIFIC DATA SUPPORTING COMPUTER USE IN TOTAL JOINT ARTHROPLASTY

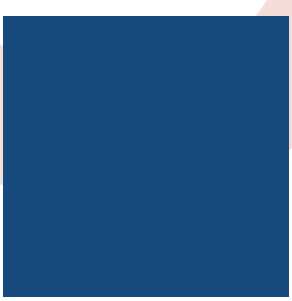
Peer reviewed journal articles on this topic demonstrate significant benefits in accuracy of alignment when compared to standard instrumentation. Other benefits include diminished blood loss and fat emboli due to lack of intramedullary instrumentation. Complications attributed to its use are sporadic. Widespread introduction of CAOS has been supported in a recent review of the ethics of incorporating new innovations in total knee anthroplasty. Interestingly, minimally invasive total knee anthroplasty did not pass the same tests regarding biomedical ethics of its widespread use. The increased cost attributed to the computer has been analyzed and found to be supported by the increase in QALY (Quality Adjustment Life Years) attributed to its use.

## FUTURE OF CAOS

Newer registration and instrumentation systems that do not require pins drilled into the skeleton to position reflective spheres are being developed. An electromagnetic device may be used to digitize the skeleton, and then guide the positioning of the instruments, rather than an optical system identifying reflective spheres. Computer guidance mated to minimally invasive joint replacement is a natural step. As the incisions become smaller, the surgeon's ability to visualize the procedure is diminished. The use of the computer will provide the above benefits, as well as diminish the complications attributed to minimally invasive surgery.

CAOS is already being used in sports medicine and orthopedic trauma procedures such as ACL reconstruction and fracture repair. Spine surgery has also benefited from the development of several computer platforms to aid in placement of instrumentation. "Soon most orthopedic residents will be extensively trained in computer surgery," stated Dr. Menzner. "The finish carpenters jigs we have been using for the past 2 decades will likely be replaced in the next 10 years." ■

*For more information on the Computer Assisted Orthopaedic Surgery at Saint Alphonsus, please contact Dr. Jeffry Menzner at the Boise Orthopaedic Clinic Hip and Knee Center, 208 323 2600.*



**Jeffry P. Menzner was raised in Marathon, Wisconsin. He graduated from Drake University in 1985 and Baylor College of Medicine in 1990. He completed his orthopedic surgery residency at the University of Utah in 1995. After serving in the United States Air Force until 1998 he completed a fellowship in musculoskeletal oncology at the Massachusetts General Hospital and Boston Children's Hospital in 1999. He is board certified in orthopedic surgery. Dr. Menzner joined the Boise Orthopedic Clinic in 1999.**