Orthopedic navigation: Questions about long-term results and costs

Like a car’s global positioning system (GPS), computer-assisted surgical navigation helps orthopedic surgeons get their bearings. A navigation system receives and transmits data about joint surfaces and placement of implants, displaying the information on a computer screen where the surgeon can view it.

Computer-assisted surgical navigation systems became commercially available in the US in 2001. The systems allow surgeons to digitize the patient’s anatomy at the beginning of surgery without any preoperative imaging.

First used in neurosurgery, navigation systems later became available for total joint replacement. Anterior cruciate ligament (ACL) reconstruction also is being performed with navigation systems, improving accuracy of the tunnel position for the ACL, leading to improved outcomes. But the technology is young. It’s estimated fewer than 10% of orthopedic surgeons are currently using navigation.

Hospitals considering this technology face questions about whether navigation improves surgeons’ performance or contributes to longer-lasting joint replacements. So far, there is not enough evidence to answer these questions. Currently, the only large prospective clinical studies comparing conventional techniques with computer-assisted navigation are for total knee arthroplasty. Some data on cost-effectiveness of navigation systems is beginning to emerge (sidebar).

How navigation works

The navigation system is a computer workstation with a screen, software, a positioning/tracking system, and surgical instruments. The positioning and tracking system is composed of small reflective spheres that are attached to the patient and tracked by an optical camera to register the location of the anatomical structures. The computer then develops a model of the joint and projects the image onto a monitor.

The surgeon touches parts of the patient’s anatomy with a pointer so the computer can identify and register those points in its memory, including specific bone structures, the anatomy, the motion and alignment of the patient’s normal anatomy, and the optimal joint alignment.

With this information, the computer can guide the surgeon in making the bone cuts for the implant. The computer knows the angle of the cut relative to the shaft of the femur or tibia, for example, and can tell the surgeon how many degrees he is off.

“It’s almost like playing a video game. The surgeon is looking at a screen and trying to balance the bone cut and the ligaments based on real-time feedback the computer is
“giving on its screen,” Thomas P. Vail, MD, spokesperson for the American Academy of Orthopaedic Surgeons (AAOS), told OR Manager.

“The computer helps us in aligning all the jigs we normally use for total knee replacement,” says Michael R. Marks, MD, MBA, an orthopedic surgeon and chief of staff at Norwalk Hospital, Norwalk, Connecticut. “It is amazing how you can change a knee from being internally rotated to externally rotated with just a few millimeters of motion. These are the things we used to look at and say, ‘It looks pretty good.’ Now, with navigation, we’re able to come within 1 or 2 degrees of correction. That’s really the incredible part of this.”

Benefits of navigation

A leading advantage of navigation in knee surgery is that it eliminates the need for an intramedullary rod. In conventional surgery, a rod is inserted up the length of the femur and used as a reference to determine proper knee implant alignment in relation to the hip joint.

Compared to the use of an intra-medullary rod, navigation techniques have been shown in randomized studies to increase the accuracy of bone resections to within 1 degree. Not having to insert an intramedullary rod also reduces the risk of fat embolism and blood loss during surgery. Over the past few years, total knee replacement has evolved into less invasive surgery with smaller instruments. Dr Marks says computer-assisted navigation can be used through these smaller incisions, ensuring more accurate bone resection and better alignment. These modifications appear to shorten recovery and time in physical therapy.

A debated issue

Whether navigated prosthesis placement can extend the longevity of an implant is one of the most debated issues with this technology, Dr Vail notes.

The literature indicates that a common cause of joint implant failure is implant misalignment.

“The idea is that navigation makes surgeons more accurate,” he says. That would decrease outliers—the occasional case where the alignment is not ideal—and therefore, increase the long-term effectiveness of the knee replacement and decrease the revision rate.

“At this point, this is speculation, because we don’t have long-term follow-up on a large group of patients. The longest follow-up we have is around 4 years.”

Notes Dr Marks, “We really are not going to know for 10 years whether knees replaced with navigation are holding up better than knees replaced with the conventional technique.”

Impact on OR time

Navigation adds OR time to a knee replacement. There is a learning curve for the surgeon using the system, but time goes down as the surgeon becomes more accomplished, says Dr Vail, who is an orthopedic surgeon at the University of California, San Francisco.

Because navigation gives surgeons the ability to check their cuts, they spend more time ensuring bone cuts and alignment are perfect. Navigation also allows them to evaluate each step of the procedure and make changes if necessary, which also takes more time. But patients may benefit later on if the possibility of a revision is less.

Dr Marks, who has used navigation for about a year, says the technology added about 45 minutes to his first case, but after about 10 cases, the extra time was down to about 15 minutes. “To add 15 minutes to a case for what potentially could be a much greater outcome, I think is well worth it,” he says.

Nurses also need additional time to bring the navigation camera and computer screen into the OR and set them up. The circulating nurse, who controls the computer and monitor screen during the case, needs to know how to push the buttons on the screen as the surgeon moves from one area to the next. Nurses attend training sessions to learn the system and how to troubleshoot it, which Dr Marks says is not difficult to learn.
Costs and reimbursement

A navigation system for joint replacement can cost from $150,000 to $300,000 and can be leased. How much navigation adds to the cost of a case depends on the volume of cases and whether the facility purchases or leases the system.

Before purchasing a system, Dr. Marks recommends that a hospital review its volume of total knee cases, figure out the cost per case, and ask whether it believes a system is worth the cost to achieve better outcomes and fewer revisions.

To date, there is no Level 1 CPT code for orthopedic computer-aided navigation and no additional reimbursement for use of navigation for Medicare patients who have total joint replacement. Dr. Marks says most insurers do not reimburse for use of the system, or if they do, it is very little.

The AAOS and specialty societies are working on getting a CPT code for orthopedic navigation.

An evolving technology

Dr. Vail says not enough is known about the technology yet to say it is ready for general use.

“Data is beginning to emerge to suggest navigation is beneficial for the surgeon and the patient,” he says. “But to translate that into general use, we’re not quite there yet for the majority of orthopedic surgeons doing knee surgery.”

He thinks the software will evolve so navigation not only will help with alignment but also with the balancing of ligaments. He thinks more surgeons will be ready to adopt navigation when they are able to pinpoint what parts of the procedure are the most important to navigate, where the computer really provides an advantage, how it benefits the patient, and whether it saves costs.

Dr. Marks says that though he and his partners had good results with the conventional technique, results are better using navigation, and they have learned a lot in the year they have been using the technology. They are now able to compare results for patients who have had one knee replaced in the conventional manner and one replaced using navigation.

Empirically, it makes sense to use computers in surgery, he adds.

“Computers have better brains than we have and can do things much better than we can with our hands. We know there are more changes in navigation technology coming. Because we are already familiar with the technology, it will be that much easier to learn.”

There is no question that computerization is the way of the future, notes Dr. Vail. “I think computer navigation will give us more and more information. Surgeons will determine which bits of information are most important and when it’s time to use navigation in their practice.”

—Judith M. Mathias, RN, MA

References


Are navigation systems cost-effective?

Computerized navigation systems make orthopedic surgery more costly. Do they also improve results? So far, the literature is mixed.

For computer-assisted total knee replacement, some reports show computer assistance allows for better alignment of the prosthesis than mechanical guides, with fewer outliers, or cases outside the acceptable range. Other reports find that for experienced surgeons, navigation systems provide no real benefit—mechanical guides and extensive experience are about equal to the computer. But on balance, more studies have found the computer reduces outliers, notes Kevin J. Bozic, MD, MBA, assistant professor of orthopedic surgery and health policy at the University of California, San Francisco.

What isn’t yet known is how computer assistance ultimately affects outcomes, such as function of the knee, pain relief, and long-term survival of the implant.

Cost-effectiveness analysis

Dr Bozic and his colleagues recently completed a cost-effectiveness study of navigation in total knee surgery. Publication is forthcoming. In the study, they used a decision model to look at:

- what the literature says about outliers and their effect on survival of implants
- what reducing outliers would mean for reducing revision rates long term
- what upfront costs could be justified for this technology.

Factoring in the fixed costs of the hardware, the variable costs of the disposables, costs of additional OR time, and the number of revisions avoided due to improved alignment associated with computer navigation, they found the threshold for achieving cost savings over the lifetime of the patient (due to avoiding future revision surgery) was an additional $650 per case.

Dr Bozic predicts that in the future, navigation will become simpler to use, less expensive, and eventually will be incorporated into most practices.