

Editorial

“In My Experience...Personalized Hip and Knee Arthroplasty”

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Keywords: personalized medicine, hip, knee, hip replacement, knee replacement

<https://doi.org/10.60118/001c.91633>

Journal of Orthopaedic Experience & Innovation

Vol. 5, Issue 1, 2024

The author shares his experience with personalized hip and knee arthroplasty.

PERSONALIZED KNEE ARTHROPLASTY

The first I heard of personalization of a knee implant was in 2004 when I was a Fellow at Brigham and Women's Hospital and a company called Conformis was started in conjunction with some of my mentors. The concept basically was why do we try and make our patients fit implants when we can make implants customized to fit the patient. It was conceived by a radiologist, Philipp Lang M.D., whose idea was to use advanced imaging to create implants for patients. After I finished fellowship, I forgot about it for a while, but I thought the concept was very intriguing.

I went about the first six years in practice performing hip and knee arthroplasty as I was trained, until I began to perform anterior approach hip replacements. When I started to do these cases, I realized how happy the hip patients were compared with the knee patients. These hip patients were coming in at two weeks out of pain, really pleased and the knee patients, a lot of them, were two to three months before they'd start to feel some pain relief. I also had this whole subset of knee patients that really never got relief or were seemingly unhappy with the result, despite everything being done right.

Over time, the literature has shown that approximately one in five patients is not satisfied after total knee arthroplasty. There are a lot of potential reasons for that. One of them is persistent pain. We've known for a long time that at least 10% to 15% of people after knee arthroplasty have residual pain that is chronic. Then there's also more subjective things, like, the knee doesn't really feel natural, it clicks, it doesn't feel right. Some knees are mildly or significantly unstable. It made me start to really wonder why this quite large group of patients is unhappy. I even thought for

a while of just becoming a hip surgeon because the results are so good. However, this customized concept intrigued me that if you made the implant fit right and shape it more like the patient's knee, that you'd have happier patients. It was a theory that I adopted in my practice early on. Now I have one of the largest experiences with personalized knee replacement and have published my mid-term outcomes.

Thinking about it, knee replacement is really a resurfacing operation. It is not like we just cut out a knee like we do with a hip. We're just resurfacing a small amount of diseased cartilage and underlying bone. What the industry has not really got right is that they've focused only on sizing and not shape. We've gone from a couple of different sizes, to where most implant companies now have a lot of different sizes, but only one shape. Of course, if the implant is not sized right, it can lead to pain, especially if it's oversized. We know that several studies have shown that just 3 millimeters of overhang can lead to chronic pain. Importantly though, from the patient's perspective, the shape is what drives the function and the feel of the knee. I always say that it is difficult to get complete success with a symmetric knee. The operation is doomed from the beginning if you start with a symmetric knee replacement because knees are asymmetric. Everyone's knee is shaped differently. Some are broad medial/lateral and some are broad anterior/posterior and some are more symmetric all around. Some have a large degree of distal femoral and/or posterior condylar offset, and some only a small amount. So there's all these different shapes of the knee and the industry doesn't really get that, they just keep making more sizes, but basically, these are symmetric shaped implants that don't come close to replicating what we're taking out. The technologies and newer concepts thusfar (eg. robotics,

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navigation, kinematic alignment etc.), although maybe a step in the right direction, hasn't really led to dramatic improvements in patient outcomes and revision rates. That's because there is only so much you can do when you're putting an implant in that doesn't really match what you're taking out. Balancing a knee is quite difficult. It is a very dynamic space that changes throughout flexion and extension and there's three parts to the joint and each one has its own individual J curve and kinematics.

I'm firmly believe that 3D planning with a customized implant is the solution to create a balanced knee and avoid many of these unsatisfied patients. We've seen now in my single surgeon published data, as well as multicenter data that's out there that the customized implants are approaching or exceeding 9 out of 10 satisfied patients. When we look at the numbers of knees being done in the U.S. alone, if you make even one out of 10 more patients satisfied, you're dealing with tens of thousands of patients happier with a customized knee..

In the early stages of use, it was a little bit of a leap of faith that made sense to me only because we weren't changing anything drastically. We weren't changing the implant material or the alignment or anything that we were doing, we were just kind of shaping and sizing the knee to fit the patient. Now we can say, after 12 solid years of doing these, the data is very supportive of the concept. Whether it's kinematic data, validating the fit and the sizing, or more importantly looking at overall patient satisfaction and even revision rates. The recent UK national registry data is showing the lowest revision rate of any knee for the customized iTotal CR knee at 10 years. Our published data is indicating that these patients' knees feel natural in the majority of cases, with 93 percent reporting a natural feeling knee all or some of the time. I believe that you're just never going to provide all patients with a natural feeling total knee if you're placing a symmetric, one-shaped implant with a limited number of sizes into an asymmetric knee that comes with an infinite number of shapes and sizes.

PERSONALIZED HIP ARTHROPLASTY

On the hip side, many may think there is no need to customize a hip because there's all these different modular parts and it's a true replacement, so a surgeon is more or less able to personalize intraoperatively. Also, hip replacements have always had a high success rate since Sir John Charnley developed the procedure. However, if surgeons evaluate their outcomes, while the hips are generally more satisfied than knees, there's still a fair amount of unhappy patients.

Most studies are still showing maybe up to 10% of patients are not happy with their hip replacement and there's definitely some unsolved issues that could be addressed with further improvement. The main one that comes to mind is leg length discrepancy. It's one of patients' greatest fears is one leg being made too short or too long. There are also more subtle things like the offset. If you create too much offset, you get these patients with chronic bursitis and lateral hip pain and if you don't have enough offset, it

could create instability. We also now know the importance of cup positioning. There's no question that if you place the cup vertically or in excessive version, you're going to have a higher rate of wear and possibly instability.

Then there is sizing of the implants. We see implant subsidence from implants being undersized and also fractures, maybe from the implants being oversized. I believe this happens because most total hip procedures are still planned in two dimensions based on x-rays done in the office. We all know if the hip is externally rotated a little bit too much or internally rotated, it dramatically changes, especially how the offset looks, but even to some degree, how the leg length looks. It's an inaccurate way that we're planning the operation, and then intraoperatively, we have very limited tools and checks and balances. With the transition of a lot of surgeons doing the anterior approach, intraoperative fluoroscopy has helped and we're now seeing some more modern technologies that can aid surgeons intraoperatively. However, there are still limitations of the implants. Modular necks tried to address this but have fallen out of favor due to corrosion issues and fractures.

Femoral neck angles and offsets vary widely and are very difficult to assess with standard radiographs. This likely leads to a lot of the errors which happen downstream intraoperatively. There are limitations in the implants provided only coming in one or two neck angles and standard and high offsets. Most doctors, they might like one or two stem geometries and they try their best to make those fit everyone, but if it's based on flawed planning, it can really lead to outlier patients. These are the patients that we really never want to have as surgeons. We don't want to have that patient who feels like, the surgeon made my leg too long or the one that shows up in the emergency room with recurrent dislocations or even that one where they feel like, their hips look asymmetric. For example in some of these petite females, they really notice if you increase their offset aesthetically or they have chronic lateral hip pain. Three dimensional planning and personalized implants on the hip side can help reduce these outliers.

SUMMARY

Eliminating outlier patients is the main reason why I'm so passionate about personalized hip and knee arthroplasty. I think we're in an era now, where our patients are really demanding. They expect, as they should, our best efforts and our best judgment of how we use technology to get them the best result. I believe this technology, more than any other out there, has the ability of giving patients what they want, which is to have as close to a natural feeling joint as possible. Having done this for so long, the only real push-back I have heard as to why is this a bad idea is cost. Manufacturing technology, however, over time, catches up and it drives cost down. I believe we're really at a turning point with this, where we are seeing improvements in 3D printing technology and this will make these personalized implants much more cost effective. As patient awareness increases, patients are going to demand an implant that's made for them.

In summary, personalized arthroplasty is all about leaving no patient behind, which is great for all involved. It is great for the patients because they are more likely to have a satisfactory outcome. It's great for the surgeons because we don't want unhappy patients. Ultimately, it's going to be great for payers and all the other parties because of lower risk of revision, which we're already starting to see the ben-

efits of in registry data. The future will likely see an integration of some of these other technologies and techniques (e.g. Robotics, alternative alignments, etc.) with personalized implants.

Submitted: December 29, 2023 EDT, Accepted: December 29, 2023 EDT



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