Archive of failed joint replacements provides tips to building a better hip replacement

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A study by Hospital for Special Surgery researchers has provided the first comprehensive look at just how metal-on-metal total hip replacements are failing in patients around the country. Made possible by what is thought to be the largest archive of failed joint replacements, the research should help doctors develop a better hip replacement for future patients. The study will be reported at the upcoming annual meeting of the American Academy of Orthopaedic Surgeons, Feb. 7-11.

"This paper is the first step in what is a path to try to understand what the problems are with metal-on-metal joints," said Timothy Wright, Ph.D., Kirby Chair of Orthopedic Biomechanics at Hospital for Special Surgery (HSS). He said that information gleaned from the study should be useful in improving metal-polyethylene implants, the most common hip implant put in patients today.

"We still use metal implants. We may rub them against polyethylene instead of against another metal, but anything we can learn about these mechanisms of damage could be important," he said. He also pointed out that evidence suggests that the physical structure of the implant might play a role in the failed metal-on-metal implants and not the metal itself. In recent years, advances in the materials have allowed implants with bigger heads to be used, which increases stability, but now evidence suggests this may cause other problems.

"What we learn about the effect of head size and learn about the effect of positioning these components, and certainly what we learn about the

biologic reaction to metallic debris is going to help us understand problems in general with total joint replacements," said Dr. Wright. "It's not enough to say, because some metal-on-metal implants have adverse reactions, it has got to be all about the metal and let's just condemn an entire technology. We need to understand, in a systematic way, what is going on."

Since 1977, whenever a patient has undergone a joint revision surgery at Hospital for Special Surgery, doctors have collected and saved the failed implants for research. At the same time, they have created a web-based system to file information on the implant, such as the manufacturer, and on the patient, such as age, weight and activity level. Doctors at HSS perform roughly 8,000 joint replacement surgeries per year and roughly 10% are revision surgeries, so this database is growing by about 800 specimens per year. Many patients who have had their joint replacement surgeries elsewhere come to Special Surgery to have revision surgery.

In the current study, HSS researchers, who did not have any ties to hip implant manufacturers, examined 46 retrieved metal-on-metal total hip replacements from 44 patients. The most common revision diagnoses were wear-related clinical concerns including osteolysis and adverse soft tissue reactions (16), loosening (11), instability (8) and infection (5). The researchers used scanning electron microscopy to determine the ways the hips were damaged, called damage modes. They found that 98 percent of the cups of the implant and 93 percent of the heads showed moderate to severe scratching. Moderate to severe pitting was found in 43 percent of the cups and 67 percent of the heads. They identified areas near the cups and heads that had completely lost their sheen.

"This study represents one of the largest collections of retrieved metal-on-metal implants," said Douglas Padgett, M.D., chief of the Adult Reconstruction and Joint Replacement Division and chief of the Hip Service at Hospital for Special Surgery. "There appears to be unique

damage patterns which to date have not been identified. A follow-on analysis using high resolution laser profiling to quantify damage is in process which may yield further clues."

The patterns and similarities of the damage modes will shed light on the mechanisms behind the damage. "The goal with these hard metal-on-metal bearings is to drag a fluid film in between the two metal surfaces so that they never touch, so the wear is theoretically zero," explained Dr. Wright. "The fact that we look at these surfaces and see scratches and wear patches means that these surfaces are touching one another. That is problematic because if you had the clearances just right, they might never touch, just like the cylinder in an engine block."

He pointed out that the study could only be done at a hospital with a large number of archived hips. Spotting patterns and variations is easier if you look across a large patient population.

Researchers will next focus on what is causing the damage patterns. If it is a corrosive problem, is the solution to change the metallurgy? If the location is always the same and the damage is always near the edge of the implant, is that because they are being installed incorrectly? Is there a way to change the design? "What we see in the retrieved implants will begin to give us a picture of what is causing this problem," Dr. Wright said.

The multidisciplinary team of HSS clinicians, biologists, engineers and imaging researchers has further studies planned to understand the problem more fully. The retrieval archive and database will allow researchers to continue to look for correlations between implants that fail and factors such as patient characteristics, the physical shape and quality of the hip replacement, surgical factors, and the biological response from a body that has an implant.

The work for this study was conducted in the recently established Mary and Fred Trump Institute for Implant Analysis.

Provided by Hospital for Special Surgery