Fixing a sticky situation

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For decades, overtightening has been blamed for the phenomenon that sometimes causes surgical screws and plates used in bone repair to irreversibly fuse together, a complication that can make subsequent removal difficult for the surgeon and traumatic for the patient. But a new study from the University of Dayton Research Institute has demonstrated that proteins naturally present in the human body, and not too much torque, are responsible for the sticking.

The results of the groundbreaking two-year study will be presented at the 2012 annual meeting of the American Osteopathic Academy of Orthopedics Oct. 25 in Silver Springs, Colo. Researchers believe the discovery will lead to improvements in the way surgical materials are manufactured, as well as fewer complications for surgeons and less trauma for patients if the hardware needs to be removed.

Metal plates and screws have long been used in bone repair, and titanium alloy is a popular choice among surgeons because of its biocompatibility, corrosion resistance and high strength-to-weight ratio, said senior research scientist Doug Hansen, who led the study at the Research Institute.

While hardware is often left in place indefinitely, there are times when it must be removed, Hansen said, if it is causing pain or other issues for the patient. Although the screws are designed to be readily removed from the plates, the parts sometimes become locked together, necessitating more complicated and risky surgery to remove them.

The prevailing belief has been that a metallurgical phenomenon known as 'galling' is causing the sticking, Hansen said. Galling occurs when titanium alloy comes into contact with the same type of titanium alloy under extreme pressure, causing the pieces to actually fuse together with a physical transfer of metal from one surface to the other.

A bioelectrochemist who has performed extensive research on the adhesive and anti-corrosive properties of shellfish proteins, Hansen suggested that human proteins might be the culprit responsible for the welding of plates and screws. "Proteins are incredibly sticky," he said.

With support from Grandview Medical Center in Dayton, which provided surgical hardware samples as well as medical technical guidance, Hansen set up tests using titanium alloy plates and screws tightened to the recommendation of the hardware manufacturer. All of the test samples were suspended in fluid; some in a fluid that included the presence of proteins, and other samples in fluid without proteins.

Hansen and his research team checked the samples regularly for signs of sticking or corrosion. At nine months, the samples with proteins present were sticking.

"We found no evidence of crossthreading and no evidence of galling or corrosion, but the screws still stuck," Hansen said. "A look at the samples under a microscope showed us exactly what we were looking for – protein bridging."

As the study continued, the researchers learned that the longer the screws remained in the plate, the greater the chance of fusion, adding that none of the samples in fluid free of proteins experienced sticking.

Vivien Fongue, D.O., an orthopedic resident in the Department of Medical Education at Grandview Medical Center, said the results of the

study are exciting.

Removing surgical hardware that has seized requires the use of a carbide drill, longer surgery and time under anesthesia, and greater risk for complications, said Fongue, who served as one of the medical technical advisors to the program.

"If we can better understand what is causing the seizing, then we can be better prepared to deal with it," said Fongue, who will present the results of the study in Colorado.. "That will also allow us to better educate and prepare our patients, and help reduce the risk of complications by shortening surgery time."

Hansen said the preliminary study was so successful that he and Fongue are pursuing additional funding to expand the study using a larger number of samples to increase the reliability of the results.

"Now that we can reproduce the problem in the lab, we have the opportunity to figure out how to fix it," Hansen said. "This information will prove very valuable to the manufacturers of medical devices. The solution may be as simple as using a different surface coating to minimize the adhesions of proteins on the metal surface."

Provided by University of Dayton