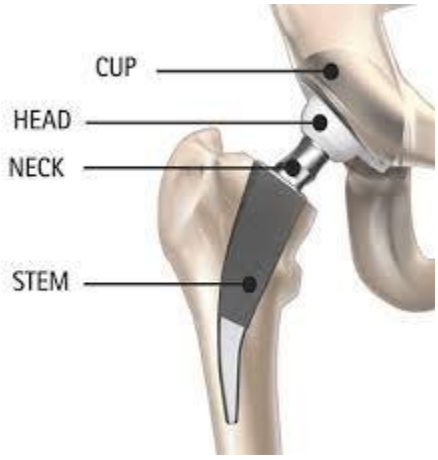
Material chemistry in hip joint implants



Since I often write about chemical subjects, I thought it would be interesting for many of our more-advanced-in-age readers to read about the chemistry of hip joint implants, a subject with which I became very familiar a few months ago.

The artificial hip joint consists of four parts: (a) the femoral stem that fits (is actually hammered) into the hollow femur (thigh bone), (b) the femural head or ball at the end of the stem, (c) the artificial liner that replaces the cartilage that was worn down and resulted in the pain as the ball bone joint rubbed against the bone cup attached to the pelvis, and (d) the artificial cup that is placed into the hip socket. All four of these components have historically been made of different materials and the technology keeps improving with time.

Material characteristics for the different parts must meet requirements relating to hardness, structural performance, integrity(i.e. minimal wear due to rubbing), corrosion resistance and chemical antipathy, as minute particles of the materials used enter the body as a result of wear. All four of the following implants have been and continue to be used.

- Metal(usually a cobalt-chrome alloy) on-plastic(polyethylene) has been used for over sixty years. An original problem of excessive wear of polyethylene has been improved through the use of ultra high molecular weight polyethylene that has been cross-linked to improve its mechanical properties.

- Metal-on-metal implants (cobalt-chromium alloy, titanium alloy) have also been in use for a long time, but wear products disseminated into the body have been an issue and the FDA issued a partial recall in 2011. Some patients had issues with metal ions entering their bodies from tiny metal particles worn off the metal surfaces.

- All-ceramic hip joints with ceramic bearings are another alternative, considered a good combination for longevity and reliability. Originally, there were a few issues of shattering and squeaking, though the former problem has now been resolved, Ceramics have the lowest wear rate and are sometimes used for very active young patients.

- Ceramic on highly cross-linked polyethylene is considered a good combination of two very reliable materials. Wear rate is less than for metal on polyethylene.

To complete the story, my surgeon used a titanium stem, a zirconium ball that was treated to have a ceramic surface, high MW polyethylene to replace the cartilage and a titanium alloy cup with traces of aluminum and vanadium. The procedure involved the so-called anterior method where the incision is closer to the front of the hip than the traditional posterior approach. I have been quite pleased with the results – was able to play golf at essentially full strength three months after the operation.

Source:http://chemengineeringposts.wordpress.com/2013/11/04/material-chemistry-in-hip-joint-implants/