Total hip replacement

Total hip joint replacement through the use of super alloys has been a medical success story, enabling hundreds of thousands of people to live fuller, more active lives. Using metal alloys, orthopaedic surgeons can replace a painful, dysfunctional joint with a highly functional, long-lasting prosthesis. Over the past half-century, there have been many advances in the design, construction, and implantation of artificial hip joints, resulting in a high percentage of successful long-term outcomes. The hip joint is called a ball-and-socket joint because the spherical head of the thighbone (femur) moves inside the cup-shaped hollow socket (acetabulum) of the pelvis.

To duplicate this action, a total hip replacement implant has three parts: the stem, which fits into the femur; the ball, which replaces the spherical head of the femur; and the cup, which replaces the worn out hip socket. Each part comes in various sizes to accommodate various body sizes and types. Cobalt/chromium-based alloys are the preferred super alloy of choice in the stem portion of hip implants in ball and stem hip joint for people needing hip replacement. The Cobalt/chromium based stem comes in different shapes and some have porous surfaces to allow for bone ingrowth. The cobalt-base superalloys have their origins in the Stellite alloys patented in the early 1900??™s by Elwood Haynes. Cobalt/chromium-based alloys have higher melting points than other alloys such as nickel (or iron) alloys. This gives them the ability to absorb stress to a higher absolute temperature.

Cobalt/chromium based alloys give superior hot corrosion resistance to gas turbine atmospheres, this is due to their high chromium content. Cobalt/chromium based alloys show superior thermal fatigue resistance and weldability over other alloys like nickel alloys for example. Cobalt/chromium-based alloys are termed austenitic in that the high temperature ??? Face Centred Cubic??? phase is stabilised at room temperature. They are hardened by carbide precipitation, thus carbon content is critical. Chromium provides hot corrosion resistance and other refractory metals are added to give solid solution strengthening ??“ tungsten and molybdenum ??“ and carbide formation ??“ tantalum, niobium, zirconium, hafnium. Processing is of course vital and whilst the above metals are helpful, others such as dissolved oxygen are not. Vacuum melting is therefore becoming the norm to give close alloy control. It is also critical that the specified compositions are adhered to, as excess of the soluble metals, W, Mo, Cr, will tend to form unwanted and deleterious phases similar to the nickel alloys.

Compared to nickel alloys, the stress rupture curve for cobalt/chromium based alloys is flatter and shows lower strength up to about 930?°C. The greater stability of the carbides, which provide strengthening of cobalt/chromium alloys, then asserts itself. The use of metals to repair and replace parts in the human body, goes back a long way. In 1775, iron wire is reported as having been used to fix a fractured bone.

It became known however that not all materials were what we would now term biocompatible. Several metals were used ??“ platinum, gold and recently nickel alloy, but it was concluded that a cobalt-chrome based alloy had the best combination of properties. Cobalt/Chromium alloys have maintained their place and one now sees composite hip joints with Cobalt/chromium balls and titanium stems.

This is also an expanding market with replacement joints being fitted more and more routinely to younger and younger people. Prosthetic devices were traditionally cast using the lost wax process but the need for higher strength and better fatigue properties led to the development of wrought versions of the alloys. The lower carbon content of these alloys resulted in improved hot workability/forgeability but lower strength than cast alloys. Thermo-mechanical forging techniques were developed that allowed the required strength of the as-forged component to be achieved. In response for the need of improved properties, alloys produced by powder metallurgy have been developed in the past few years.