Tribology, Corrosion and Tribocorrosion of Metal on Metal Hip Implants

Jorge Rituerto1, Xinming Hu 2, Anne Neville 2, Nazanin Emami1*

1 Biotribology and Biomaterials research group Department of Engineering Sciences and Mathematics, Luleå University of Technology, Luleå, Sweden
2 School of Mechanical Engineering, University of Leeds, Leeds, UK

Introduction
Total hip joint replacement is considered one of the most successful surgical interventions due its effectiveness for treatment of different diseases. Metal on polyethylene (MoP) implants have been commonly used during the last decades. However, the longevity of MoP is not higher than 12-15 years due to the biological reactions induced by polyethylene wear debris, which causes osteolysis [1]. Hard on hard joint replacements, such as metal on metal (MoM) or ceramic on ceramic (CoC), are an alternative to MoP implants, especially in the case of young patients who require a safe and long-term performance of the device. The reduction of wear particles is a key factor in order to improve the life time of the implant in the human body.

Metals have excellent properties that increase the long-term success of the artificial joint replacement. However, corrosion of the metallic implant leads to an increase of the ion levels into the urine and blood of the patient. Metallic ions may produce a host response that can induce a catastrophic failure of the implant [2].

Ion Release and biological response.
Evidences of higher ion level in patients with MoM implants in comparison with other bearing couples have been reported by different authors [3,4]. In adition, variations in head size and activity of the patient may also affect the ion levels of the patients.
The biological response to the use of MoM implants is an important factor that must be borne in mind when studying this type of prosthesis. Hypersensitivity, pseudotumours, genetic effects, are some of the causes of failure on MoM implants [5].

Tribology of MoM implants.
The study of lubrication, wear and friction in both natural and artificial joints in biological systems is known as biotribology. The importance of the lubrication is explained as well as its dependence on different factors such as the head diameter, the surface roughness, etc.
The wear mechanisms that affect the MoM implants are important in terms of material degradation and future research on this field. A better understanding of these factors may lead to more efficient research and, thus improved materials in the future.

Corrosion of MoM implants.
Biomaterials in general and metals in particular are exposed to corrosive biological environments. The metallic materials most commonly used over the years for biomedical applications are passive metals. Their corrosion resistance resides on the protective passive layer formed on their surface [6]. The stability of this layer in biological systems affects the possible release of ions and consequently the biological response to the device. The effect of proteins on the corrosion behaviour of the metals will be also reviewed.

Tribocorrosion of MoM implants.
Wear and corrosion of MoM implants are key factors that affect the release of particles and metallic ions into the body [7]. The relationship between these two factors has a great importance in order to understand the exact mechanisms of degradation of the prostheses. There are a number of studies that use different methods to simulate and study the performance of metals under wear-corrosion conditions but the exact effect of factors such as the presence of proteins is not fully understood.

Conclusion
First, the problems related with MoM implants have been reviewed in order to understand the need of further research on MoM implants. After that, the factors that control the release of degradation products are explained in order to establish the fundaments of the performance of MoM implants. A deeper understanding of the degradation mechanisms of metals in the body may lead to new ideas in future research.

References