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A Study of Wear and Frictional Behavior of Metals and Polymers in Total Hip Arthroplasty : A Review

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Abstract--Wear is recognized as the most important limitation to long term stability of Hip devices. Wear occurs when two surfaces in contact are subjected to a relative motion. The advancement in biotechnology has successfully converted the conventional bearing couples into artificial joints, however the materials used today have not been satisfactory. Problems such as osteolysis and aseptic loosening lead to failure of artificial joints. This paper will review the various ways of increasing the lifespan of the joints and improving current biomechanical understanding of failure modalities in Total Hip Arthroplasty (THA)

INTRODUCTION

Total hip arthroplasty (THA) is the treatment of choice to relieve joint pain andloss of mobility as a result of end-stage osteoarthritis or other severe hip pathologies, andis widely considered to be one of the most successful surgical inventions in all of medical history. Currently, 5lac (approximately) hip replacements are done in UK and around 2 lac (approximately) in United States, every year. Similarly more than 7 lac (approximately) knee replacements are done every year in UK and around 5 lac (approximately) in United States. In India the figure is around 30,000(approximately) total hip replacements every year and in Kashmir its 800-1000 a year, this is a figure which is expected to double in the next 20 years. Over many decades of innovation, hip replacement has seen continual advances; however, the rates of failure, measured in terms of diagnoses requiring a revision surgery, have actually increased in recent years, underscoring the need to further our understanding of THA failure mechanisms. Historically, the most common cause of failure in conventional THA has been from loosening of the implant (osteolysis) due to immunological reaction to polyethylene wear. Efforts to reduce wear have led to a recent shift their own novel failure mechanisms. However, mechanistic information regarding these failure modalities are under-investigated relative to their burden of morbidity. Therefore, the objective of this review paper is to look at the biomechanical understanding of failure mechanisms in contemporary THA.

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LITERATURE REVIEW

The total hip arthroplastic surgery was a major medical advance of the 20th century. The materials used in this medical application must possess satisfactory mechanical properties such as stiffness and fatigue strength, wear and corrosion resistance, and biocompatibility. The first metal-on-metal (MOM) total hip prostheses implanted during the1960s decade presented unsatisfactory short-term performance due to geometrical in accuracies which led to high frictional forces and increased wear [1–5]. However, in some cases the implants lasted at least for two decades without osteolysis [2, 5–7] and negligible wear [2, 8–11]. The use of second generation Co–Cr alloy metal-on-metal bearing joints in total hip arthroplasty surgery represents an attractive alternative to the traditional metal- on-polyethylene pairs [12]. Despite the tribological pair metal-on-metal has proven to be more wear resistant than metal-on-polyethylene couple, the toxicity of metallic ions of cobalt and chromium released from wear particles from metal-on-metal hip prostheses into the human body [13–16] is a concern which has motivated to look for alternatives to solve or diminish this problem. In recent years, polymer composites have been extensively used to replace metal materials in engineering applications involving wear and friction. The advantages of polymers