بسم الله الرحمن الرحيم

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A Systematic Review of the Clinical Efficacy of Oxidized Zirconium as a Bearing Surface in Hip Arthroplasty

Systematic Review

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List of Abbreviations

Abb.	Full term
ASIS	Anterior Superior Iliac Spine
AVN	Avascular necrosis
CoCr	Cobalt-chromium
HHS	Harris Hip Score
LCFA	Lateral circumflex femoral artery
MgO	Magnesium oxide
MOP	Metal-on-polyethylene
OA	Osteoarthritis
OxZi	Oxidized zirconium
PE	Polyethylene
QOL	Quality of life
THA	Total hip arthroplasty
THR	Total hip replacement
VAS	Visual analogue scale
WOMAC	Western Ontario and McMaster Universities Osteoarthritis Index
XLP	Highly cross-linked polyethylene
Y2O3	Yttrium oxide
ZTA	Zirconia-toughened alumina

INTRODUCTION

Total hip arthroplasty (THA) is one of the most successful surgical procedures in orthopaedics. It is associated with high satisfaction rates and significant improvements in quality of life following surgery. On the other hand, the main cause of late revision is osteolysis and wear, as a result of failure of bearing surfaces. Now, several options are available to the surgeon when choosing the bearing surface in THA. [1,2]

Total hip replacement (THA) is an established treatment for end stage hip arthritis providing reliable pain free function. The long-term survival of THA is multifactorial, the main modes of failure being aseptic loosening and wear induced osteolysis. This has brought about the search for alternative bearing surfaces. [3]

Total hip arthroplasty (THA) has had a dynamic process which has different bearing surfaces and bearing combination abandoned and reintroduced to be able to reach to understand and improve materials over time. The bearing surfaces generally can be grouped into two main categories: hard-on-hard and hard-on-soft surfaces. Such as metal-on-polyethylene, ceramic on-polyethylene, metal-on-metal and ceramic-on-ceramic.[4]

The ideal bearing surface for THA should have satisfactory wear characteristics and should be durable, bio-inert, cost-effective, and easy to implant. On the femoral head side, historically, cobalt-chromium and ceramic have been the materials of choice as bearing surfaces articulated with the

polyethylene liner. A relatively new, alternative type of material that combines the strength of a metal with the surface/wears properties of a ceramic is oxidized zirconium (OxZi) (Oxinium; Smith & Nephew, Memphis, TN).[5]

The thermally oxidized metal zirconium surface (zirconiumd 2.5% niobium alloy) is transformed into low-friction hard ceramic surface that is resistant to abrasion. The oxide layer is not a coating but rather the surface zone of the metal alloy, conferring bearing properties of ceramic without the fracture risk.[6]

Fretting and corrosion at the junction between the head and the trunnion of the femoral component in modular total hip arthroplasties (THAs) has recently emerged as a mechanism of failure. This may lead to clinically significant adverse local tissue reactions in both metal on-polyethylene and ceramic-on-polyethylene articulations, following on from earlier concerns with metal-on-metal bearings. [7]

The tribocorrosion seen at the head-trunnion interface is associated with mechanically assisted crevice-type corrosion. It is exacerbated when the interface is between different metals. It has been postulated that the use of inert head material such as solid ceramic head or a head made of oxidized metal might mitigate against tribocorrosion.[8]

Wear is a gross or microscopic loss of particles from the articulating surface, it is now considered as a multifactorial

process affecting the longevity of the hip joint, which can be divided into patient, implant and surgical factors. Patient factors are mainly age, weight, activity level, and special cultural demands. Implant factors consist of design and manufacturing methods, materials and bearing couples. Surgical factors include the approach, component positioning, soft-tissue balancing, third-body wear, history of dislocation and surgeon experience. [9]

A variety of characteristics contribute to the optimal performance of bearing surfaces, the most important of which are corrosion resistance, wear resistance, synoviaphilic surface, low friction and fracture toughness. Each bearing combination has its own advantages and disadvantages. [10]

Table 1: Comparison between different types of bearing surfaces combination: [11]

	Advantages	Disadvantages
Metal on polyethylene	✓ Most forgiving combination. ✓ Least expensive. ✓ Used for elderly patients with low functional demands.	✓ Highest wear ✓ Relative decrease in stability and range of motion with smaller femoral head ✓ Boundary lubrication mechanism which increases wear with bigger femoral head ✓ Backside wear
Ceramic on polyethylene	✓ Increased hardness, scratch resistance and burst strength ✓ Increased wettability for improved lubrication ✓ Lower wear rates ✓ Excellent clinical results	✓ Risk of fracture of the ceramic ✓ Higher wear rates than ceramic-on-ceramic
Metal on Metal	✓ Larger femoral heads available with increased stability, jump distance and range of motion ✓ Mixed fluid film lubrication mechanism which decreases wear with bigger femoral heads ✓ Self-polishing capacity ✓ Better wear resistance than metal-on polyethylene (low volumetric wear) ✓ Used in young patients with high functional demands	✓ Highest biological reactivity and cytotoxicity with highest number of wear particles ✓ High levels of metal ions in blood, urine and remote organs ✓ Metal sensitivity (Delayed type hypersensitivity) ✓ Possible carcinogenesis and genetic damage
Ceramic on ceramic	✓ Lowest biologic reactivity ✓ Low friction and wettability ✓ Low surface roughness ✓ Highest wear resistance ✓ Reserved for young, high functional demand patients with metal sensitivity	✓ Brittleness and possible component fractures ✓ Small femoral heads with decreased range of motion ✓ Stripe wear with possible squeaking ✓ Less forgiving combination ✓ Most expensive

AIM OF THE WORK

Our aim in this study is to evaluate efficacy of Oxide zirconium femoral head as a bearing surface in Total hip arthroplasty patients regarding clinical and radiological outcomes.

TYPES OF BEARING SURFACES OF TOTAL HIP ARTHROPLASTY

Total hip arthroplasty (THA) has been described as one of the most successful surgery of the 20th century, however implant longevity remains a limiting factor in long-term clinical outcomes. Wear debris generated from bearing surfaces has been shown to result in osteolysis and catastrophic implant failure. Interest of bearing surfaces couples with low wear rates and wear debris due to decrease age of patients who undergo total hip arthroplasty. We discuss the most current bearings for THA, including highly cross-linked polyethylene (XLP), antioxidant polyethylene (eg, vitamin E XLP), and various ceramic alloys. The longevity of conventional THA is limited by the wear of the articulating surfaces, which results in loosening, instability, or fracture from osteolysis and tissue necrosis.[12-13]

Metal on polyethylene, metal on metal, and ceramic on ceramic bearings will continue as the dominant bearing materials for total hip arthroplasty because of their excellent track record, resistance to damage, and ease of manufacture and use. Clinically, most bearing combinations consist of cobalt-chromium (CoCr) alloy or ceramic femoral heads articulating against highly cross-linked ultra-high-molecular weight polyethylene acetabular inserts. Alumina on alumina ceramic and CoCr on CoCr articulations are used in younger and more active patients. Each