Faculty of Medicine
Ain Shams University

Wear in Dual Mobility Cups in Total Hip Arthroplasty

Systematic review for partial fulfillment for the master degree in
Orthopaedic Surgery

By

Al Qassem Amin Mahmoud
M.B.B.Ch
Faculty of Medicine, Cairo University

Under Supervision of

Prof. Dr. Ayman Abdel Aziz Bassiouny
Prof. of Orthopaedic Surgery
Faculty of Medicine,
Ain Shams University

Dr. Sherif Ishak Azmy
Lecturer of Orthopaedic Surgery
Faculty of Medicine,
Ain Shams University

Faculty of Medicine,
Ain Shams University
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Contents

List of Abbreviations

DMC	:	Dual mobility cup
DXA	:	Dual-energy X-ray Absorptiometry
HXLPE	:	Highly cross-linked polyethylene
THA	:	Total hip arthroplasty
CI	:	Confidence interval
UHMWPE	:	Ultra-high molecular-weight polyethylene
MACC	:	mechanically assisted crevice corrosion
CoC	:	ceramic-on-ceramic
MoM	:	metal-on-metal
RANKL	:	Receptor activator of nuclear factor kappa-B ligand
TNF	:	Tumor necrosis factor
PE	:	Poly Ethylene

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Abstract

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Purpose: Instability following total hip arthroplasty remains a common and disabling complication. The dual mobility cup (DMC) allows a reduction in the dislocation rate. The goal of this systematic review was to assess wear of DMC and assess its use in young and active patients.

Methods: A comprehensive literature review was performed using the keywords ‘dual mobility’ and ‘wear’ with no limit regarding the year of publication. One hundred twenty two publications were identified.

Results: Current literature shows that second generation of dual mobility cup has significant low wear rate and low rate of aseptic loosening.

Conclusions: Newest generations of DMC can be used to minimize dislocation rate even in young and active patients with better quality of life.

Keywords Dislocation . Dual mobility cup . Loosening .Wear .

Revision surgery . Total hip arthroplasty

Introduction

Total hip arthroplasty (THA) is one of the most successful and cost-effective procedures in Orthopaedics. It effectively treats pain, improves function, and quality of life. (1)

The concept of dual mobility invented by Prof Bousquet in 1974 is now increasingly recognized in Europe. (2) This concept has been shown to provide high stability after revision total hip arthroplasty and to successfully address chronic instability after total hip arthroplasty. Implanting a dual-articulation acetabular cup is like using a large head; it reduces the postoperative instability. (1,3)

There were three main goals of these dual-articulation implants; to decrease wear, restore near-normal range of motion, and increase implant stability. This concept is an ingenious combination of the Charnley's low friction principle using a 22.2 mm diameter head that articulates against polyethylene to decrease wear and the McKee-Farrar theory using a large-diameter polyethylene liner that articulates against a metal shell (in the same way as a large head) to enhance implant stability.(4)

Although dual-mobility articulations are relatively new to the USA market, variations on the concept have been used clinically in Europe for more than 35 years. Bousquet developed the first model in an effort to reduce the incidence of dislocations following primary THA. His development of the dual-mobility articulation is thought to blend the advantages of several attractive design options. (1)

The dual mobility component consists of a stainless steel outer shell with a highly polished inner surface that articulates with a mobile, ultra-high molecular-weight polyethylene (UHMWPE) liner. This in turn articulates with the femoral head, which remains mobile yet ‘captured’ within the liner. (4)

The outer shell is anatomically shaped. It has superior and posterior lips as well as anterior and inferior ‘cut-outs’. The design is intended to reduce impingement with the psoas and soft tissues as well as to eliminate dislocation of the liner from the shell. The opening diameter of the polyethylene liner is smaller than that of the femoral head such that a compression instrument is required to force the head into the liner. This discrepancy prevents dislocation of the head from the liner, yet enables full movement within it. The opening of the liner is chamfered, so that a smooth articulation, when required, can take place between the neck of the femoral component and the liner (4)

The outer metal shell has a press-fit option (hydroxyapatite plasma-sprayed onto a titanium coating) as well as a cemented option. The cemented option has a grooved pattern into the stainless steel shell to aid cement prosthesis mechanical interlock. cementless acetabular component do not have the option of screw fixation as the inner surface of the shell is highly polished and articulate with the mobile polyethylene liner. [4]

The usual wear rate of metal-on-polyethylene couples is 0.1–0.2 mm/year. The only predictive factor of loosening was a wear rate higher than 0.1 mm per year. [5]

The trade off with larger femoral heads is thinner acetabular bearings. To date, there is a large body of evidence that suggests that thinner liners that are made of conventional polyethylene are associated with excessive wear rates, thereby invariably limiting implant survival. [6,7]

Measuring the wear of tripolar cups cannot be performed using the X-ray technique described by Wroblewski[8] for standard acetabular cups. This method quantifies the extent of eccentric placement of the head within the liner. In tripolar cups, the femoral head is poorly visible on standard antero-posterior views due to its deep position in the metal cup, which often is designed with a cylindrical extension onto the hemisphere. In addition, the position of the mobile liner cannot be accurately determined on plain radiography, as head eccentricity reflects the combined wear of both the inner and outer liner surface, which is difficult to distinguish on plain X-rays. As a result, due to the large diameter of the inserts in tripolar cups, volumetric wear at the interface between the liner and the cup may be substantial even with minimal linear wear, so follow up of wear the dual mobility cups has no direct method in vivo but longevity of it without complication like dislocation and aseptic loosening may give a way for follow up and assessment. (8)

Another type of liner wear that has been described is "intra-prosthetic dislocation" which has been introduced to describe excessive wear at the head-liner interface, leading to internal subluxation and an incongruent articulation between the head and the metal cup and the development of excessive metallosis.(8)

The combined wear on both the convex and concave surface in tripolar cups was comparable with conventional metal-on-polyethylene bearings. (9)

To overcome increased wear rates of dual mobility cups, highly cross-linked polyethylene liners have been introduced replacing ultra-high molecular-weight polyethylene (UHMWPE) liner in first generation of dual mobility cups. Wear rates of such implants appear to be lower than previously reported for standard polyethylene liners. Not only changes on polyethylene liners were introduced to next generations of dual mobility cups but also to mechanics , metal shell and methods of fixation trying to improve the defects of previous generation aiming to decrease wear and increase lifetime .[10, 5]