Early Complications of using Dual Mobility Cup in Total Hip Arthroplasty.

A Systematic Review

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By

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List of Contents

Title	Page No.

List of Tables

List of Figures

List of Abbreviations

Abb.	Full term
AFHC	*Approximate femoral head center*
DM	*Dual-mobility*
FDA	*Food and Drug Administration*
IPD	*Intraprosthetic dislocation*
PE	*Polyethylene*
RCTs	*Randomized control trails*
RF	*Retentive failure*
TAR	*True acetabular region*
THA	*Total hip arthroplasty*
UHMWPE	*Ultra-high molecular weight polyethylene*

INTRODUCTION

Total hip arthroplasty (THA) is considered one of the most successful surgical procedures providing pain relief and improvement of function in patients with end-stage hip arthritis that does not respond to non-operative treatments[1].

As health care continues to improve and life expectancy increases, the demand for total joint replacement will grow to reflect this more active, aging population[2].

Reducing or preventing medical and mechanical complications such as post-operative THA instability will be of paramount importance particularly in an emerging health care environment based on quality control and patient outcome. The incidence of instability after THA in the primary and revision setting has been reported as high as 7% and 25% respectively[3].

Risk factors for instability after THA are multifactorial and may be patient specific (gender, age, abductor deficiency) or related to operative variables (surgical approach, component malposition, femoral head diameter)[4].

Instability after THA remains one of the major causes of readmission and revision surgery accounting for 32.4% of THA readmissions and 22.5% of all THA revisions in the United States[5][6].

Dual mobility acetabular components (also known as unconstrained tripolar implants) have recently gained wider attention as an alternative option in the prevention and treatment of instability in both primary and revision THA and offer the benefit of increased stability without compromising clinical outcomes and implant longevity[7].

The dual mobility cup was developed by Professor Gilles Bousquet and André Rambert (engineer) in 1974 and combined the "low friction" principle of THA popularized by Charnley with the McKee-Farrar concept of using a larger diameter femoral head to enhance implant stability [7].

The dual-mobility cup is a tripolar cup with a fixed porous-coated or cemented metal cup, which articulates with a large mobile polyethylene liner. Into the latter, a standard head (usually 22 or 28 mm) is inserted.

The articulation between the head and the liner is constrained, while the articulation between the liner and the metal cup is unconstrained[8].

The original goal of the DM cup, introduced at the end of the 1970s as an alternative to standard sockets, was to reduce the risk of THA dislocation in patients undergoing primary THA. Currently, DM cups are a well-accepted treatment option for any patient at an elevated risk for instability after primary or revision THA and in the treatment of recurrent dislocation[9].

Dual mobility acetabular components are associated with some specific complications secondary to its dual articulating design. For example, intra-prosthetic dislocation or retentive failure is a complication observed exclusively with this type of implant and involves failure of the articulation between the femoral head and the PE liner[10].

Aim of the Work

This study aims to review early complications of dual mobility cup arthroplasty. The objective is to perform a systematic review of early complications of dual mobility cup arthroplasty for primary and revision cases.

REVIEW OF LITERATURE

Biomechanics of the hip joint

The biomechanics of the hip are as follows:

Surface joint movement and center of rotation:

Surface movement of the hip joint is defined as the sliding of the head of femur on the acetabulum. This is because the ball and socket pivot in three different planes around the center of rotation of the head of femur.[11]

The center of rotation of the hip joint is equivalent to the geometrical center of the femoral head. Good preoperative planning, templating and selection of used implant are needed to ensure the restoration of the hip center of rotation after total hip replacement. [11]

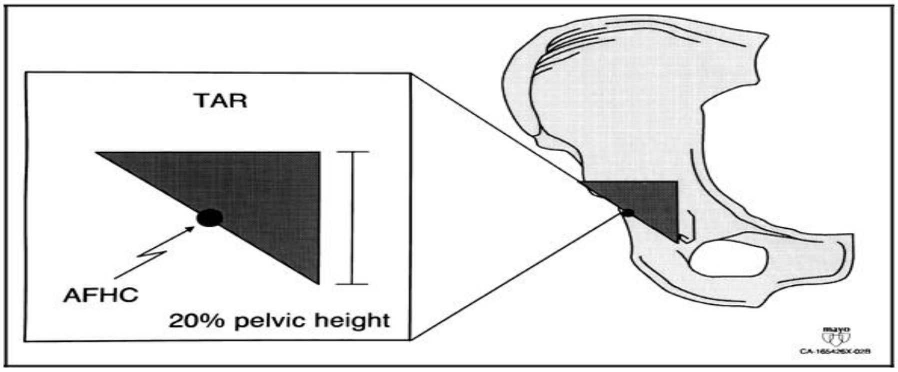

Fig. 1: This diagram shows the true acetabular region (TAR) which is the area enclosed by an isosceles triangle, where the height and width are equal to 20% of the pelvic height. The inferomedial corner of the true acetabular region is five millimeters lateral to the intersection of radiographic teardrop and the kohler line. The mid point of the triangle's hypotenuse is defined as the approximate femoral head center (AFHC) and represents the normal center of rotation of the hip joint. [11]

Anteversion:

The anteversion of both the femoral stem and the acetabular cup plus some anatomical landmarks such as the transverse acetabular ligament should help to reflect patients normal anatomy. This provides adequate range of movement before implant impingement takes place. Retroversion or decreased anteversion of the acetabular cup increases risk of dislocation, especially with posterior approach. This is caused by relative weakness of the posterior structures after surgery in addition to anterior impingement with internal rotation of the lower limb.[12]

The Offset:

It is the perpendicular distance between the neutral long axis of the femur and the center of rotation of the hip joint. Total hip replacement aims to restore the normal degree of the femoral offset, thus making this measurement valuable. The offset is affected by the hip degeneration making it is useful to measure the offset on the contralateral normal hip. It can also be affected by each of cup positioning, choice of suitable femoral stem and position of the stem. [13]

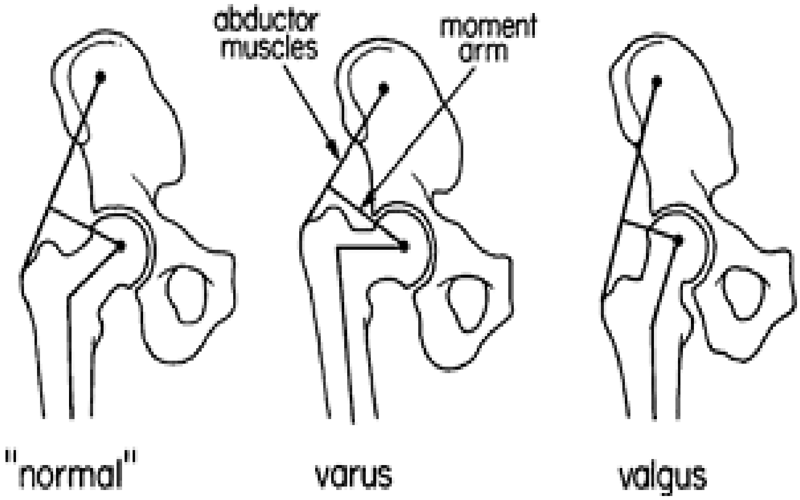

Fig. 2: Effect of changes in neck shaft angle on femoral offset. [12]

Range of motion:

The planes of motion of the hip joint are sagittal, frontal, and transverse. The largest range of motion of the hip joint occurs in the sagittal plane, where flexion ranges from 0 to 140 degrees extension ranges from 0 up to 15 degrees. In the frontal plane, abduction usually ranges from 0 to 30 degrees, while adduction is found to be less to some extent, from 0 to 15 degrees. In the transverse plane, external rotation ranges from 0 to 90 degrees and internal rotation ranges from 0 to 70 degrees, when the hip joint is flexed. Less range of rotation occurs with hip joint extension due to limitation by the soft tissue.[11]

Role of abductors:

In patients with degenerative joint disease or artificial joints it is noted that they usually try to change how they perform their daily life activities. This is considered a mechanism to adapt to a stimulus such as pain, muscle weakness, or instability. For example, during the single-leg stance phase of gait, the hip abductors contract to prevent the opposite side of the pelvis from dropping because the weight of the swinging limb and upper body is supported by the weight-bearing limb. In case of reduction in either strength or length of the abductor moment arm, patients may have a Trendelenburg gait pattern to decrease the work load on the hip abductors. [13]

Biomechanics of Dual mobility cup

The 2 different articulations found in dual-mobility designs are: one between the femoral head and the polyethylene liner, and the other at the interface between the convex surface of the polyethylene liner and the acetabular shell. [14]

The primary articulation, which is between the femoral head and the polyethylene liner, is involved during most of activities with normal range-of-movement requirements. [14]

The role of the secondary articulation, the one between the polyethylene liner and the acetabular shell, is during activities that exceed normal range of movement, when the neck of the femoral stem contacts the rim of the liner. [14]

There is a close relation between the ROM of hip implants, the prosthetic head size and head to neck ratio. By increasing the head to neck ratio, a greater ROM is achieved before impingement. By including an additional bearing, the tripolar design has a more effective head design. Therefore, it is expected to provide greater ROM before impingement than conventional implants which will improve stability in patients at risk for dislocation due to increase in jumping distance.[14]

Design of Dual mobility cup

The dual mobility cup was designed by Professor Gilles Bousquet and André Rambert (engineer) in 1974. It includes 2 concepts: the “low friction” principle of THA by Charnley and the McKee-Farrar concept which uses a femoral head of greater diameter to increase implant stability[7].

The original design (Novae-1®, Serf, Décines, France) was a 22.2 mm metallic head articulating with the acetabular shell. The shell was made of stainless steel, coated with a layer of porous plasma sprayed alumina (AL2O3) and had a cylindrical/spherical shape. The fixation system consisted of 3 items: two Morse taper pegs to impact into the ischiopubic ramus and the ischium, and a bicortical iliac screw to enhance press-fit cup fixation The liner was made from ultra-high molecular weight polyethylene (UHMWPE), gamma sterilized in air[7].