Functional Outcome of Dual Mobility Cup in Complex Primary Hip Arthroplasty - Our Experience from Developing World

Khalil Ahmed[1], Vijay Golani[2], Ausif Ali[3], Mustafa Pervez[4], Sateesh Pal[5], Imam ud Din[6], Muhammad Umer[7]

[1-4]Fellow of Arthroplasty Department of Orthopedic Surgery (IOS), Karachi
[5-6]Consultant Orthopaedic Surgeon, Department of Orthopedic Surgery Institute of orthopedic and surgery (IOS), Karachi
[7]Professor, Department of Orthopedic Surgery, Institute of Orthopedic and Surgery (IOS), Karachi

Authorship and contribution Declaration:
Each author of this article fulfilled ALL 04 Criteria of Authorship:
1. Conception and design of or acquisition of data or analysis and interpretation of data.
2. Drafting the manuscript or revising it critically for important intellectual content.
3. Final approval of the version for publication.
4. All authors agree to be responsible for all aspects of their research work

Corresponding author:
Khalil Ahmed
E-mail: dr.khalil90@yahoo.com

ABSTRACT

Introduction: Instability following total hip arthroplasty (THA) is the most common indication of revision surgery globally. It is peculiarly prevailing among high-risk patients such as those with neuromuscular disorders, failed hip fractures, and previous spinal fusion. Dual mobility cups (DMC) is the ultimate solution to reduce the risk of dislocation following THA among patients with complex deformed hip. Our aim of the study is to determine the functional outcome of DMC in the complex deformed hip.

Material & Methods: This is a single-center prospective study conducted in a renowned tertiary care hospital in Karachi, Pakistan. A total of 38 patients underwent THA with DMC for complex deformed hips. Factors analyzed were age, gender, comorbid, American Society of Anesthesiologist (ASA) score, cause of THA, risk factors of dislocation, Body mass index (BMI), surgical approach, implant characteristics (acetabular & femoral components), radiographs immediate post-operative and at final follow-up, Harris Hip Score (HHS) and complications associated with primary THA. All patients were asked to follow up in the clinic at 6 weeks, 3 months, 6 months, and annually thereafter. The minimum follow-up period was 1 year whereas the maximum follow-up period was 3 years. The primary endpoint of our study was to determine the number of patients who presented with dislocation following THA with DMC. The secondary outcome was to assess functional outcomes in patients who underwent THA for complex hips. The data were statistically analyzed using IBM SPSS version 20.0 statistics.

Results: The mean age of patients was 52.3 ± 9.2. In our study, failed hip fractures were the most common reason for performing THA with DMC. An excellent to the good functional outcome was achieved in 36 (94.7%) patients. 1 patient had atraumatic posterior dislocation at 4 weeks following surgery. A closed reduction was performed and an abduction brace was applied for 3-5 days followed by full-weight bear mobilization with a walker allowed.

Conclusion: We conclude that THA with DMC is a reasonable option to prevent dislocation among patients with complex deformed hips.

Keywords: Deformed Hip, Total Hip Replacement, Dual Mobility Cup, Functional Outcome, Harris Hip Score

This article may be cited as: Ahmed K, Golani V, Ali A, Pervez M, Pal S, Din I, Umer M. Functional Outcome of Dual Mobility Cup in Complex Primary Hip Arthroplasty - Our Experience from Developing World. J. Pak. Orthop. Assoc. 2023; Vol 35 (04): 165-171.

INTRODUCTION

Primary THA is the most effective treatment of advanced hip OA[1]. Joint replacement surgery aims to provide pain relief and restore function. THA is the most common procedure performed frequently by arthroplasty surgeons. The frequency of hip OA is

increasing with aging; hence the demand for THA is also increasing to improve the quality of life among the aging population[2]. Although THA is the most successful treatment for end-stage OA hip, complications are not even uncommon such as instability, septic or aseptic loosening, and peri-prosthetic fractures[3]. The increased prevalence of complications following primary THA significantly increases the financial burden on patients and the health care system. Therefore, reducing post-operative complications following primary THA is of paramount importance in developing nations like Pakistan, where health is not insured and patients bear all hospital expenses[4].

A primary THA is considered complex when an arthroplasty surgeon faces additional challenges beyond a routine hip replacement such as bone loss or soft tissue contractures[5]. These surgeries necessitate extensive surgical skills, specialized implants, meticulous dissection, and careful pre-operative planning to obtain good to excellent functional outcomes[6]. Hip instability remains an issue following soft tissue release to overcome deformities. The prevalence of hip instability in primary THA was found to be 7%, whereas it was 25% in revision THA[7]. The factors associated with hip instability following primary THA are gender, age, status of abductor muscles, approach, component positioning, and diameter of the femoral head[8]. DMC is specifically designed to potentially reduce the risk of hip dislocations following primary complex THA[9]. DMC reduces the rate of hip dislocations by increasing jump distance, and range of motion, optimizing soft tissue tensioning, and reducing impingement[10]. The factors take into account before considering DMC to prevent hip dislocation are activity level, hip anatomy, and surgical expertise[11].

The data regarding the functional outcomes of DMC in complex deformed hip is limited especially in developing nations like Pakistan. We hypothesized that DMC plays a vital role in preventing hip dislocations especially in complex primary hip cases. Therefore, the aim of our study is to determine the functional outcome of THA with DMC in complex deformed hip.

MATERIALS AND METHODS

A single-center prospective study was performed in a renowned tertiary care hospital in Karachi, Pakistan. From September 2020 to September 2023, a total of 41 patients with complex hip deformities underwent primary THA at our institution. The study was approved by the Ethical review committee of the hospital.

INCLUSION CRITERIA:

- ➔ Patients with a dysplastic and ankylosed hip.
- ➔ Patients with prior failed internal fixation of hip fractures, neuro-muscular disorders, deformed spine or, previous spinal fusion.
- ➔ Patients who completed a minimum of 1 year of follow-up.

EXCLUSION CRITERIA:

- ➔ Patients who failed to complete a minimum of 1 year follow-up period.
- ➔ DMC were used during revision surgery.

Factors analyzed were age, gender, comorbid, American Society of Anesthesiologist (ASA) score, reasons for performing THA, Body mass index (BMI), surgical approach, implant characteristics (acetabular & femoral components), radiographs immediate post-operative and at final follow-up, Harris Hip Score (HHS) and complications associated with primary THA. All surgeries were performed by a single arthroplasty surgeon with more than 30 years of performing primary and revision hip arthroplasty. All patients were operated under combined spinal epidural (CSE) anesthesia. A Posterior (Moore) approach with the patient in a lateral decubitus position was used. Un-cemented cups were used in all patients. The stem type (cemented/un-cemented) was determined by pre-operative templating and by assessing the proximal femur calcar-canal ratio. A G7 Zimmer Biomet acetabular system was used in all patients. Screws were used to stabilize cups in patients with a similar size of the implant as what was reamed/broached (line-to-line fit). A 28mm femoral head was commonly used followed by 32mm and 36mm heads, whereas the mean size of the acetabular cup was 52.8±3.2mm in all patients. The drain was not used in any patient. All patients received subcutaneous low-molecular-weight heparin for thrombo-prophylaxis. The patient was allowed non-weight bear mobilization with the help of a walker under strict supervision of a physiotherapist on the third postoperative day followed by full weight bear mobilization at four weeks.

FOLLOW-UP:

All patients were asked to follow up in the clinic at 6 weeks, 3 months, 6 months, and annually thereafter. The minimum follow-up period was 1 year whereas the maximum follow-up period was 3 years. Stitches were removed at 2 weeks. During follow-up visits,

standard radiographs were performed to assess osteolysis. Radiolucent lesions of ≥2mm around the prosthesis that was not present on immediate radiographs were indicative of osteolysis. The acetabular component was considered loosened when there is more than 5^0 changes in inclination or more than 2mm horizontal migration of the component on follow-up visit. Radiographs were also assessed to detect the presence of complications mainly dislocation and peri-prosthetic fractures. Functional outcome was assessed using HHS[12]. HHS was recorded at final follow-up.

The primary endpoint of our study was to determine the number of patients who presented with dislocation following THA with DMC. The secondary outcome was to assess functional outcomes in patients who underwent THA for complex deformed hips.

STATISTICAL ANALYSIS:

The data were statistically analyzed using IBM SPSS version 20.0 statistics (IBM Corp., Armonk, NY, USA). For categorical variables, values are expressed as numbers and frequencies. For continuous variables, values are expressed as mean ± standard deviation. Categorical data were statistically analyzed using the Chi-square test or Fisher's exact test. P value <0.05 was considered significant.

RESULTS

A total of 41 patients were enrolled during the study period. 3 patients were lost to follow-up before 1 year. Therefore, 38 patients were analyzed. The mean age of patients was 52.3 ± 9.2. Out of 38 patients, 15 had underlying comorbid with 23 (60.5%) had class 1 ASA, 5 (13.1%) had class 2 ASA and 10 (26.3%) had class 3 ASA. In our study, failed hip fractures were the most common reason for performing THA with DMC. The detailed demographic characteristics of study participants are presented in Table 1.

Table 1: Demographic characteristics of study participants (n=38):

VARIABLE	PARTICIPANTS (N=38)
Age (years)	52.3 ± 9.2
Gender	
- **Male**	9 (23.6%)
- **Female**	29 (76.3%)
Comorbid	
- **Hypertension**	2 (5.26%
- **Diabetes Mellitus**	1 (2.63%)
- **CLD**	1 (2.63%)
- **IHD**	3 (7.89%)
- **Ankylosing spondylitis**	5 (13.1%)
- **RA**	3 (7.89%)
BMI (Kg/m^2)	25.2±3.1
Reasons for performing THA:	
- **Ankylosing spondylitis**	5 (13.1%)
- **Neuromuscular Disorder**	4 (10.5%)
- **Spinal Disease/Fused Spine**	3 (7.89%)
- **Failed Hip Fracture (Extracapsular)**	18 (47.3%)
- **RA**	3 (7.89%)
- **Dysplastic hip**	4 (10.5%)
- **Failed Hip Fracture (Intra-capsular)**	1(2.63%)
ASA Status	
- I	23 (60.5%)
- II	5 (13.1%)
- III	10 (26.3%)

CLD- Chronic Liver Disease
IHD-Ischemic Heart Disease
RA-Rheumatoid Arthritis
Values are presented as mean ±standard deviation

Table 2: Operative data of patients who underwent THA with DMC:

VARIABLE	FREQUENCY n=38 (%)
Bearing surface	
- **Metal on Polyethylene (MOP)**	25 (65.7%)
- **Ceramic on polyethylene (COP)**	12 (31.5%)
- **Ceramic on Ceramic (COC)**	1 (2.63%)
Femoral Head Size	
- **28mm**	21 (55.2%)
- **32mm**	9 (23.6%)
- **36mm**	8 (21%)
Design	
- **Uncemented**	9 (23.6%)
- **Cemented**	5 (13.1 %)
- **Hybrid**	24 (63.1%)
Acetabular liner	
- **1st generation (Standard)**	18 (47.3%)
- **2nd generation (Elevated)**	4 (10.5%)
- **3rd generation (HXLPE)**	16 (42.1%)

Table 3: HHS of patients who underwent THA with DMC:

HHS	FREQUENCY (%)	P VALUE
Excellent	17 (44.7%)	**0.000**
Good	19 (50 %)	
Fair	2 (5.2%)	

HHS- Harris Hip Score

Table 4: Complications:

VARIABLES	FREQUENCY (%)
PJI	1 (2.63%)
DISLOCATION	1 (2.63 %)
PERI-PROSTHETIC FRACTURE	2 (5.26%)
ASEPTIC LOOSENING	-
DVT	-
HETEROTOPIC OSSIFICATION	**-**

PJI- Prosthetic Joint Infection
DVT-Deep Vein Thrombosis

The most common bearing surface used in our patients was metal on polyethylene (MOP), followed by Ceramic on Polyethylene (COP), and Ceramic on Ceramics (COC). The mean cup anteversion in our patients was 20.0±4.4. The mean cup inclination was 41.4±4.5. The mean cup size was found to be 52.8±3.2. We used 28mm femoral head in 21 (55.2%) patients followed by 32mm head in 9 (23.6%) and 36mm head in 8 (21%) patients. The operative details of patients who underwent THA with DMC are presented in Table 2. Functional outcomes were assessed using HHS. An excellent to the good functional outcome was achieved in 36 (94.7%) patients with a P value <0.05 as shown in Table 3. Out of 38 patients, 3(7.89%) patients require revision surgery as shown in Table 4. 1 patient had atraumatic posterior dislocation at 4 weeks following surgery. A closed reduction was performed and an abduction brace was applied for 3-5 days followed by full-weight bear mobilization with a walker allowed.

1 patient had prosthetic joint infection (PJI) diagnosed at 8 months following THA. Two-stage revision surgery was performed. He had a growth of MRSA during first stage for which antibiotics were given according to culture and sensitivity. Intravenous antibiotics were given for initial 5 days followed by oral antibiotics for 8 weeks. Revision surgery was performed at 3 months. No organism was isolated during second stage. 2 patients had

peri-prosthetic (Vancouver type B2) fracture for which long uncemented stem was used during revision surgery with cables.

DISCUSSION

The primary endpoint of our study was to determine the frequency of patients who presented with dislocation following THA with DMC. The secondary endpoint was to assess functional outcomes of THA with DMC in patients with complex deformed hips. In our study, only 1 (2.63%) patient sustained posterior dislocation following THA with DMC at 4 weeks which was reduced closely. A good to excellent functional outcome was observed in patients who underwent THA with DMC for a complex deformed hip. This study supported the idea that THA with DMC is a good viable option in patients who presented with complex deformed hips to prevent dislocation. To the author's best knowledge, this study is the first from a developing nation like Pakistan to determine outcomes following THA with DMC in the complex primary hip. A number of patient-specific factors associated with dislocation were analyzed initially namely neuromuscular disorders, hip dysplasia, and failed hip fractures[13,14]. The use of DMC in preventing dislocations in patients with complex deformed hips has yielded encouraging results in several studies. A case-control study was conducted to compare DMC and standard bearings in patients who were at risk of postoperative dislocation. 105 patients with DMC and 215 patients with standard bearings were operated on with a 22mm femoral head. The authors observed a significant reduction in dislocation following THA among patients with DMC. They found 0.9% dislocation rate among patients with DMC with 12.9% among controls at 10-year follow-up[15]. In another matched case-control study, authors found an increased number of dislocations among patients with standard bearing as compared to DMC THA[16]. THA with DMC is most commonly used in France. The data regarding the survivorship of DMC THA in the complex deformed hips is limited globally. However, the figures are expected to change as the American registry reported increased use of DMC in primary hip arthroplasty since 2017. The result of DMC in the European registry is promising. They compare 620 DMC THA with 2170 cemented Exeter cups containing 28mm femoral heads. The revision rate was 3.9% in patients with DMC as compared to 5.2% in the cemented Exeter group. On the other hand Dutch registry reveals a 0.2% revision rate in the DMC group versus 0.5% in the standard bearing group[17,18]. There is an increasing need to determine figures from developing nations like Pakistan where the number of complex deformed hips is significantly increasing with time.

The THA is the choice of treatment for displaced neck of femur fractures in active elderly. Following THA for a neck of femur fracture, patients are at increased risk of dislocation due to muscular insufficiency. However, despite this complication, several centers report good to excellent results following THA with DMC for displaced neck of femur fractures. Earlier, a study showed that the dislocation rate is significantly reduced in patients who underwent THA with DMC for displaced neck of femur fractures. Their study revealed that no dislocation observed in patients who underwent THA with DMC compared to 10.4% in those having standard cups[19]. Another multicenter study showed that the dislocation rate following THA with DMC was found to be 1.4% at 9 months[20]. Formerly, a study compared dislocation rate among patients who underwent hemiarthroplasty (HA) versus those who underwent THA with DMC for displaced neck of femur fractures. The dislocation rate following HA was found to be 14.6%, whereas it was 4.6% following THA with DMC[21]. In addition, THA with DMC is an excellent option in those with previous failed extracapsular hip fractures. Salvage THA with DMC in a setting of failed extracapsular hip fractures poses a significant challenge to experienced arthroplasty surgeons with a high rate of postoperative instability. Factors that are likely contribute to instability following THA in patients with failed extracapsular hip fractures include structural damage following removal of the implant, loss of osseous landmarks due to displacement of the greater trochanter, osteoporotic bone, and cognitive dysfunction[22]. Earlier authors used THA with DMC in four patients with failed extracapsular fractures and found no dislocation at 20 months of follow-up. We had 18 patients who underwent THA with DMC for failed extracapsular hip fractures and only one patient sustained dislocation at 4 weeks that was reduced closely.

Patients with neuromuscular disorders are also at high risk of instability following THA. Coxa Valga, increased femoral anteversion, and unbalanced muscular forces around the hip likely contribute to instability following THA. A 14% dislocation rate was observed in patients with cerebral palsy who underwent standard THA with a mean follow-up of 9.7 years[23]. Another study revealed no dislocation in those who underwent THA with DMC at 39 months of follow-up[24]. Spinopelvic mobility and acetabular component inclination and anteversion are the two

important factors that mainly influence stability following THA. Fixed spinopelvic alignment (spine fusion or multilevel degenerative lumbar disc disease) causes a significant increase in dislocation rate following THA. THA with DMC is a reasonable option to overcome problems associated with dislocation among patients with fixed spinopelvic alignment.

Our results must be understood in light of their flaws. A single-center retrospective study with a minimal number of patients was the main drawback of our study. A multicenter study with a large cohort of patients is required. There was no control group to determine the efficacy of DMC in preventing dislocation among patients with complex deformed hips. All patients were followed up by a single arthroplasty surgeon with vast experience in performing primary and revision hip replacement surgeries, so there was no blinded examiner.

CONCLUSION

THA is a reasonable option in patients with end-stage OA to relieve pain and restore function. The dislocation is a common reason for revision following THA in the complex deformed hips. We conclude that THA with DMC has excellent to good functional outcomes among patients with complex deformed hips with minimal risk of dislocation. DMC represents the gold standard technique in reducing dislocations among high-risk populations.

Conflict of Interest: None

Grants/Funding: None

REFERENCES

1. Hussein IH, Zalikha AK, Tuluca A, Crespi Z, El-Othmani MM. Epidemiology of obese patients undergoing revision total knee arthroplasty: understanding demographics, comorbidities, and propensity weighted analysis of inpatient outcomes. JAAOS Global Research & Reviews. 2022 Feb;6(2).
2. Kremers HM, Larson DR, Crowson CS, Kremers WK, Washington RE, Steiner CA, Jiranek WA, Berry DJ. Prevalence of total hip and knee replacement in the United States. The Journal of bone and joint surgery. American volume. 2015 Sep 9;97(17):1386.
3. Fingar KR, Stocks C, Weiss AJ, Steiner CA. Most frequent operating room procedures performed in US hospitals, 2003–2012: statistical brief# 186.
4. Iqbal F, Shafiq B, Noor SS, Ali Z, Memon N, Memon N. Economic burden of periprosthetic joint infection following primary total knee replacement in a developing country. Clinics in Orthopedic Surgery. 2020 Dec;12(4):470.
5. Vidyarthi AR, Barman R, Kisku L, Akhtar MN, Keshkar S. Total hip arthroplasty for complex primary hips–A tertiary center experience. Journal of Orthopedics, Traumatology and Rehabilitation. 2021 Jul 1;13(2):117.
6. Patel I, Nham F, Zalikha AK, El-Othmani MM. Epidemiology of total hip arthroplasty: demographics, comorbidities and outcomes. Arthroplasty. 2023 Dec;5(1):1-9.
7. Patel PD, Potts A, Froimson MI. The dislocating hip arthroplasty: prevention and treatment. The Journal of arthroplasty. 2007 Jun 1;22(4):86-90.
8. Prudhon JL, Ferreira A, Verdier R. Dual mobility cup: dislocation rate and survivorship at ten years of follow-up. International orthopaedics. 2013 Dec;37:2345-50.
9. Ko LM, Hozack WJ. The dual mobility cup: what problems does it solve?. The Bone & Joint Journal. 2016 Jan;98(1_Supple_A):60-3
10. Batailler C, Fary C, Verdier R, Aslanian T, Caton J, Lustig S. The evolution of outcomes and indications for the dual-mobility cup: a systematic review. International orthopaedics. 2017 Mar;41:645-59.
11. Combes A, Migaud H, Girard J, Duhamel A, Fessy MH. Low rate of dislocation of dual-mobility cups in primary total hip arthroplasty. Clinical Orthopaedics and Related Research®. 2013 Dec;471:3891-900.
12. Iqbal F, Uddin AA, Younus S, Zia OB, Khan N. Surgical outcomes of acute acetabular transverse fracture using ilioinguinal and Stoppa approach. Journal of Acute Disease. 2017 Nov 1;6(6):278.
13. García-Rey E, García-Cimbrelo E. Abductor biomechanics clinically impact the total hip arthroplasty dislocation rate: a prospective long-term study. The Journal of arthroplasty. 2016 Feb 1;31(2):484-90.
14. Sculco PK, Cottino U, Abdel MP, Sierra RJ. Avoiding hip instability and limb length discrepancy after total hip arthroplasty. Orthopedic Clinics. 2016 Apr 1;47(2):327-34.
15. Caton JH, Prudhon JL, Ferreira A, Aslanian T, Verdier R. A comparative and retrospective study of three hundred and twenty primary Charnley type hip replacements with a minimum follow up of ten years to assess wether a dual mobility cup has a decreased dislocation risk. International orthopaedics. 2014 Jun;38:1125-9.
16. Prudhon JL, Desmarchelier R, Hamadouche M, Delaunay C, Verdier R, SoFCOT sofoct@ info. fr. Causes for revision of dual-mobility and standard primary total hip arthroplasty: matched case–control study based on a prospective multicenter study of two thousand and forty four implants. International orthopaedics. 2017 Mar;41:455-9.
17. Tarasevicius S, Smailys A, Grigaitis K, Robertsson O, Stucinskas J. Short-term outcome after total hip arthroplasty using dual-mobility cup: report from Lithuanian Arthroplasty Register. International orthopaedics. 2017 Mar;41:595-8.
18. Bloemheuvel EM, Van Steenbergen LN, Swierstra BA. Dual mobility cups in primary total hip arthroplasties: trend over time in use, patient characteristics, and mid-term revision in 3,038 cases in the Dutch Arthroplasty Register (2007–2016). Acta orthopaedica. 2019 Jan 2;90(1):11-4.
19. Tarasevičius S, Robertsson O, Dobozinskas P, Wingstrand H. A comparison of outcomes and dislocation rates using dual articulation cups and THA for intracapsular femoral neck fractures. Hip International. 2013 Jan;23(1):22-6.
20. Adam P, Philippe R, Ehlinger M, Roche O, Bonnomet F, Molé D, Fessy MH. Dual mobility cups hip arthroplasty as a treatment for displaced fracture of the femoral neck in the elderly. A prospective, systematic, multicenter study with specific focus on postoperative dislocation. Orthopaedics & Traumatology: Surgery & Research. 2012 May 1;98(3):296-300.
21. Bensen AS, Jakobsen T, Krarup N. Dual mobility cup reduces dislocation and re-operation when used to treat displaced femoral neck fractures. International orthopaedics. 2014 Jun;38:1241-5.

22. Archibeck MJ, Carothers JT, Tripuraneni KR, White Jr RE. Total hip arthroplasty after failed internal fixation of proximal femoral fractures. The Journal of arthroplasty. 2013 Jan 1;28(1):168-71.
23. Raphael BS, Dines JS, Akerman M, Root L. Long-term followup of total hip arthroplasty in patients with cerebral palsy. Clinical Orthopaedics and Related Research®. 2010 Jul;468:1845-54.
24. Stefl M, Lundergan W, Heckmann N, McKnight B, Ike H, Murgai R, Dorr LD. Spinopelvic mobility and acetabular component position for total hip arthroplasty. The Bone & Joint Journal. 2017 Jan;99(1_Supple_A):37-45.