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Dual mobility THR: Resolving instability and providing near normal range of movement

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ABSTRACT

Background: Dislocation is a common complication of Total Hip Replacement (THR), particularly when performed in primary (indications with increased risk of instability) and in revision scenarios. Dual mobility THR (DMTHR) minimizes the risk of instability in such scenarios, however most of the evidence is from western literature. Results of DMTHR in Indian scenarios where patient want to go back to their normal routine activities of squatting and sitting cross-legged is lacking. The aim of our study was to evaluate the short to mid-term results of DMTHR for varied indications (both primary and revision) in Indian scenario. To evaluate the outcome of the DMTHR in terms of functional range of motion and the ability to go back to their pre-injury level of activity.

Methods: This is a retrospective study of 150 patients operated with DMTHR between January 2015 to February 2019 with a minimum follow-up of 12 months. Patients were evaluated clinically using Modified Harris Hip Score (HHS), Range of Motion (ROM), and Patient Reported Outcome Measures (PROM) like ability to squat and sit cross legged. Radiological evaluation was done using radiographs to assess loosening, stress shielding, osteolysis.

Results: Mean follow up in our study was 25.2 months (Range 12–46 months). Mean Modified HHS was 71.8 ± 8.11 at 6 weeks post-op and 85.8 ± 7.62 at last follow-up. HHS showed excellent outcome in 36 hips (26.7%), good outcome in 76 hips (56.7%), fair outcome in 20 hips (14.6%), poor outcome in 3 hips (2%). All our patients were allowed to squat and sit cross-legged at a mean follow-up period of 13 weeks (8 weeks–20 weeks) except 10 cases of Revision THR where patients were advised not to squat or sit cross-legged. All patients were able to resume their activities of daily living.

Conclusion: DMTHR in patients of all ages has shown a good short to midterm clinical outcome which is comparable to conventional THR. It confers the benefit of stability allowing our patients to squat and sit cross legged which is often one of the expectation and requirement of a patient undergoing THR in India. DMTHR in both primary and revision scenarios exhibit a low risk of dislocation, complications and revision surgery.

1. Introduction

Total hip arthroplasty is one of the most common orthopaedic procedure enjoying a high rate of success with patients leading a fairly comfortable life following the surgery. Primarily its design fits into the needs of the Western population, where a patient following a conventional hip replacement can manage most of his activities of daily living. In contrast, lifestyle and religious habits plays a crucial role in the lives of Asian and Middle Eastern population, requiring extreme degrees of flexion and rotation around the hip joint to allow squatting and sitting on the floor.[1]

There are high incidences of dislocation with a conventional Total Hip Replacement (THR) and instability remains one of the major complications. Early dislocations vary from 2 to 3%,[2,3] which increases in the long run, ranging from 4.8% at ten-year to 7% at 25 years follow-up.[3] Many factors affect the stability of a total hip prosthesis including surgical approach,[2] orientation of the components,[4] patient-related factors like age,[5] neurological disorders

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and most importantly, head diameter and head–neck ratio. Biomechanical studies have shown that instability can be addressed by increasing the diameter of the head.[6] Larger the head diameter, higher is the head–neck ratio and lower is the potential for instability. Many studies have reported lower instability rates with a head diameter of 28 mm and above .[7]

Dual mobility THR (DMTHR) developed by Gilles Bousquet in 1974, has shown low dislocation rates[8,9] and high range of motion[10,11] in primary as well as revision cases. Earlier, DMTHR was used for patients with short life span as there were complications such as early wear of polyethylene in 1st generation DM cups. However, recent advancements in the 2nd and 3rd generation designs like adoption of smoother and thinner necks,[12–15] and usage of highly cross-linked polyethylene appears to have improved this issue, as both in vitro tests[16,17] and early clinical data have shown good results in comparison with conventional polyethylene,[18–20] paving the way for its use in patients with various etiologies especially patients with high risk of instability like displaced fracture neck of femur, neuromuscular disorders and revision hip replacement. Most of the studies evaluating the results of DMTHR are from the western literature. However, results of DMTHR in Indian scenario where patients want to go back to their normal routine of squatting and sitting cross-legged is lacking.

The aim of the study was to evaluate the short to mid-term results of DMTHR for varied indications (both primary and revision) in Indian scenario. To evaluate the outcome of the DMTHR in terms of functional range of motion and the ability to go back to their pre-injury level of activity. We share our experience with 150 cases, where the use of DMTHR has shown great merit with distinct advantages.

2. Materials and methods

This is a retrospective study where all patients operated with DMTHR between January 2015 to February 2019 at a Tertiary Care Referral center with a minimum follow up of 12 months were included in the study. A total of 150 patients were included in the study, 115 (76.66%) were fracture neck of femur, 15 (10%) were secondary arthritis of head due to AVN, 10 (6.66%) were revision arthroplasties, 10 (6.66%) of the cases comprised of rheumatoid arthritis, ankylosing spondylitis, intertrochanteric fracture femur, excision arthroplasty and an old posterior dislocation of the hip (Table 1).

Data of 150 patients treated by DMTHR for various indications was collected by the primary investigator which included the demographic details, etiology, co-morbidities, type of approach, implant details including bearing surfaces, stem size, sizes of head/cup and the use of cement (Table 1). Evolutis Dual Mobility Cup (cemented/uncemented) and Hactiv Stem was used in all of the cases.

2.1. Surgical technique

Pre-operative templating was done with standard true-size Anteroposterior and lateral radiographs of the hip and proximal femur using a 25 mm metal ball marker, and the sizes noted down for reference. Lateral modified Hardinge approach was used in all cases except in one case of old neglected posterior dislocation of the hip, where a posterior approach was used. The osteotomized extracted head measured and the final cup size inserted was usually found to be 6–8 mm more than the final size of the extracted head. The stem was inserted and fitted with or without cement augmentation depending on bone quality. In all dual mobility cups, the cup was well seated with no overhang superiorly, and inclined according to the patient's native acetabulum so as to facilitate easy reduction at the end of the procedure.

Post-operative patients were made to walk on the same day. DVT prophylaxis in the form of Aspirin and mechanical prophylaxis as intermittent calf compression was given to all patients. At follow-up visits, patients were evaluated both clinically and radiologically at 2 weeks, 6 weeks, 3 months, 1 year and yearly thereafter.

2.2. Assessment

Harris Hip Score (HHS) was used for clinical assessment. The score is considered excellent if it is between 90 and 100, good if between 80 and 90, fair if between 70 and 80, and poor if below 70. Patient Reported Outcome Measures (PROMs) like the ability to squat, sit cross-legged or any squeaking were also noted. HHS and PROMs also tell us the satisfaction of the patient in terms of outcome following THR. Radiological evaluation was done using standard antero-posterior and lateral hip radiographs where cup inclination, cement mantle adequacy, radiolucent lines, periprosthetic osteolysis and heterotopic ossification if present was recorded.

2.3. Statistical analysis

SAS statistical software, Version 10 (SAS Institute Inc.) was used for all analyses. For descriptive analysis, continuous variables were summarized by using summary statistics i.e. a number of observations, mean and standard deviation with ranges. Categorical values were summarized by using frequencies and percentages. The changes in average Harris Hip score were estimated by student t-test. All p-values were reported based on two-sided significance test and all the statistical tests were interpreted at 5% level of significance level.

Table 1
Patient demographics and distribution of implant used.

Variable	Total Number of patients (150)
Diagnosis	No of cases
Fracture neck of femur	115 (76.66%)
Avascular Necrosis	15 (10%)
Revision arthroplasties	10 (6.66%)
Rest of cases (RA, Ankylosing Spondylitis, IT fracture, Excision arthroplasty, old post dislocation of hip)	10 (6.66%)
Gender	
Males	70 (46.73%)
Females	80 (53.26%)
Male/Female ratio	0.87
Mean Age (years/SD)	74.65 ± 11.63
Mean BMI (kg/m^2,SD)	26.24 kg/m^2
Profile of side among study cases	
Right	77 (51.3%)
Left	73 (48.7%)
Head size	
22 mm head	10 (7.60%)
28 mm head	140 (93.47%)
Femoral stem:	
Cemented	107 cases (71.7%)
Uncemented	43 cases (28.26%)
Acetabulum	
Cemented	16 cases (10.7%)
Uncemented	134 cases (89.3%)

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3. Results

150 patients were treated with DMTHR of which 15 (10%) patients died, and 135 (83.69%) patients were available for final follow-up. There were 70 (46.73%) males and 80 (53.26%) females aged between 36 and 89 years with a mean age of 74.65 ± 11.63.73 (48.91%) THR were performed for the left side and 77 (51.08%) for the right side (Table 1). Evolutis dual mobility cup was used in all of the cases, 76 (51.08%) ceramic and 74 (48.91%) metal heads were used. A 28 mm head was used in 140 (93.47%) of the 150 cases, in 10 (7.60%) of the cases a 22 mm head was used. Cementing on femoral side was done in 107 (71.73%) cases with only 43 cases (28.26%) being uncemented. Cement was used in acetabulum in 16 cases (10.66%), whereas 134 cases (90.66%) were uncemented.

Data was collected with a minimal follow up of 1 year, mean follow up in our study was 25.2 months with a maximum follow up of 46 months. The mean modified Harris Hip Score was 71.8 ± 8.11 at 6 weeks post-op and 85.8 ± 7.62 at last follow-up. HHS showed excellent outcome in 36 hips (26.7%), good outcome in 76 hips (56.7%), fair outcome in 20 hips (14.6%), poor outcome in 3 hips (2%). The mean HHS showed a statistically significant improvement of 64.5% (from 54.66 ± 6.42 pre-operatively to 89.95 ± 4.32 post operatively) (p-value: 0.001).

The mean ROM was 120 in flexion, 10 in extension, 30 in adduction, 45 in abduction, 25 in internal rotation and 25 in external rotation. All our patients were allowed to squat and sit cross-legged at a mean follow-up period of 13 weeks (8–20 weeks) except 10 cases of revision total hip arthroplasty where patients were advised not to squat or sit cross-legged. All patients were able to resume their activities of daily living. Mean cup inclination on Anteroposterior view was 42.21 ± 5.27° and radiological follow-up at last follow-up did not show any signs of loosening, radiolucent lines or heterotrophic ossification.

There were 3 (3.26%) complications seen of which one patient had a loosening and failure of cemented acetabular cup 2 months after surgery due to faulty cementing technique, following which the cup was revised (Figs. 1 and 2). One patient had wound discharge at 3 weeks post-op, which resolved after open debridement and wound lavage. There was one case of intra-operative periprosthetic fracture of the femur where internal fixation of the fracture was done with a locking plate (Fig. 3). All these patients recovered well and had a good outcome.

4. Discussion

The unanswered question in THR is the stability of normal implant articulation along with a safe physiological range of movement. A wide range of options in THR are available to suit specific patient demands, but each have their own advantages and disadvantages. Religious and lifestyle habits of Indian population play an important factor in choosing the mode of surgery and implant. Sitting on the floor and squatting following a THR requires a joint which can allow more flexion and external rotation of the hip without any risk of dislocation.

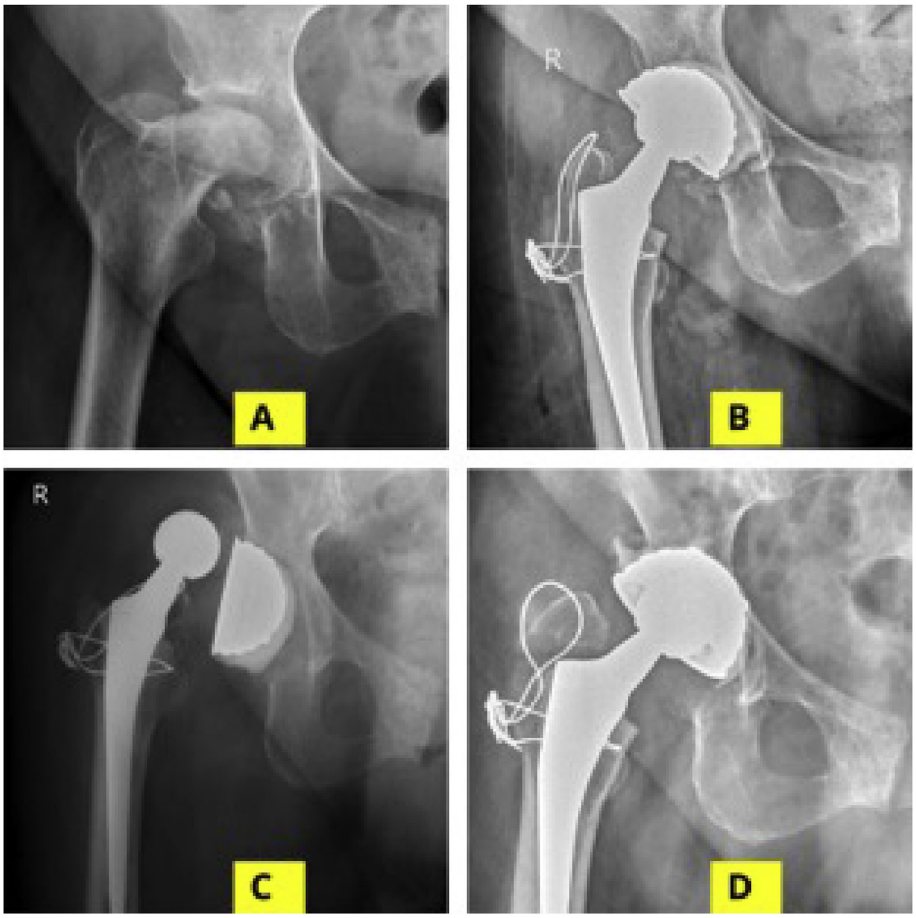

Fig. 1. (A) Anteroposterior radiograph of 88 years female showing Right hip AVN with secondary arthritis with collapsed head; (B) Immediate postoperative radiograph showing Right hip dual mobility cemented THR; (C) Loosening and failure of cemented acetabular cup 2 months after surgery; (D) Revision with cemented dual mobility acetabular cup with retention of femoral stem was performed.

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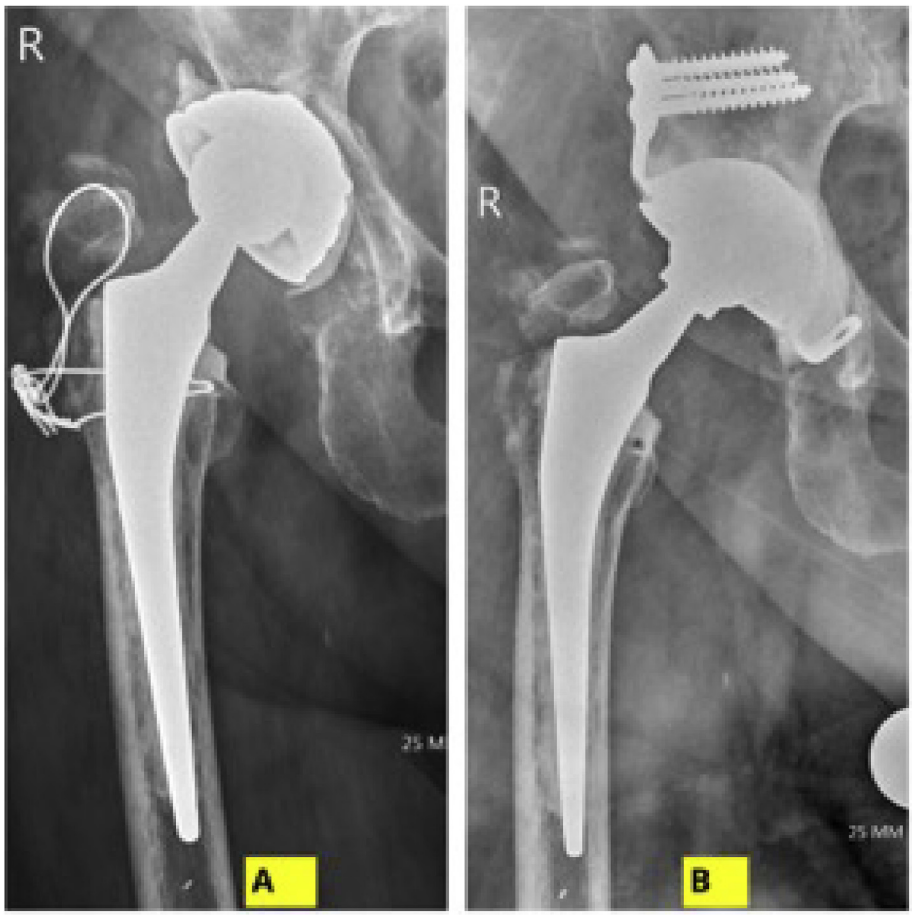

Fig. 2. (A) Anteroposterior radiograph of the patient in Fig. 1 showing revised acetabular cup loosening at 1 year; (B) Revision of right acetabular cup with anti-protrusio cage with dual mobility cup.

There are a subset of patients who are at increased risk of dislocation following a conventional total hip arthroplasty. Elderly patients with fracture neck of femur, patients with neuromuscular disorder (epilepsy, cerebral palsy, poliomyelitis, Parkinson and myopathy) cognitive dysfunction (dementia, alzheimer and alcoholic) and revision surgery cases are at increased risk of dislocation.[3] Options available to tackle the instability includes bipolar hemiarthroplasty, DMTHR or constrained hips. Bipolar hemiarthroplasty has chances of dislocation of poly liner and acetabular erosion, which may require conversion to THR.[21] THR provides a better functional outcome than bipolar Hemiarthroplasty.[21] Constrained hips restrict range of motion and lead to abnormal stresses on the cup-bone interface causing early loosening.

The DMTHR attempts to lower the risk of instability by giving a wide range of motion with a favourable femoral head-to-neck ratio and using two articulations. Most movements are provided by the inner head, but in terminal motion the neck abuts with the outer polyethylene head causing it to move at the acetabular articulation. The jump distance increases, which in turn gives further stability and increased range of motion along with a decreased incidence of impingement[22,23]

These biomechanical advantages come along with complications associated with the implant design such as intra-prosthetic dislocation. Studies have showed that the chances of intra-prosthetic dislocation decreased significantly when femoral head size of 28 mm or larger were used.[24] The overall incidence of any type of prosthetic dislocation in dual mobility THA (1.9%) is less than that of conventional THA (3.9%).[25] Intra-prosthetic dislocations is irreducible by closed means and requires open reduction.[26] Other complications seen with Dual mobility articulation are cup loosening, dislocation, accelerated wear, Iliopsoas impingement due to cup design or large femoral head and infection.[27] It was thought that DMTHR will have more wear due to the presence of two articulating surfaces and friction with Polyethylene (PE) convexity, but recent analysis have not shown any increase in the wear rate as compared to metal or conventional PE bearings.[27,28]

Boyer et al.[29] did a retrospective study on Primary THR with dual mobility cup for 240 primary THR, There was no dislocation at mean follow up of 22 years which demonstrates excellent implant stability. But this is the original designer series, where this implant has shown its efficacy in providing stability and excellent long term survivorship. The question remains is that whether other surgeons can replicate such results too?

Zogorov et al.[30] assessed dislocation rate after THR with Dual mobility cup and dislocation with conventional THR and Bipolar Hemiarthroplasty for displaced femoral neck fractures and concluded that DMTHR had significantly reduce dislocation rate as compared to conventional THR and Hemiarthroplasty. In a retrospective study on DMTHR in neck femur fractures by Gianluca et al.[31] there was no case of hip dislocation reported at mean follow-up of 5.67 years. In our study out of 115 patient who were operated for fracture neck femur with DMTHR, there was no dislocation seen in any of the patients. All the patients were allowed to squat or sit cross-legged and were able to go back to their pre-injury activity levels.

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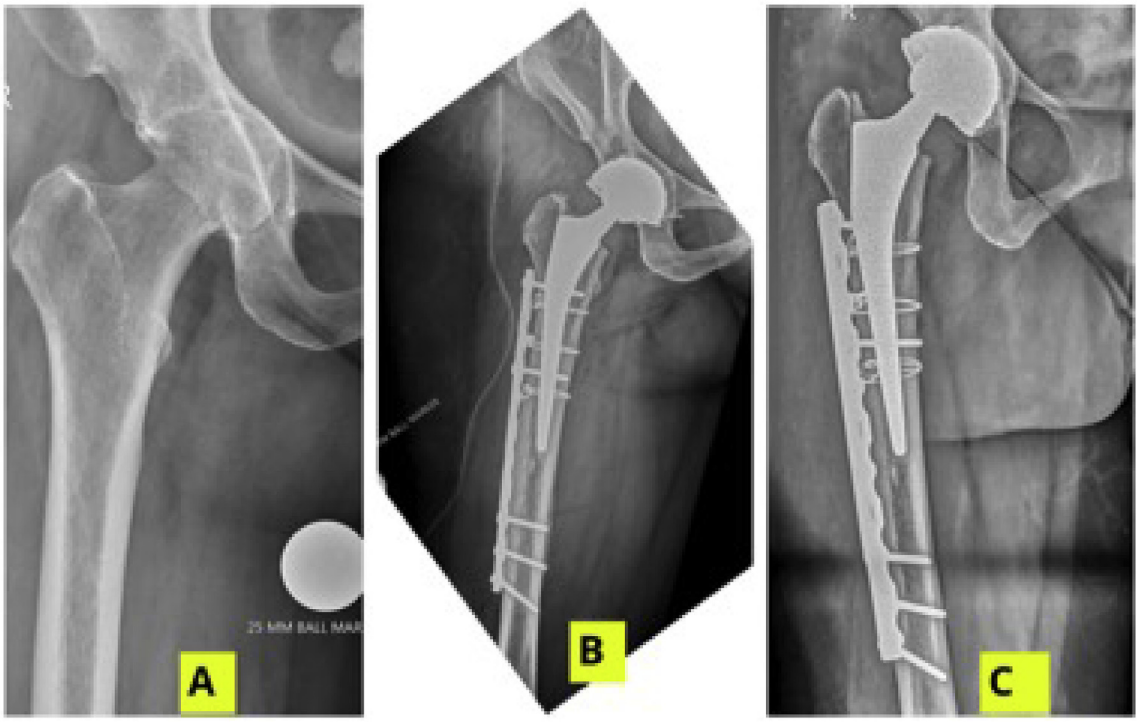

Fig. 3. (A) Antero-posterior radiograph of a 56 year old female patient with secondary osteoarthritis of the right hip; (B) Right cemented dual mobility THR with plating for intra-operative periprosthetic femur fracture was done; (C) Follow up radiograph at 15 months.

Wackenheim F et al.[32] evaluated recurrent THR Dislocation using a Dual mobility cup in 59 revision THR, There was only one dislocation at mean follow up of 8 years. In 74 cases of revision THR managed with Dual Mobility THR, the authors have reported only one case of dislocation at mean follow up of 5 years.[33] These studies show the advantage of DMTHR in managing instability in revision scenarios. In our study, 10 patients were operated for revision arthroplasty and all patient had excellent results. No dislocation was seen in our study in revision scenario. In a systemic review by Darrith et al.[34] on the outcomes of dual mobility components in 10,783 primary and 3008 revision the rate of dislocation in primary as well as revision THR was approximately 2%.

Although DMTHR confers great benefit in managing instability associated with primary as well as revision scenarios, but the survivorship of this implant has always been debatable with many authors believing that the implant would have shorter survivorship as compared to conventional THR. Boyer et al.[29] in his study on DMTHR in primary THR with a 22-year follow-up had shown survival rate of 74%, but this is a designer series. Although, other studies have also shown excellent mid to long term survivorship with this implant. Darrith et al.[34] in a systemic review of the literature on outcomes of dual mobility components in total hip Arthroplasty showed the survivorship in primary THR was 98% at a mean of 1.3 years and in Revision THR the survivorship was 96.6% at a mean of 5.4 year. Although, initial concerns regarding the dual mobility cups like accerelared PE wear rate or intra-prosthetic dislocation were commonly reported with first generation designs. Studies with newer generation designs have resolved these issues, still there is paucity of literature about the long term survivorship of this implant, therefore, the indications and use of Dual mobility should still be viewed with caution.

This study has certain limitations of being a retrospective study with a short to mid-term follow-up. However, literature is lacking about the results of DMTHR in Indian patients where the routine and cultural practices requires a higher degree of range of motion. To the best of our knowledge, this is the largest study on the use of DMTHR in primary and revision scenario conducted in Indian patients.

5. Conclusion

The use of DMTHR has shown a good short to mid-term clinical outcome which is comparable to conventional THR. It confers the benefit of stability allowing our patients to squat and sit cross legged which is often one of the expectation and requirement of a patient undergoing THR in India. This study indicates that use of DMTHR in both primary and revision scenarios exhibit a low risk of dislocation, complications and revision surgery.

Disclosure

No conflict of interest to be disclosed.

Declaration of competing interest

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None.

References

1. Agarwala S, Vijayvargiya M, Chaudhari S. Restoring natural hip movements with large head (ceramic on ceramic) total hip replacement: experience of our 150 patients over 6 years. Open Journal of Orthopaedics 07(12):414-427.

2. Berry DJ, von Knoch M, Schleck CD, Harmsen WS. The cumulative long-term risk of dislocation after primary Charnley total hip arthroplasty. *J Bone Joint Surg Am*. 2004;86-A:9–14.
3. Woo RY, Morrey BF. Dislocations after total hip arthroplasty. *J Bone Joint Surg Am*. 1982;64:1295–1306.
4. Goergen TG, Resnick D. Evaluation of acetabular anteversion following total hip arthroplasty: necessity of proper centring. *Br J Radiol*. 1975;48:259–260.
5. Levy RN, Levy CM, Snyder J, Digiovanni J. Outcome and long-term results following total hip replacement in elderly patients. *Clin Orthop Relat Res*. 1995: 25–30.
6. Burroughs BR, Rubash HE, Harris WH. Femoral head sizes larger than 32 mm against highly cross-linked polyethylene. *Clin Orthop Relat Res*. 2002:150–157.
7. Kelley SS, Lachiewicz PF, Hickman JM, Paterno SM. Relationship of femoral head and acetabular size to the prevalence of dislocation. *Clin Orthop Relat Res*. 1998:163–170.
8. Berry DJ, Harmsen WS, Cabanela ME, Morrey BF. Twenty-five-year survivorship of two thousand consecutive primary Charnley total hip replacements. *J Bone Joint Surg Am*. 2002 Feb;84-A(2):171–177.
9. Boyer B, Philippot R, Geringer J, Farizon F. Primary total hip arthroplasty with dual mobility socket to prevent dislocation: a 22- year follow-up of 240 hips. *Int Orthop*. 2011;36:511–518.
10. 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 whether a dual mobility cup has a decreased dislocation risk. *Int Orthop*. 2014;38:1125–1129.
11. Lachiewicz PF, Watters TS. The use of dual-mobility components in total hip arthroplasty. *J Am Acad Orthop Surg*. 2012;20:481–486.
12. Philippot R, Farizon F, Camilleri JP, et al. Survival of cementless dual mobility socket with a mean 17 years follow-up. *Rev Chir Orthop Raparatrice Appar Mot*. 2008;94(8):e23.
13. Vielpeau C, Lebel B, Ardouin L, Burdin G, Lautridou C. The dual mobility socket concept : experience with 668 cases. *Int Orthop*. 2011;35:225–230.
14. 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 whether a dual mobility cup has a decreased dislocation risk. *Int Orthop*. 2014;38(6): 1125–1129.
15. Prudhon J-L, Ferreira A, Verdier R. Dual mobility cup: dislocation rate and survivorship at ten years of follow-up. *Int Orthop*. 2013;37(12):2345–2350.
16. Leclercq S, Benoit J, De Rosa J, Tallier E, Leteurtre C, Girardin P. Evora® chromium–cobalt dual mobility socket: results at a minimum 10-years' follow-up. *Orthop Traumatol Surg Res*. 2013;99(8):923–928.
17. Loving L, Lee RK, Herrera L, Essner AP, Nevelos JE. Wear performance evaluation of a contemporary dual mobility hip bearing using multiple hip simulator testing conditions. *J Arthroplasty*. 2013;28(6):1041–1046.
18. Loving L, Herrera L, Banerjee S, et al. Dual mobility bearings withstand loading from steeper cup-inclinations without substantial wear. *J Orthop Res*. 2015;33(3):398–404.
19. Vigdorchik JM, D'Apuzzo MR, Markel DC, et al. Lack of early dislocation following total hip arthroplasty with a new dual mobility acetabular design. *Hip Int*. 2015;25(1):34–38.
20. Epinette JA. Clinical outcomes, survivorship and adverse events with mobile-bearings versus fixed-bearings in hip arthroplasty-A prospective comparative cohort study of 143 ADM versus 130 trident cups at 2 to 6-year follow-Up. *J Arthroplasty*. 2015;30(2):241–248.
21. Marya SKS, Thukral R, Singh C. Prosthetic replacement in femoral neck fracture in the elderly: results and review of the literature. *Indian J Orthop*. 2008;42(1): 61–67.
22. McKee GKW-FJ, Watson-Farrar J. Replacement of arthritic hips by the McKee-Farrar prosthesis. *J Bone Joint Surg [Br]*. 1966;48-B:245–259.
23. Charnley J. The long-term results of low-friction arthroplasty of the hip performed as a primary intervention. *J Bone Joint Surg [Br]*. 1972;54-B:61–76.
24. Bouchet R, Mercier N, Saragaglia D. Posterior approach and dislocation rate: a 213 total hip replacements case-control study comparing the dual mobility cup with a conventional 28-mm metal head/polyethylene prosthesis. *Orthop Traumatol Surg Res*. 2011;97:2–7.
25. Malkani AL, Ong KL, Lau E, et al. Early- and late-term dislocation risk after primary hip arthroplasty in the Medicare population. *J Arthroplasty*. 2010;25(suppl):21–25.
26. De Martino Ivan, D'Apolito Rocco, Bradford S, Waddell, Alexander S, McLawhorn, Peter K, Sculco, Thomas P, Sculco. Early intraprosthetic dislocation in dual-mobility implants: a systematic review. *Arthroplast Today*. 2017 Sep;3(3): 197–202.
27. Hernigou P, Dubory A, Potage D, Roubineau F, Flouzat Lachaniette CH. Dual-mobility arthroplasty failure: a rationale review of causes and technical considerations for revision. *Int Orthop*. 2017;41(3):481–490. https://doi.org/10.1007/s00264-016-3328-7.
28. Philippot R, Meucci JF, Boyer B, Farizon F. Modern dual mobility cup implanted with an uncemented stem: about 100 cases with 12-year follow-up. *Surg Technol Int*. 2013;23:208–212.
29. Boyer Bertrand, Philippot Rémi, Geringer Jean, Farizon Frédéric. Primary total hip arthroplasty with dual mobility socket to prevent dislocation: a 22-year follow-up of 240 hips International Orthopaedics. *(SICOT)*. 2012;36: 511–518.
30. Zagorov M, Mihov K, Dobrilov S, Tabakov A, Gospodinov A, Nenova G. Dual mobility cups reduce dislocation rate in total hip arthroplasty for displaced femoral neck fractures. *J of IMAB*. 2018 Apr-Jun;24(2):2077–2081.
31. Gianluca Canton, Alessandro Moghnie, Mirco Cleva, Kostoris Francesco M, Luigi Murena. Dual mobility total hip arthroplasty in the treatment of femoral neck fractures: a retrospective evaluation at mid-term follow-up. *Acta Biomed*. 2019;90(Suppl 1):98–103.
32. Leiber-Wackenheim F, Brunschweiler B, Ehlinger M, Gabrion A, Mertl P. Treatment of recurrent THR dislocation using of a cementless dual-mobility cup: a 59 cases series with a mean 8 years' follow-up. *Orthop Traumatol Surg Res*. 2011;97(1):8–13.
33. Simian E, Chatellard R, Druon J, Berhouet J, Rosset P. Dual mobility cup in revision total hip arthroplasty: dislocation rate and survival after 5 years Orthopaedics & Traumatology. *Surgery & Research*. 2015;101:577–581.
34. B. Darrith, P. M. Courtney, C. J. Della Valle, Outcomes of dual mobility components in total hip arthroplasty
A systematic review of the literature 2018, The British Editorial Society of Bone & Joint Surgery. BJJ-2017-0462.R1.

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