RESEARCH ARTICLE

Dual Mobility Cup in Fractures of the Femoral Neck in Neuromuscular Disorders and Cognitive Dysfunction Patients above 60 years-old

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Abstract

Objectives: Dislocation rate of total hip arthroplasty (THA) can be as high as 20% for patients with fracture neck of femur, which is a disastrous complication in these vulnerable patients. Numerous techniques, including bipolar arthroplasty and constrained liner, have been adopted to minimize the risk of dislocation. We aimed to evaluate the role of dual mobility Cups in treating patients with fractures of the femoral neck with high risk of postoperative dislocation due to neuromuscular instability disorders.

Methods: A prospective cohort study was conducted (place is blinded as asked during submission), between 2016 and 2019, with a post-operative follow up period of two years. We included skeletally mature patients with femoral neck fractures having neuromuscular disorders and cognitive dysfunction who are candidates for THA above 60 years. Patients were then followed up clinically and radiographically at the clinic using Harris Hip Score (HHS) and x-rays at six weeks, six months, one year and two years postoperatively.

Results: Twenty patients (20 hips) with femoral neck fractures with high risk of postoperative dislocation due to neuromuscular instability disorders undergoing dual mobility cup were included. The mean age of patients was 70.5 ±6.42 years. There is highly significant difference between HHS preoperatively and postoperatively (six weeks, six months and one, two years) $p<0.001$.Infection occurred in one case (5 %), sciatic nerve injury occurred in one case (5%), and none of the patients had postoperative dislocation.

Conclusion: Dual mobility cup is effective in preventing early dislocation in patients suffered from fracture neck of femur with muscle weakness due to neurologic disorders.

Level of evidence: IV

Keywords: Dual mobility cup, Fracture neck femur, Neuromuscular instability disorders, Total hip arthroplasty

Introduction

Femoral neck fractures (FNF) have been challenging for orthopedic surgeons.[1] They are a leading cause of death and disability among the elderly.[2,3] A large proportion of FNF patients meet the requirements to have a THA. Dislocation rate of THA is 20% for patients with FNF. Early recurrent dislocation may lead to revision surgery and is associated with a high risk of complications.[4]

Risk factors for instability after THA include patient-specific (gender, age, abductor deficiency), operative factors (surgical approach, component malposition, femoral head diameter), and wide range of motion.[5,6] FNF patients are at higher risk for prosthetic dislocation compared to hip arthritis patients, because of a combination of muscular insufficiency, cognitive and neurologic disorders and recurrent falls that characterize this population of patients.[7]

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Conversion to a bipolar arthroplasty and a constrained liner as salvage procedures for recurrent instability has reduced the functional outcome and implant longevity.[8] Dual mobility acetabular components have recently gained wider attention as an alternative option in the prevention and treatment of instability in both primary and revision THA.[9]

The dual mobility implant keeps small head stemming from the Charnley's hip prosthesis to have minor wear and tear, but an added UHMWPE insert acts as a big femoral ball and allows a wider range of motion. The femoral head slides against the inner surface and the outer surface slides against the metallic shell.[10] Dual mobility cup offers increased stability without compromising clinical outcomes and implant longevity.[11] we aim to evaluate the role of dual mobility cup in patients with femoral neck fractures with high risk of postoperative dislocation.

Materials and Methods

Study design and setting

This prospective cohort study was conducted at (place is blinded as asked during submission), between 2016 and 2019, with a post-operative follow up period of two years. We reviewed medical records of 20 patients with femoral neck fractures with high risk of postoperative dislocation due to neuromuscular disorders and cognitive dysfunction underwent dual mobility cup THA.

Inclusion and exclusion criteria

We included skeletally mature patients, above 60 years, with femoral neck fractures having neuromuscular disorders and cognitive dysfunction that are undergoing THA. Moreover, we excluded skeletally immaturity patients, those with active infection or potential source of infection that could affect follow-up care or treatment outcome.

Postoperative follow-up

Patients were then followed up clinically and radiographically for two years postoperatively at the clinic using Harris Hip Score (HHS) and x-rays. Walking was started on the first postoperative day in patients with cemented stem prosthesis while patients with cement less stem prosthesis received indications to limit the load on the affected limb for three weeks. One Patient with intra-operative fracture femur around the stem, fixed by cerclage, was informed to non-weight bearing for six weeks. Weight bearing, as tolerated, is allowed using walking aids for balance.HHS was recorded preoperatively, at six weeks, six months, one year and two years postoperatively. At each follow-up visit, the patients were assessed clinically and radiographically by anteroposterior (AP) view.

Surgical technique

Lateral approach was used in all cases.

The true acetabulum was identified by following the ligamentum teres; the acetabulum was then prepared in the standard manner, then a trial cup is applied to test fitting of the cup and adequate coverage, then cup was applied. 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. 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. Zimmer Biomet Dual Mobility Hip System was used.

Femoral side preparation was then started with a cancellous bone impactor followed by a small broach. The broach size was increased gradually until reaching a broach size that was rotationally stable and does not subside with hammering. Trial of reduction was done. After ensuring good orientation, the femoral broach was removed and the actual stem was inserted. After ensuring proper orientation and determining the length of the head needed, the actual head applied and reduction was done.

Statistical analysis

Statistical analysis was done through SPSS version16.0. Descriptive statistics were presented with mean or percentage according to type of data. We used non-parametric Wilcaxon signed rank test for non-categorical variables. P value <0.05 was considered statistically significant.

Results

The mean age of patients was 70.5 ±6.42years. Thirteen patients were males. Other descriptive data including neuromuscular comorbidities, Garden's classification, and type of prosthesis are shown in [Table 1].

Table 1. Demographic data distribution of the study group

		Mean±SD	N	Percentage
Age		70.5±6.42		
Gender	Male		13	65%
	Female		7	35%
Neuromuscular comorbidities	Stroke, Hemiparesis		5	25%
	Alzeheimer,Parkinsonism		4	20%
	Epilepsy		3	15%

Table 1. Continued

	Advanced senile dementia		3	15%
	Psychic Depression		3	15%
	Old poliomyelitis		1	5%
	ICHge, Hemiparesis		1	5%
Garden's classification	II	3.100±0.718	4	20%
	III		10	50%
	IV		6	30%
Trochanteric extension	Yes		6	30%
	No		14	70%
arthritis	Yes		16	80%
	No		4	20%
Type of prosethesis	Cemented		13	65%
	Cementless		4	20%
	Reverse hybrid		3	15%
Operative time		1.55±0.500		
Blood loss		830±275.06		

ICHge: intracranial Hemorrage.

Radiological Results

Immediate postoperative and follow up X-ray:

Acetabular inclination was determined in relation to the inter teardrop line. We measure the anteversion of the cup on a cross-table view. The acetabular bony metal shell of cup coverage was adequate in (80%) and not adequate in (20%). Hip centre was restored in (95%) and near anatomical site in (5%). Acetabular inclination in all patients was 44.000±3.839 (mean±SD). [Fig 1a, 1b], [Fig 2a, 2b], [Fig 3a, 3b].Follow up radiographs were examined for Component position or migration, presence of heterotropic ossification or delayed union of fixed trochanteric extension. None of these complications were encountered till the last follow up.

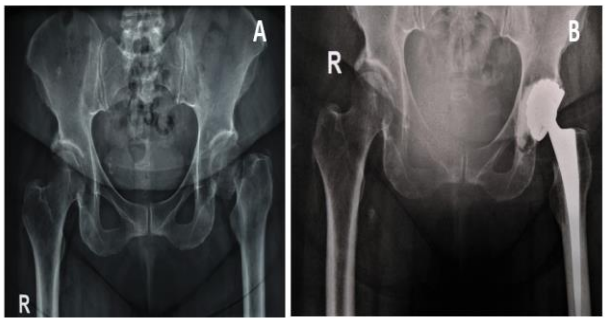

Figure 1. (1A): Pre-operative X-Ray of a 65 years Female, Hypertensive, Stroke, Hemiparesis had Fracture neck of left Femur with Osteoarthritic hip (1B): Post-operative X-Ray of the patient after Cemented Dual Mobility THA

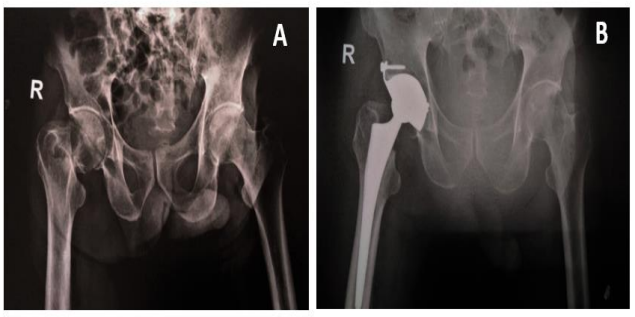

Figure 2. (2A): Pre-operative X-Ray of a 70 years Male, Hypertensive, Diabetic, Psychic Depression, had Fracture neck of right Femur with Osteoarthritic hip and neglected (2B): Post-operative X-Rayof the Dual Mobility THApatient after Cementless

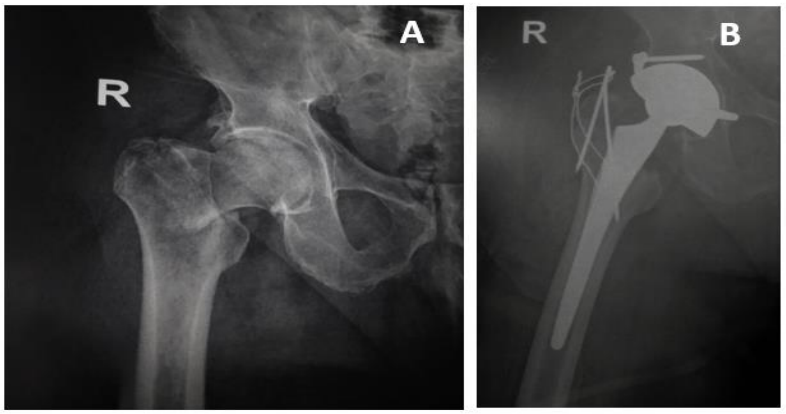

Figure 3. (3A): Pre-operative X-Ray of a 70 years Male, Hypertensive, Diabetic, Advanced Senile Dementia had Fracture neck of right Femur with Trochanteric Extension and Osteoarthritic hip (3B): Post-operative X-Ray of the patient after Cementless Dual Mobility THA with Trochanteric Reconstruction by Tension Band technique

Harris hip score

Tables 2, 3 show the HHS during preoperative and postoperative periods of follow-up. There is highly significant difference between HHS preoperatively and postoperatively (six weeks, six months and one, two years) P<0.001. No significant difference in HHS during one year and two years postoperatively [Table 2, 3].

Table 2. Comparison between pre and postoperative Harris hip score after 6 weeks, 6 months, 1 year and 2 years of follow-up

Time	HHS					COMP	Paired Differences		Wilcaxon signed rank test	
	Range			Mean	± SD		Mean	SD	Z	P-value
HHS Pre	15	-	40	25.700	± 6.634					
HHS Post 6 Weeks	45	-	80	61.250	± 8.391	**P-P6W**	-35.550	7.633	-3.927	<0.001*
HHS Post 6 Months	80	-	98	89.150	± 4.694	**P-P6M**	-63.450	8.114	-3.923	<0.001*
HHS Post 1Year	88	-	99	94.000	± 3.685	**P-P1Y**	-68.300	7.726	-3.923	<0.001*
HHS Post 2 Years	92	-	99	97.200	± 1.795	**P-P2Y**	-71.500	7.207	-3.923	<0.001*

HHS: Harrison Hip Score

Table 3. Age, Sex, Preoperative Diagnosis, Medical Condition, Risk factors of Dislocation and Harris Hip Score

No	Age	Sex	Preoperative Diagnosis Medical Condition	Risk Factors of Dislocation	Pre HHS	Post HHS 2 years
1	72	Female	Fracture neck of femur, Garden's IV.	ICHge, Hemiparesis, Trochanteric extension	20	99
2	66	Male	Fracture neck of femur, Garden's IV, Diabetes Mellitus, Hypertension, HCV.	Alzheimer, Parkinsonism, Arthritis	25	98
3	68	Male	Fracture neck of femur, Garden's III, Hypertension, HCV, Nephropathy.	Epilepsy, Arthritis	30	95
4	85	Male	Fracture neck of femur, Garden's II, Hypertension, IHD.	Advanced senile dementia, Trochanteric extension, Arthritis	19	97

Table 3. Continued

5	72	Female	Fracture neck of femur, Garden's IV, IHD.	Alzeheimer, Parkinsonism	26	92
6	60	Male	Fracture neck of femur, Garden's II, Hypertension.	Stroke, Hemiparesis	24	97
7	75	Male	Fracture neck of femur, Garden's III, Hypertension.	Stroke, Hemiparesis, Trochanteric extension, Arthritis	30	96
8	75	Male	Fracture neck of femur, Garden's II, Hypertension, IHD.	Alzeheimer, Parkinsonism, Arthritis	22	99
9	67	Female	Fracture neck of femur, Garden's III, Hypertension.	Epilepsy, Arthritis	25	95
10	62	Male	Fracture neck of femur, Garden's III, Diabetes Mellitus, Hypertension, IHD.	Old poliomyelitis, Arthritis	40	96
11	70	Male	Fracture neck of femur, Garden's III, Diabetes Mellitus, Hypertension.	Advanced senile dementia, Trochanteric extension, Arthritis	29	97
12	79	Male	Fracture neck of femur, Garden's III, Hypertension.	Stroke, Hemiparesis, Arthritis, Neglected 5 months	15	99
13	66	Female	Fracture neck of femur, Garden's III, Hypertension, DVT, IVC filter.	Psychic Depression, Arthritis	23	97
14	70	Male	Fracture neck of femur, Garden's III, Diabetes Mellitus, Hypertension.	Psychic Depression, Arthritis, Neglected 2 months	24	99
15	65	Female	Fracture neck of femur, Garden's IV, Hypertension.	Stroke, Hemiparesis, Arthritis	21	97
16	62	Female	Fracture neck of femur, Garden's II.	Advanced senile dementia	32	98
17	70	Male	Fracture neck of femur, Garden's IV, Diabetes Mellitus, Hypertension, IHD.	Alzeheimer, Parkinsonism, Trochanteric extension, Arthritis	39	98
18	80	Male	Fracture neck of femur, Garden's III, Hypertension.	Epilepsy, Arthritis	26	99
19	75	Female	Fracture neck of femur, Garden's III, Diabetes Mellitus, IHD.	Stroke, Hemiparesis Trochanteric extension, Arthritis	29	99
20	72	Male	Fracture neck of femur, Garden's IV, Diabetes Mellitus, Hypertension.	Psychic Depression, Arthritis	15	97

HCV, Hepatitis C Virus; IHD, Ischemic Heart Disease; DVT, Deep Venous Thrombosis; IVC, Inferior Vena Cava; ICHge, Intra Cranial Hemorrhage

Complications

One patient encountered intraoperative femoral fracture that was managed with fixation using cerclage wires and didn't affect the final outcome. Another patient had sciatic nerve palsy managed with medical treatment and physiotherapy, improved to full function after four months of the operation. Finally, one patient showed postoperative superficial infection that was managed with debridement and targeted antibiotic therapy after culture and sensitivity [Table 4].However, we did not encounter any of the following complications: Heterotrophic ossification, thrombo-embolic complications, stems subsidence, cup migration, or aseptic loosening.

Table 4.postoperative Complication rate

postoperative Complicatio	N	%
Intraoperative fracture	1	5.00
Sciatic Nerve	1	5.00
Infection	1	5.00
Dislocation	0	0.00

Discussion

Many patients have THA for FNF.FNF patients are at high risk for prosthetic dislocation with respect to hip arthritis patients, because of a combination of muscular insufficiency, cognitive and neurologic disorders, and recurrent falls that characterize this population of patients.[7]

Diseases that directly cause muscle weakness, particularly with abductor weakness, increase dislocation incidence. Other neurological conditions, such as cerebral palsy and multiple sclerosis can lead to similar muscle weakness. For these patients, noncompliance or inability to follow postoperative activity restrictions was implicated as the likely cause for dislocation.[12]

Dual mobility acetabular components have recently gained wider attention as an alternative option in the prevention and treatment of instability in both primary and revision THA.[9] The Dual Mobility cup, developed by Professor Gilles Bousquet and the engineer André Rambert at the end of the 1970s, was innovative in the field of total hip replacement. It implies two articular surfaces: one with a larger diameter situated between a metallic cup and a polyethylene insert and the other one with a smaller diameter situated between the femoral head and the retentive polyethylene insert.[13]

The Dual Mobility Cup is not a mechanical blocker of dislocation. There is no stress on the Polyethylene rim that limits the range of motion to prevent dislocation before its failure. The Dual Mobility Cup appears more stable with a wider range of motion without impingement of the rim with less wear and failure rates.

Regarding postoperative dislocations, FNF with or without trochanteric extension is a recognized risk factor due to impairment of surrounding muscles and great propensity for falls. Mallory and Lombardi reported a higher risk for dislocation when the THA was performed for femoral neck fracture compared to hip osteoarthritis.[14] Lee and Berry reported a 10% rate of dislocation in a series of primary THA for acute femoral neck fracture.[15] Brooks P. J. and Ries M.D. informed that the main patient factor of dislocation postoperatively is abductors impairment resulting in considerable functional impairment and hip instability.[16,17]

We considered neuromuscular disorders and cognitive dysfunction such as old stroke, old polio, intra cranial hemorrhage, advanced senile dementia, Alzheimer, Parkinsonism, Psychic Depression and Epilepsy as risk factors of dislocation due to muscle weakness and lack of ability to respect dislocation precautions. Fackler and Possob reported a high incidence of severe medical or neurologic problems in patients who experienced hip implant dislocation.[18] Also Abdelazim et al stated that neuromuscular disorders are risk factors of dislocation.[19] Because of the weakening of the stabilising muscles around the hip, particularly the abductor group, these individuals are at a higher risk of dislocation. In these individuals, the unrestricted Dual Mobility Cups provides a well-functioning and stable hip. Dual Mobility Cups were found to be useful in preventing early dislocation of hip arthroplasty in this study. Bassiony et al in their study informed that Dual Mobility cups were efficient in reducing THA dislocations in Parkinson's patients who are at more risk of instability due to neurologic impairment. Furthermore, they gave superior functional results. Ryu H G and colleagues conducted a study on 162 patients who received dual mobility articulation THA for misplaced femoral neck fractures. Thirty-five of the 162 individuals had neuromuscular illness, such as cerebral palsy, poliomyelitis, hemiplegia, and Parkinson disease. They reported that the incidence of dislocation in the neuromuscular disease group was the same as in the non-neuromuscular disease group. Furthermore, they support the notion that THA with dual mobility articulation is a viable therapeutic option for femoral neck fractures in the elderly with neuromuscular illness.[19] While Zhuang TF and his colleagues reported in their study on 17 patients suffering from fracture neck of femur with residual poliomyelitis who underwent THA with dual mobility articulation with a mean follow-up period of 77.05 months that dual mobility THA is a valid choice as a treatment for displaced femoral neck fractures in elderly with residual poliomyelitis.[20]

The mean preoperative HHS for all patients was 25.7 while mean postoperative HHS for all patients in the last follow up in our study was 97.2. In their study of 103 patients with broken neck of femur who were operated on using THR and were eligible for final follow up at one year, Agarwala S and colleagues reported findings of 52 patients who received dual mobility THR and 51 patients who underwent conventional THR. The dual mobility THR group had a mean Harris Hip Score (HHS) of 76.37 at three months and 87.02 at one year, which was considerably higher than the conventional THR group, which had an HHS of 65.65 at three months and 72.96 at one year. Eighty percent of dual mobility THR patients were able to squat and sit cross-legged, compared to just 55 percent of traditional THR patients.[21] In a study done by Combes et al on 2179 patients the mean HHS increased from 39 preoperatively to 91 at latest follow up.[22] Guyen et al stated that there is clinical improvement in their study group of 163 patients with preoperative HHS improved from 39.6 to 83.4 at latest follow up.[23] Boyer et al showed clinical improvement in their study group of 205 patients with mean preoperative HHS 65 and mean postoperative HHS at last follow up 92 points.[24] In a study done by Assi et al including 74 patients the mean postoperative HHS was 97.1 and all patients returned to their normal activities and Religious patients (65%) who were experiencing pain during their prayer or could not pray in such positions were all able to do so three months after surgery.[25] In another study done Neri et al which reviewed 137 hips in 114 patients the mean preoperative HHS was 48.3 and improved to 85.1 at last follow up.[26]

In our study there were 13 cemented prosthesis, four cementless prosthesis and three reverse hybrid prosthesis with mean acetabular inclination angle 440. All cups showed no migration, osteolysis, loosening and heterotopic ossification at last follow up and no loosening in femoral stem was detected with no large articulation dislocation.

Compared to other studies Guyen et al of 163 hips with mean follow up 40 months,[23] Hamadouche et al including 168 hips at mean follow up of 6 years,[27] Neri et al which

reviewed 137 hips in 114 patient with mean follow up of 25 years (longest follow up in the literature),[26] there was no large articulation dislocation. Dual Mobility THA in treatment of femoral neck fracture postoperative rate of dislocation was zero % in Tarasevicius and colleagues' study.[28] this can be compared to the incidence after non Dual Mobility Cup which is between two and 22 %.[4]

Three patients developed postoperative complications. One case encountered intraoperative femoral crack that was managed with fixation with cerclage wires and didn't affect the final outcome. One case had sciatic nerve palsy postoperatively that was managed conservatively and improved to full function after four months of the operation. Finally, one patient showed postoperative superficial infection that was managed with debridement and antibiotics according to culture and sensitivity.No patient experienced postoperative dislocation. Those three complications did not affect the final clinical outcome of the three patients. Our study is limited to its study design and sample size which might introduce bias in the study findings. However, according to our findings and to the most recent literature on the topic, we conclude that DMC THA presents short-term outcomes comparable to conventional THA.

Our study supports the use of Dual mobility cups in preventing the risk of dislocation for patients suffered from FNF with neuromuscular disorders and cognitive dysfunction (old Stroke, old Polio,intra cranial Hhmorrhage, advanced senile dementia, Alzheimer, Parkinsonism, Psychic Depression and Epilepsy) combined or not with trochanteric extension with high risk of weakness of the stabilizing muscles around the hip especially the abductor group. Dual mobility cups showed good clinical and radiological results with zero % of dislocation and intraprosthetic dislocation which is comparable to recent studies published in the literature.

Conclusion

The Dual mobility cup is effective in the prevention of early dislocation in patients suffered from FNF with muscle weakness due to neurologic disorders and cognitive dysfunction. Long term follow up is needed to confirm results, determine long term outcome and detect future complications associated with the use of DM cups.

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References

1. Kakkar R, Kumar S, Singh AK. Cephalomedullary nailing for proximal femoral fractures. Int Orthop. 2005; 29(1):21–4. doi: 10.1007/s00264-004-0624-4.
2. Moroni A, Faldini C, Pegreffi F, Hoang-Kim A, Vannini F, Giannini S. Comparing dynamic hip screw to external fixation for treatment of osteoporotic pertrochanteric fractures: A prospective randomized study. Key Eng Mater. 2005; 284–286:1037–40.
3. Moroni A, Faldini C, Pegreffi F, Hoang-Kim A, Giannini S. Osteoporotic Pertrochanteric Fractures Can Be Successfully Treated with External Fixation. J Bone Joint Surg Am. 2005:87 Suppl 2:42-51. doi: 10.2106/JBJS.E.00437.
4. Mukka SS, Mahmood SS, Sjödén GO, Sayed-Noor AS. Dual mobility cups for preventing early hip arthroplasty dislocation in patients at risk: experience in a county hospital. Orthop Rev (Pavia). 2013; 5(2):48-51. doi: 10.4081/or.2013.e10.
5. Prudhon JL, Ferreira A, Verdier R. Dual mobility cup: Dislocation rate and survivorship at ten years of follow-up. Int Orthop. 2013; 37(12):2345–50. doi: 10.1007/s00264-013-2067-2.
6. Canton G, Moghnie A, Cleva M, Kostoris FM, Murena L. Dual mobility total hip arthroplasty in the treatment of femoral neck fractures: A retrospective evaluation at mid-term follow-up. Acta Biomed. 2019; 90(1-S):98-103. doi: 10.23750/abm.v90i1-S.8070.
7. Patel PD, Potts A, Froimson MI. The Dislocating Hip Arthroplasty. Prevention and Treatment. J Arthroplasty. 2007; 22(4 Suppl 1):86-90. doi: 10.1016/j.arth.2006.12.111.
8. Zhao F, Ma C, Xiong C. Treatments of dislocation after total hip replacement. Zhongguo Xiu Fu Chong Jian Wai Ke Za Zhi.2007; 21(1):12-4.
9. Langlais FL, Ropars M, Gaucher F, Musset T, Chaix O. Dual mobility cemented cups have low dislocation rates in THA revisions. Clin Orthop Relat Res.2008; 466(2):389-95. doi: 10.1007/s11999-007-0047-9.
10. Sanchez-Sotelo J, Haidukewych GJ, Boberg CJ. Hospital cost of dislocation after primary total hip arthroplasty. J Bone Joint Surg Am.2006; 88(2):290-4. doi: 10.2106/JBJS.D.02799.
11. Werner BC, Brown TE. Instability after total hip arthroplasty. World J Orthop.2012; 3(8):122-30. doi: 10.5312/wjo.v3.i8.122.

12. Vielpeau C, Lebel B, Ardouin L, Burdin G, Lautridou C. The dual mobility socket concept: Experience with 668 cases. Int
13. Mallory TH, Lombardi AV, Fada RA, Herrington SM, Eberle RW. Dislocation after total hip arthroplasty using the anterolateral abductor split approach. Clin Orthop Relat Res. 1999 ;(358):166–72.
14. Lee BP, Berry DJ, Harmsen WS, Sim FH. Total hip arthroplasty for the treatment of an acute fracture of the femoral neck. Long-term results. JBJS. 1998; 80(1):70-5.
15. Brooks PJ. Dislocation following total hip replacement: causes and cures. The bone & joint journal. 2013; 95(11_Supple_A):67-9.
16. Ries MD. Hip abductor deficiency: What can you do about it? Semin Arthroplasty. 2016; 27(1):67–9.
17. Fackler CD, Poss R. Dislocation in total hip arthroplasties. Clin Orthop Relat Res. 1980 ;(151):169–78.
18. Abdelazim H, Michael F. Dual mobility cup for prevention of early total hip arthroplasty dislocation in patients with neurological disorders. Eur Orthop Traumatol. 2015; 6(4):427–32.
19. Ryu HG, Roh YJ, Oh KJ, et al. Dual mobility articulation total hip arthroplasty for displaced neck fracture in elderly with neuromuscular disorder. Injury. 2021; 52(6):1480–6. doi:10.1016/j.injury.2021.01.005.
20. Zhuang TF, Huan SW, Luo SM, et al. Outcomes of dual mobility articulation total hip arthroplasty in ipsilateral residual poliomyelitis. Int Orthop. 2022; 46(3):489–96. doi: 10.1007/s00264-021-05222-y.
21. Agarwala S, Katariya A, Vijayvargiya M, Shetty V, Swami PM. Superior functional outcome with dual mobility THR as compared to conventional THR in fracture neck femur: A prospective cohort study. SICOT J.2021:7:42. doi: 10.1051/sicotj/2021041.
Orthop. 2011; 35(2):225-30. doi: 10.1007/s00264-010-1156-8.
22. Combes A, Migaud H, Girard J, Duhamel A, Fessy MH. Low rate of dislocation of dual-mobility cups in primary total hip arthroplasty. Clin Orthop Relat Res.2013; 471(12):3891-900. doi: 10.1007/s11999-013-2929-3.
23. Guyen O, Pibarot V, Vaz G, Chevillotte C, Carret JP, Bejui-Hugues J. Unconstrained Tripolar Implants for Primary Total Hip Arthroplasty in Patients at Risk for Dislocation. J Arthroplasty. 2007; 22(6):849–58. doi: 10.1016/j.arth.2006.11.014.
24. 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. 2012; 36(3):511–8. doi: 10.1007/s00264-011-1289-4.
25. Assi C, El-Najjar E, Samaha C, Yammine K. Outcomes of dual mobility cups in a young Middle Eastern population and its influence on life style. Int Orthop. 2017; 41(3):619–24. doi: 10.1007/s00264-016-3390-1.
26. Philippot R, Neri T, Boyer B, Viard B, Farizon F. Bousquet dual mobility socket for patient under fifty years old. More than twenty year follow-up of one hundred and thirty one hips. Int Orthop. 2017; 41(3):589–94. doi: 10.1007/s00264-016-3385-y.
27. Hamadouche M, Arnould H, Bouxin B. Is a cementless dual mobility socket in primary THA A reasonable option? Clin Orthop Relat Res.2012; 470(11):3048-53. doi: 10.1007/s11999-012-2395-3.
28. Tarasevicius S, Busevicius M, Robertsson O, Wingstrand H. Dual mobility cup reduces dislocation rate after arthroplasty for femoral neck fracture. BMC Musculoskelet Disord.2010:11:175. doi: 10.1186/1471-2474-11-175.