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Original article

Outcome of Dual Mobility Acetabular Cup for Instability in Total Hip Arthroplasty

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Abstract:

Background: Dislocation after revision total hip arthroplasty (THA) continues to be one of the most common and concerning complications after the procedure. Dual-mobility (DM) acetabular components decrease the risk of post-operative instability also in high-risk patients, both in primary and revision hip arthroplasty. This study aimed to evaluate the outcome of DM acetabular cup (DMC) for instability in THA. **Methods:** This prospective study included 20 patients with Hip abductor insufficiency underwent total hip replacement using dual mobility cup. Complete local examination of the involved hip joint and radiological evaluation to ensure precise templating The Harris hip score (HHS) is used for clinical evaluation of patients at 6 weeks, 3months, 6 months, and the last follow-up. Standard radiographs are taken for all patients at subsequent follow-up examinations to examine component position or migration, osteolysis and loosening, and union of transfemoral osteotomy if used. **Results:** Regarding the prothesis, Cementless cup-Cementless stem was used in 3 (15.0%) patients, Cemented cup-Cementless stem was used in 9 (45.0%) patients and Cemented cup- Cemented stem was used in 8 (40.0%) patients. Harris hip score is improved over time postoperatively. HHS was significantly higher after 6 wks., after 6 months and after 1 years compared to preoperative HHS. **Conclusion:** the use of DMC has been found to be an effective technique for preventing hip arthroplasty instability. The clinical outcomes achieved with DMC were quite satisfactory, and the incidence of complications was significantly lower compared to other techniques.

Keywords: Dual Mobility; Acetabular Cup; Instability; Total Hip Arthroplasty.

Introduction

Although long-term report of total hip arthroplasty (THA) showed successful results, instability remains a major complication [1].

Secondary THA after failed fixation of proximal femur fracture has more complication than primary THA. Subgroup analysis identified more complication problems in the THA cases after extra capsular fracture and a higher number of complications, particularly dislocation and periprosthetic fractures [2].

Dislocation after revision THA continues to be one of the most common and concerning complications after the procedure. As with every hip arthroplasty, it is essential to optimize component positioning, minimize impingement, and maintain the integrity of the abductor complex during the revision THAs. However, in several re vision circumstances additional strategies are required to mitigate the risk of dislocation, particularly those being reviser for instability or those with cognitive or neuromuscular disorders [3].

Recently, dual-mobility cups (DMC) have gained more and more interest among clinicians, with encouraging results in terms of lower rate of dislocation associated with good clinical results, but a lack of evidence exists regarding the real efficacy of this implant design compared to traditional fixed-bearing total hip arthroplasty [3].

Dual-mobility acetabular components decrease the risk of post-operative instability also in high-risk patient, both in primary and revision hip arthroplasty [1].

The combination of a large dual-mobility femoral head, combined with a soft tissue repair that spares the spares the deep the capsule, has the potential to Significantly reduce dislocation rates when using the posterior approach to the hip [4].

Dual mobility (DM) total hip arthroplasty (THA) may reduce dislocation risk but might increase the risk of high Polyethylene (PE) wear due to double wearing surfaces [5].

DMC may provide excellent stability in patients with abductor –trochanteric complex insufficiency [6].

DM THA following displaced FNF provides a good functional result and quality of life in addition to high patient satisfaction [7].

Revision THAs, DM constructs offer lower rates of dislocations and re –revisions for dislocations in the midterm. However, it is important to note that dual –mobility constructs should not be considered as compensation for Poor surgical technique or technical errors such as poor Cup orientation or inappropriate of soft –tissue tension [3].

The purpose of this study was to evaluate the outcome of DM acetabular cup for instability in THA.

Patients and methods

This prospective study included 20 patients with hip abductor insufficiency underwent total hip replacement using DMC. The study was carried out at Orthopedic Surgery Department, Benha University Hospital from June 2019 to October 2022.

An informed written consent was obtained from the patients. Every patient received an explanation of the purpose of the study and had a secret code number. The study protocol gained the ethical committee of Faculty of medicine, Banha university.

Inclusion criteria were old patient, young patient with risk of instability, revision cases, failed fixation of trochanteric fracture, CNS problems, aseptic loosening with abductor weakness, neglected dislocation.

Exclusion criteria were infection, complete paralysis of abductors, young patient without risk of instability, neurological spasticity, acute dislocation.

All studied cases were subjected to the following: careful clinical assessment in the form of detailed clinical history and thorough examination, a comprehensive

evaluation of the patient's medical history and present hip condition, general assessment to thoroughly evaluate the patient's physical fitness and wellbeing ahead of a major surgical procedure, Complete local examination of the involved hip joint was routine with particular emphasis on limb length discrepancy, abductor strength, scars of operations, neurovascular status and Harris hip score, radiological evaluation to ensure precise templating, it is imperative to have a thorough understanding of the specific anatomical landmarks that play a significant role in the hip replacement surgery. These include the teardrop, ischial tuberosities, top of the lesser trochanter, top of the greater trochanter, lateral superior edge of the acetabulum, and normal center of rotation.

Templating

During the hip replacement surgery, the main objective is to restore the normal anatomical hip center of rotation and femoral offset. Additionally, if there is any difference in the length of the patient's limbs, it must be equalized. To achieve this, the surgeon uses femoral side templating technique. This involves placing femoral overlay templates on the X-ray film to select the most appropriate size that matches the shape of the proximal canal and fills it most completely. After selecting the size, the surgeon determines the appropriate neck length of the implant to restore the limb length and femoral offset. This technique ensures that the implant is placed correctly and helps in achieving optimal post-operative results.

Femoral side templating:

We placed the femoral overlay templates on the film and selected the size that most precisely matched the contour of the proximal canal and fills it most completely. Next, we selected the appropriate neck length to restore limb length and femoral offset (Fig 1).

Acetabular side templating:

Place appropriately sized acetabular template with roughly 40 degrees of abduction, medial border of cup should approximate the ilioischial line and lie close to the teardrop, a medial cup will decrease joint reactive forces and decrease force required by abductors to maintain a level pelvis, inferior border of cup should be at level of inferior teardrop line (Fig 2).

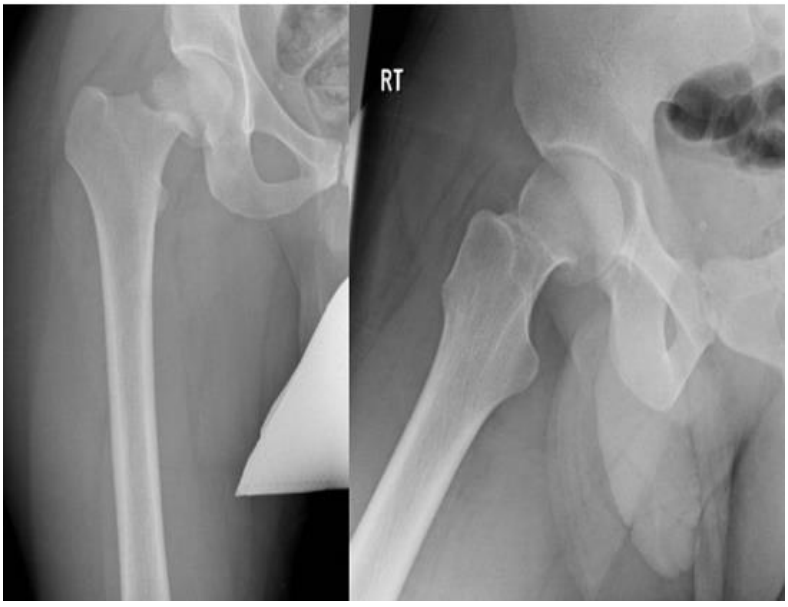

Figure 1: Pre-operative X ray Male patient 70 years old, with RT fracture neck femur.

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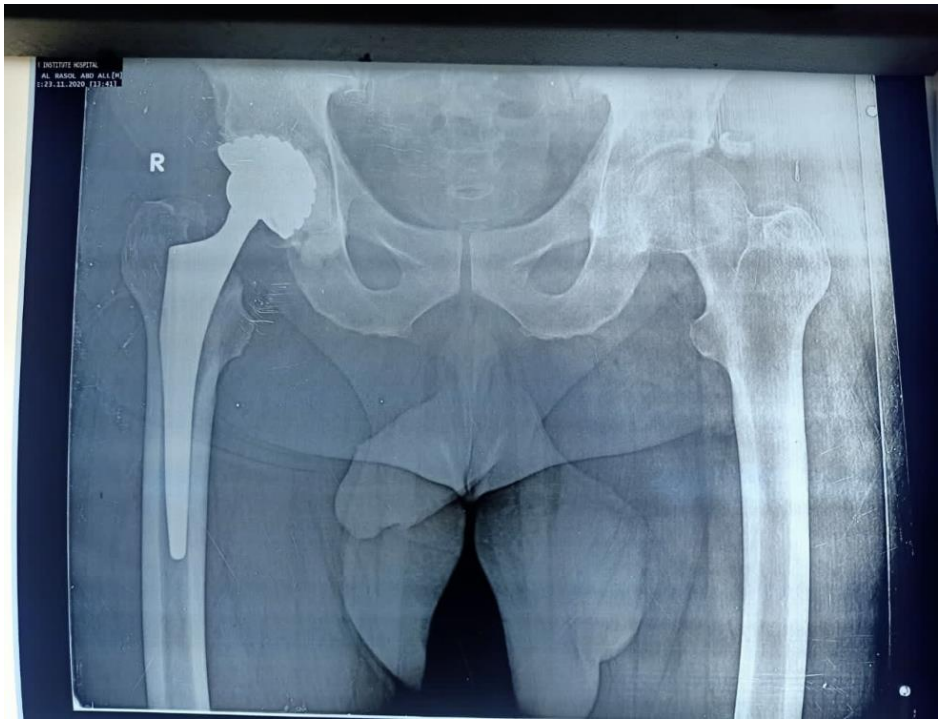

Figure 2: Post-operative radiographs of RT dual-mobility primary THA in a 70-year-old male.

Preoperative preparation of the patient:
Besides the routine preoperative investigations that were carried out for all patients, further special investigations were requested by anesthesiologists according to each case to complete anesthetic judgment. Preoperative hemoglobin was at least 10 g/dl in all patients. Two units of blood were prepared for each patient, but their use was according to the individual situation. Preoperative hydration: one liter of Ringer's solution on the morning of operation. All the patients received a single dose of prophylactic antibiotic third-generation cephalosporin 1000mg before induction of anesthesia preoperative and continued for five days postoperatively.

Operative Procedure:
Anesthetic technique, asepsis, and Antibiotics.

Operative Technique:

Exposure:
The posterior approach was used in all cases. The patient was placed in the lateral decubitus position. Again, the involved limb was draped freely to facilitate dislocating the hip and permit maneuverability to improve visualization throughout the procedure.

The skin incision began 5 cm distal to the greater trochanter, centered on the femoral diaphysis. The incision continued proximal to the greater trochanter. It then curved toward the posterior superior iliac spine for 6 cm. Alternatively, the incision continued proximally in line with the femur, flexing the hip to 90°.

We then incised the fascia lata overlying the gluteus maximus and bluntly split the muscle down to the short external rotators. A Charnley retractor was positioned to retract the gluteus maximus. The sciatic nerve was carefully protected as it travels immediately posterior to the short external rotators. After identification of the piriformis, the short external rotators and piriformis were then tenotomized at their insertion onto the greater trochanter. They were then tagged with a braided suture for identification and repair at the end of the procedure. This then exposed the posterior

joint capsule, which was incised to reveal the femoral neck and head.

Alternatively, the joint capsule was incised with the short external rotators in a single layer during tenotomy. The femoral head was then dislocated by rotating the hip internally. A femoral neck osteotomy was then performed using Hohmann retractors anteriorly and posteriorly to protect soft tissues.

Once the osteotomized bone was removed, access was gained to the acetabulum and proximal femur. Careful placement of Hohmann retractors around the acetabulum permitted adequate exposure for the reconstruction. The femur was retracted anteriorly to expose the acetabulum to allow adequate restoration of acetabular anteversion. A posterior retractor or self-retaining retractor was used to retract the posterior joint capsule to facilitate acetabular visualization. During acetabular preparation, soft tissue landmarks, such as the transverse acetabular ligament, reamer position relative to the floor and cup-positioning guides, were used to verify acetabular version and inclination.

Acetabular preparation:

When reaming reached this concentric socket and bleeding subchondral bone and adequate reamer size, a trial cup was inserted to check the size and fitting, then the original cup was inserted.

Femoral preparation:

Femoral side preparation was then started with a cancellous bone impactor and a small broach. The broach size increased gradually until reaching a broach size that was rotationally stable and did not subside with hammering.

Trial of reduction was repeated with the actual stem. After ensuring proper orientation and determining the length of the head needed, assembly of the metal head with mobile polyethylene liner with compression device is done.

The assembled head-polyethylene liner is impacted over the actual stem then introduced into the acetabular shell.

Wound closure:

The gluteus minimums were sutured with the hip in the abduction and neutral rotation, followed by the gluteus medius in the same position; then, the iliotibial band was sutured after the application of a suction drain.

After subcutaneous and skin closure, the patient was brought back to the supine position while holding the limb in abduction and neutral rotation.

Postoperative Component:

Patient transfer procedure:

The transfer procedure was supervised by the surgeon or at least his assistant. The patient was directly transferred from the operating room to his/her bed, the surgeon held the legs with the operated hip abducted and neutral rotation. The anesthetist looked after the head and neck.

Recovery room:

In the recovery room, the patient was observed by a nurse and pulse oximeter was used to record the pulse and the oxygen saturation. The blood pressure was also checked, and analgesia was started.

In the Ward:

All patients received intravenous third generation cephalosporin for 5 days postoperatively, then patient was discharged from the hospital on oral broad-spectrum antibiotics and continued till stitches removed (15days from the surgery). All patients received low molecular weight heparin during hospitalization, followed by oral anticoagulants after discharge and for 6 weeks. Hemoglobin level was checked in the first postoperative day and blood transfusion was given if necessary. Wound condition was followed during the first 2 weeks, which is the time by the end of which the wound is supposed to be healed and the stitches are removed.

Ambulation protocol:

Patients were instructed to do immediate hip and knee flexion, rapid foot pumps, and deep breathing exercises to minimize the risk of thrombo-embolic and pulmonary complications after surgery.

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Walking was started on the first day after the operation, and patients were advised to bear weight as tolerated. They were instructed to be full weight bearing immediately after the operation, and to use a walker or two crutches for balance support only. Patients with transfemoral osteotomy and those with graft reconstruction of acetabular defects were advised to delay weight bearing for 6 weeks, and then gradually start with walking aids as described above.

Follow up program:

First visit was at one week after operation for wound dressing, 2nd visit at 2 weeks for remove of stiches, 3rd visit at 6 weeks for imaging, 4th visit at 3month for imaging, 5th visit at 6month for imaging, 6th visit at 1year.

Radiological Evaluation:

An anteroposterior radiograph of the pelvis is taken to assess the femoral offset, acetabular inclination in relation to the inter teardrop line (ideally 45º), and femoral stem orientation (ideally neutral or slightly valgus 5º). After discharge, all patients undergo regular clinical and radiological evaluations during their follow-up period. The Harris hip score is used for clinical evaluation of patients at 6 weeks ,3months ,6 months, and the last follow-up. Standard radiographs are taken for all patients at subsequent follow-up examinations to examine component position or migration, osteolysis and loosening, and union of transfemoral osteotomy if used.

Statistical analysis

The collected data was revised, coded, tabulated and introduced to a PC using Statistical package for Social Science (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.). Data were presented and suitable analysis was done according to the type of data obtained for each parameter. Shapiro-Wilk test was done to test the normality of data distribution. Significant data was nonparametric. Mean, Standard deviation (± SD), minimum and maximum for parametric numerical data. Frequency and percentage of non-numerical data. Student T Test was used to assess the statistical significance of the difference between two study group means. Chi-square and Fisher's exact test were used for comparison of qualitative variables. Paired sample t test was used to assess changes in parameters over time. Repeated Measures ANOVA (Analysis of Variance) compares means across one or more variables that are based on repeated observations. A p value is considered significant if <0.05 at confidence interval 95%.

Approval Code: MD 11-2018

Results

Regarding demographic data of the studied patients, age ranged from 49 – 80 years with a mean of 66.1 ± 8.22 years. There were 11 (55%) males and 9 (45%) females. Regarding the anthropometric measurements of the studied patients, height ranged from 1.57 - 1.7 m with a mean of 1.6 ± 0.04 m. The weight of the studied patients ranged from 61 – 84 Kg with a mean of 71.7 ± 6.12 Kg. The BMI ranged from 22.14 - 32.01 Kg/m^2 with a mean of 26.6 ± 2.37 Kg/m^2. Among the studied patients, 11 (55%) patients had DM, 11 (55%) patients had hyperlipidemia and 7 (35%) patients had hypertension. Table 1

Among the studied patients, 2 (10%) patients were diagnosed with aseptic loosening with abductor weakness, 6 (30%) patients were diagnosed with failed fixation of trochanteric fracture, and 12 (60%) old patients with fracture neck femur. Table 2

Regarding the prothesis, Cementless cup-Cementless stem was used in 3 (15.0%) patients, Cemented cup- Cementless stem was used in 9 (45.0%) patients and Cemented cup- Cemented stem was used in 8 (40.0%) patients. Table 3

Harris hip score was used for clinical evaluation of patients pre and postoperatively at 6 wks., 6 months and

after 1 year. Table 4 shows that Harris hip score is improved over time postoperatively. Harris hip score was significantly higher after 6 wks., after 6 months and after 1 years compared to preoperative HHS.

Among the twenty patients in the study group with higher risk of dislocation, no large articulation dislocation was encountered till the end of follow-up. Regarding complications 2 (10%) patients had deep vein thromboses not complicated with pulmonary embolism and treated with anticoagulant, superficial wound infection occurred in 2 (10%) patients treated by antibiotic and dressing only one case needed debridement. Whereas 16 (80%) patients did not exhibit any complications. Table 5

Table 1: Demographic data, anthropometric measurements, and comorbidities of the studied groups.

		N=20
Age (years)	**Mean ± SD**	66.1 ± 8.22
	Range	49 – 80
Sex	**Male**	11 (55%)
	Female	9 (45%)
Height (m)	**Mean ± SD**	1.6 ± 0.04
	Range	1.57 - 1.7
Weight (Kg)	**Mean ± SD**	71.7 ± 6.12
	Range	61 – 84
BMI (Kg/m^2)	**Mean ± SD**	26.6 ± 2.37
	Range	22.14 - 32.01
Comorbidities	**DM**	11 (55%)
	Hyperlipidemia	11 (55%)
	HTN	7 (35%)

DM: diabetes mellitus, HTN: hypertension

Table 2: Diagnosis of the studied patients

	N=20
Aseptic loosening with abductor weakness	2 (10%)
Failed Fixation of trochanteric fracture	6 (30%)
Old patient with fracture neck femur	12 (60%)

Table 3: The prothesis of the studied patients

	N=20
Cementless cup- Cementless stem	3 (15.0%)
Cemented cup- Cementless stem	9 (45.0%)
Cemented cup- Cemented stem	8 (40.0%)

Table 4: Harris hip score of the studied patients

		Preoperative	**After 6 wks.**	**After 6 months**	**After 1 year**
HHS	**Mean± SD**	30.3 ± 7.8	62 ± 4.3	91.4 ± 4.01	95 ± 2.9
	Range	16 – 44	55-68	85-98	88-98
P value			**<0.001***	**<0.001***	**<0.001***

HHS: Harris hip score, *: statistically significant as P value <0.05.

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Table 5: Incidence of complications in the studied patients

	N=20
No	16 (80%)
Deep vein thromboses	2 (10%)
Superficial wound infection	2(10%)

Cases:

Case 1:

Male patient 70 years old, history of trauma with fracture RT neck femur with risk factor for instability old age and fracture neck femur treated by dual mobility total hip replacement with cemented dual mobility acetabular cup and cementless femoral stem. (Fig 3).

Case 2

Female patient 65 years old, with history of intertrochanteric fracture fixed by DHS with failed DHS with no signs of infection, with risk factor for instability and abductors insufficiency and revised to dual mobility THR with cemented dual mobility acetabular cup and cemented femoral stem. (Fig 4).

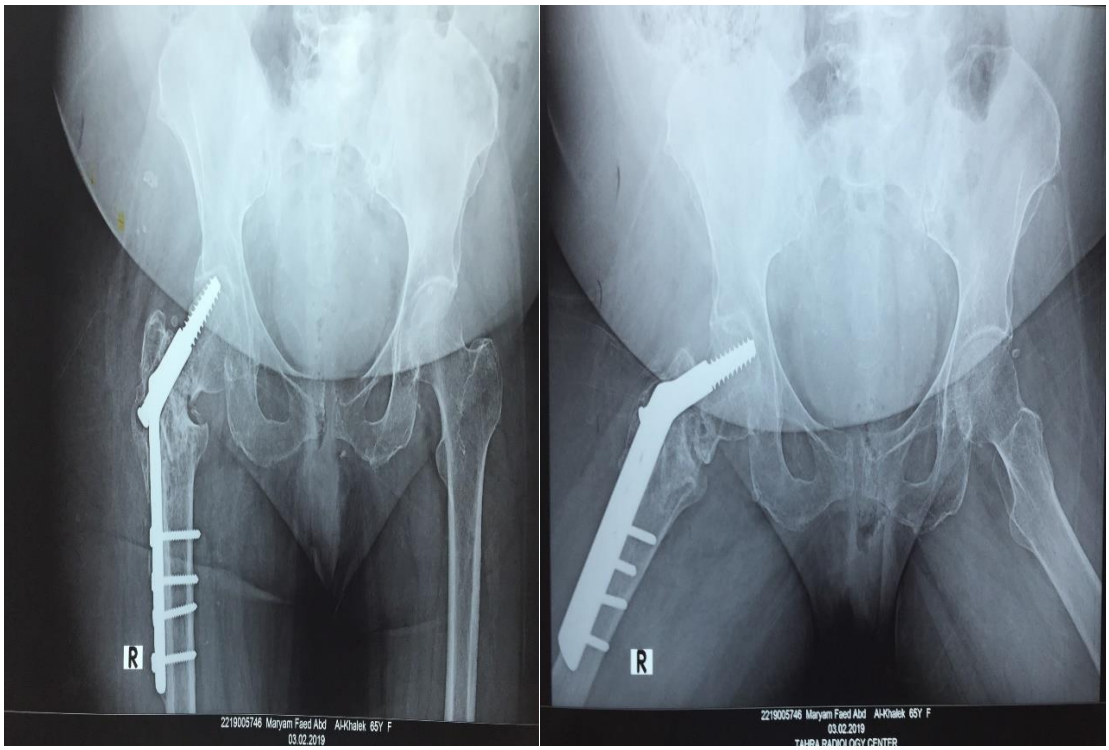

Figure 3: Pre-operative X ray Female patient 65 years old, Rt failed DHS.

Figure 4: Post-operative radiographs of RT failed DHS revised to dual mobility THR.

Discussion

Identification of patients at risk for dislocation is important preoperative to prevent the occurrence of hip instability specially in critically ill patient who cannot tolerate repeated surgeries [8].

The DMC designed by Gilles Bousquet are used in an expanding range of indications. This implant has been demonstrated to improve hip stability in primary THA and recurrent hip dislocation after THA. Theoretically, the design should reduce the risk of dislocation according to two principles: the mobile insert should minimize prosthetic neck impingement over the polyethylene component and the large articulation between the insert and the metallic shell should increase ROM before dislocation with increase of jumping distance [8].

The main goal of this study was to evaluate the outcome of dual mobility acetabular cup for instability in total hip arthroplasty.

In this study, Among the studied patients, 2 (10%) patients diagnosed with aseptic loosening with abductor weakness, 6 (30%) patients diagnosed with failed

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fixation of trochanteric fracture, 12 (60%) Old patient with fracture neck femur.

In this study, the following are considered as risk factors of dislocations, old age, previous hip surgery (e.g., failed proximal femoral fracture fixation), post traumatic e.g., femoral neck fracture with neuromuscular disease (e.g., epilepsy, Parkinson's disease, and myopathy, cerebrovascular stroke), cognitive dysfunction (e.g., dementia and Alzheimer's disease) and pathological fracture of proximal femur.

We found that among the twenty patients in the study group with higher risk of dislocation, no large articulation dislocation was encountered till the end of follow-up.

Harris hip score was used for clinical evaluation of patients pre and postoperatively at 6 wks., and 6 months. Harris hip score was significantly higher after 6 wks., after 6 months and after one years compared to preoperative HHS.

In the present study, the DMC has been used for selective cases of hip replacement, which were at high risk of postoperative instability. Our early results with these implants during follow-up period present without implant loosening. We have had no dislocations in our study group.

Dual mobility cups may be used in patients with a higher risk of dislocation such as those who are older, with increased comorbidities [(9)], or with neuromuscular diseases [(10)]. The use of a dual mobility cup increases the range of motion before impingement and dislocation. In our study, postoperative dislocation didn't occur confirming the recognized efficiency of the DM concept in preventing dislocation.

Researchers [(11)] advocated use dual mobility acetabular cup in patients with increased dislocation risk, including those undergoing revision THA for recurrent instability, revision THA for all other causes, THA after femoral neck fracture, and THA after tumor resection. Initial indications for DM components at their institution were for primary THA in elderly women with ligamentous laxity and revision THA in the setting of recurrent dislocations despite appropriate component position.

A different study [(12)] advocates the use of DM cups to treat instability in three situations: patients in whom no cause for instability could be identified or corrected, patients in whom prior surgical attempts at stabilization failed, and patients with a marked deficiency of the hip abductors; instead of a constraining device.

Recently scientists performed a prospective study on 152 patients. The patients were classified into dual-mobility (DM) and fixed-bearing (FB) acetabular cup groups. The occurrence of postoperative dislocation and functional evaluation of the hip joint was analyzed before and after surgery using the Harris hip score (HHS). They found that the preoperative evaluation of hip joint function using the HHS, the FB group and the DM group showed average scores, but there was no significant difference. The HHS performed early postoperative, postoperative 1 year and 2 years after surgery showed no difference between the two groups. This difference may be due to different groups.

Hip fractures are a common and serious injury in elderly patients and they constitute the second cause of hospitalization [(14)]. Most hip fractures in elderly population mark the beginning of a downward trend in the patients' health. More than 1.6 million hip fractures occur worldwide each year. On average, hip fractures reduce life expectancy by 25% in comparison with the age-matched general population. In addition, hip fractures are linked to the high cost that is associated with the care of these patients and burdens on the health care systems [(15)].

The main treatment goal for these injuries is early mobilization to prevent complications that are associated with prolonged immobilization. Another important goal is the return to pre-fracture

functional activity, which can be achieved with surgery.

There are few studies in the literature regarding DM THA for fracture neck of femur treatment. However, some recent reports demonstrate a growing interest in this topic. In particular, the theoretical advantage of a very low dislocation rate together with good clinical results led to the growing indication for DM THA in fracture neck of femur treatment [(12)].

The systematic use of total hip arthroplasties to treat displaced intracapsular fractures of the proximal femur in elderly patients is not common practice. Postoperative dislocation is a key issue when treating displaced fractures of the femoral neck. One of the potential drawbacks of performing a total hip arthroplasty in such a situation is that the dislocation rate may be higher than what is observed when performing a hemiarthroplasty [(16)].

Elderly patients with a femoral neck fracture have improved hip scores and better functional results after the THR [(17)]. There are higher postoperative dislocation rates following the THR after femoral neck fracture, which is almost five times higher than that reported for THR after osteoarthritis, meta-analysis has shown dislocation rates of 10.7% [(18)]. A randomized control trial comparing the internal fixation with THR in 100 patients found a dislocation rate of 22% in patients undergoing THR [(17)]. The use of DMC for THR in the case of a femoral neck fracture has shown a dislocation rate of 1.4 % [(19)].

F.B versus DM THA dislocation rate in femoral neck fracture patients in 2010 and 2013, was evaluated, FB and DM dislocation rate was 14.29% vs 0%. [(20)]

However, in a prospective cohort study of 103 elderly patients, researchers compared DM group with FB group in femoral neck fracture patients with minimum follow up of 1 year. Fifty-two patients were treated with DM and 51 patients were treated with FB. There was no dislocation occurred in both groups, but the range of motion was significantly better in DM group [(21)].

Comparing the series of dual mobility cups in the treatment of displaced fractures of the femoral neck to recent series of bipolar hemiarthroplasties, the relative risk of dislocation appears 4-4.7 times higher for hemiarthroplasties. The use of dual mobility cups in the treatment of displaced fractures of the femoral neck also appears safer in terms of the criteria of postoperative dislocation when compared to conventional cups [(22)].

A study concluded that, using DM in primary THA with caution only in high-risk patients for dislocation, keeping in mind that dislocation and IPD can still occur with this type of implant, leading to survival rates for dislocation comparable to FB group [(23)].

It is known that postoperative dislocation usually occurs within 3 months after THA, and joint laxity related to polyethylene wear is the cause of chronic dislocation. The modern DM cup has evolved considerably since the first-generation model of Bousquet in 1974. The retrieval study of polyethylene DM components by D'Apuzzo et al. [(24)] showed that motion occurs at both articulations, but the motion of the femoral head relative to the inner aspect of the polyethylene head dominant, which produces more wear. Previous studies have reported decreased dislocation rates with primary THA in patients at risk, but with an elevated risk for doing revision surgery compared to conventional implants. This might be a result of the release of polyethylene microparticles from the liner and eventually lead to aseptic loosening [(25)]

In the Swedish [(26)], the American [(27)], the Australian [(28)], the New Zealand [(29)] registries, dislocation appears as the first or second reason for revision THA and peri-prosthetic fracture PPF ranks in the fourth or fifth position for revision THA [(30)]. However, in the French registry [(14)], PPF ranks as the second reason for revision THA and dislocation appears as

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the fifth reason for revision THA. In France, the use of DM in primary THA is widespread.

In 2015 fit was found that complications affecting patient who underwent primary THA using DM prostheses included two patients who presented with concerns for deep vein thrombi, which were both medically managed, as well as one patient who had a non-fatal pulmonary embolism, which was also medically managed [(31)].

In the present study, the DMC has been used for selective cases of hip replacement, which were at high risk of postoperative instability. Our early results with these implants have shown no implant loosening during follow-up period. We have had no dislocations in our study group. Instability remains a significant issue after both primary and revision THA. Dual mobility or tripolar unconstrained acetabular components can provide a viable alternative in preventing and treating instability. Reported outcomes of studies using DM cups with mid- to long-term follow up support their effectiveness. Concerns such accelerated wear have been emphasized, although they seem to be less significant in older, low-demand patients.

Our study is limited by a single-center, small number of patients and short follow-up.

Conclusion

According to the results of our recent study, the use of DMC has been found to be an effective technique for preventing hip arthroplasty instability. The study found that the clinical outcomes achieved with DMC were quite satisfactory, and the incidence of complications was significantly lower compared to other techniques. Based on these findings, it is highly recommended that DMC should be used in all patients who are at high risk of dislocation.

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Author contribution

Authors contributed equally to the study.

Conflicts of interest

No conflicts of interest

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