Trauma Monthly 2022; 27(3): 504-512

10.30491/tm.2021.271571.1234

Trauma Monthly

Original Article

# Dual Mobility Cups Hip Arthroplasty as A Treatment for Displaced Fracture of the Femoral Neck in the Elderly Patients: A Prospective Study

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**Received** 2021-02-02; **Accepted** 2021-12-07; **Online Published** 2022-05-27

**Abstract**

**Background:** Arthroplasty is a treatment for displaced fractures of the femoral neck in the elderly. The type of arthroplasty remains controversial as total hip replacements potentially have a higher dislocation rate. The study aimed to evaluate dual mobility cups to manage fractures of the femoral neck with the posterior approach in the elderly.

**Methods:** This prospective study was conducted in Amritsar (Punjab), India. All patients with displaced fractures of the femoral neck treated via arthroplasty were operated on with the insertion of a dual mobility cup with the posterior approach. All patients were followed by clinical and radiological assessment at immediate post-op, 3 and 6 months, 1 and 3 years after surgery.

**Results**: Overall in the 240 patients, arthroplasty on the right hip of 121 (50.4%) and the left hip of 119 (49.6%) cases were performed. Majority of patients was male, and all patients were followed. The mean Harris hip score improved from 16.62 ± 6.34 preoperatively to 92.86 ± 2.28 at one-year follow-up and 95.20 ± 1.82 at three years' follow-up. Three dislocations occurred, and Open Reduction was performed through a posterior approach under regional anesthesia for two patients. Closed Reduction was performed on one patient, and there was no recurrence of dislocation.

**Conclusion**: The low dislocation rate after acute total hip replacement using dual mobility design cups is comparable with hemi arthroplasties. The dual mobility cups may be considered a valuable option to prevent postoperative dislocation when treating displaced intra-capsular fractures of the proximal femur in elderly patients. A dual mobility cup reduces the incidence of postoperative instability even after using the posterior approach.

**Keywords:** Femoral neck fracture; Total hip arthroplasty; Dual mobility; Elderly, Posterior Approach.

## Introduction

Arthroplasty is well accepted as a treatment for displaced fractures of the femoral neck in the elderly. In the case of conservative treatment, local complications occur in 42% of the cases, with only 57% of the survivors being free of complications, according to Blomfeldt et al. [1]. There is an increased risk of reoperation after osteosynthesis; when compared to hip arthroplasty [2]. Functional results are also better after arthroplasty than after osteosynthesis of the femoral neck [3,4]. However, the best-adapted type of arthroplasty in this clinical setting is still under debate. Dislocation is the most frequent complication when a total hip arthroplasty is implanted to treat a displaced fracture of the femoral neck [5]. Owing to the large diameter of the head, implantation of a hemi arthroplasty has a lower rate of postoperative dislocation [6]. The best functional results, especially in the case of active elderly patients, are obtained with total hip arthroplasties rather than hemi arthroplasties [7,8]. Dual mobility cups have been reported to have a low rate of postoperative dislocation in elective surgery, in primary total hip arthroplasties, revision procedures, and the most particularly as a treatment for recurrently dislocating hip replacements. Do these implants also perform well in the setting of femoral neck fractures in the elderly, and is there an advantage to use such implants to prevent postoperative dislocation?

A prospective study was designed with the inclusion of all displaced femoral neck fractures in patients aged 60

and older from September 2015 to August 2017. The study aimed to evaluate dual mobility cups to manage fractures of the femoral neck with the posterior approach in the elderly.

## Methods

From September 2015 to August 2017, 240 primary total hip arthroplasties were performed using a Dual mobility cup implant. The study was conducted at Amandeep Hospital, Amritsar, after obtaining the ethical clearance from the institutional ethical committee. Including all patients aged 60 or older with a diagnosis of a displaced intracapsular femoral neck fracture, for which the chosen treatment was an arthroplasty as primary treatment. Inclusion covered a two years, from September 2015 to August 2017.

A Dual mobility cup was inserted in each case, and posterior surgical approaches were used in the study. Prophylaxis intravenous antibiotic was given preoperatively. Isometric exercises were started on the 1st postoperative day. Patients were allowed to stand or walk with partial or complete weight-bearing with a walker depending on bone quality and patient's conditions.

Clinical and radiographic evaluations were performed at immediate post-op, 3 and 6 months, and 1 year and 3 years after surgery. Patients were clinically examined for pain, walking, and range of motion using the Harris Hip scores (HHS) system. The HHS was assessed preoperatively and at the last follow-up examinations in all cases.

Radiographic evaluations are done for implant positioning and subsequent analysis for subsidence: 1) enough criteria [9] for Osseo integration of uncemented femoral stems (shown by the formation of the bony pedestal at the tip of the stem), radiolucency, and change in implant position and sign of osteointegration (viz. no radiolucent line surrounding stem, cortical hypertrophy at the end of porous surface), 2) The cementation quality of the femoral component was graded according to the system proposed by Barrack et al. [10] [A: Medullary canal filled w/ cement (whiteout). B: Slight radiolucency exists at the bone cement interface. C: Radiolucency of more than 50% at the bone cement interface. D: Radiolucency involving more than 100% of the interface between bone and cement in any projection, including the absence of cement distal to the tip of stem]. Patients were allowed partial weight-bearing and subsequently full weight bearing depending on patient compliance, radiographic follow-up, and total loading was permitted.

Initial placement of the prosthetic components should mimic the average positions of the native acetabulum and femoral head and neck [11]. Specific anatomical landmarks and measurements were used to verify correct placement. In the initial evaluation of hip arthroplasty, the following elements were assessed according to the radiographic assessment of hip replacements by Jessica Williams and Michael Neep [11].

1. Leg length
2. Horizontal center of rotation
3. Acetabular inclination
4. Femoral stem positioning
5. Cement mantle [The most common system for assessing radiolucencies within the acetabular mantle is the Charnley-Delee system [12]. In this method, the acetabular cement mantle is divided into three equal zones, I, II, and III, from lateral to medial (on AP views). Similarly, the femoral cement mantle can be divided into seven zones on an AP view, according to the Gruen method [13].]

Postoperatively complications including aseptic loosening, osteolysis, infection, peri-prosthetic fracture, dislocation, and implant fracture were recorded.

Descriptive statistics were analyzed with SPSS version 17.0 software. cContinuous variables were presented as mean ± SD, categorical variables were expressed as frequencies and percentages. Continuous variables, including HHS over time, were analyzed using repeated-measures analysis of variance (ANOVA) followed by Bonferroni's post hoc testing for paired comparisons. Kaplan Meier curve was made to show the dislocation rate during one-year period. $P<0.05$ was considered statistically significant.

## Result

Among these 240 patients, 139 patients were males and 101 females with ages between 60 – 100 years. The surgery of the right hip was performed in 121 (50.4%) patients and the left hip in 119 (49.6%) patients. The

male preponderance was seen, and 101 (42.1%) out of 240 patients were female. In this study, analysis of age distribution showed a narrow range with the maximum number of patients in the 60-70 years' age group, constituting 58.3% of total subjects. The mean hospital stay of patients in our series was 8.85 ± 2.32 days with a variation of a minimum number of 4 -7days in 61 patients and more than ten days in 54 patients. 52.1% of patients had a stay duration of 8-10 days.

In this study, at three years of follow-up, three dislocations occurred among 240 dual mobility cup total hip arthroplasty patients within the first three months following surgery, and none of these cases had any recurrent dislocation. Harris' hip score increased mostly in the first three months. The mean Harris hip score improved from 16.62 ± 6.34 preoperatively to 92.86 ± 2.28 at the time of 1 year follow up and 95.20 ± 1.82 at the time of three year follow up (Figure 1).

Radiologic analysis revealed no osteolysis or radiolucent lines around the acetabular and femoral components during the follow-up period. No features of implant loosening and no evidence of component migration were found radiologically, while all radiographs demonstrated the implants being properly seated with evidence of bone ingrowth (> +10). The dislocated patients were treated with open reduction for two patients and close reduction done in one patient and did not re-dislocate at 3-year follow up (Figure 2-4).

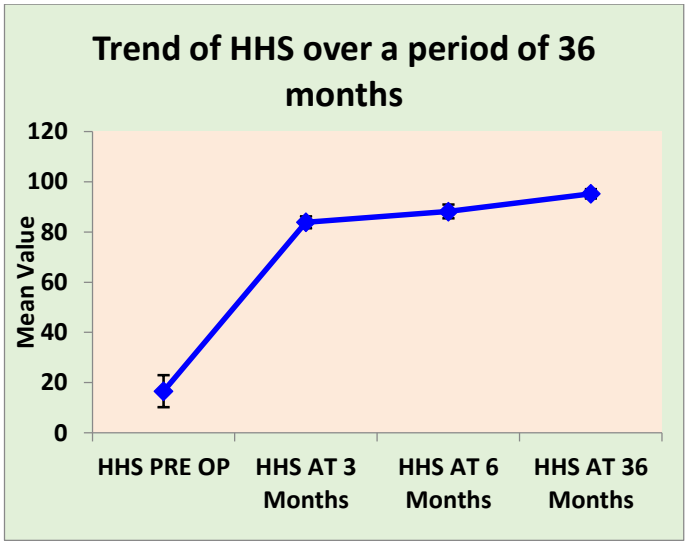


Figure 1: Showing signified HHS improvement from Pre-op to initial 3 months of Post-op.

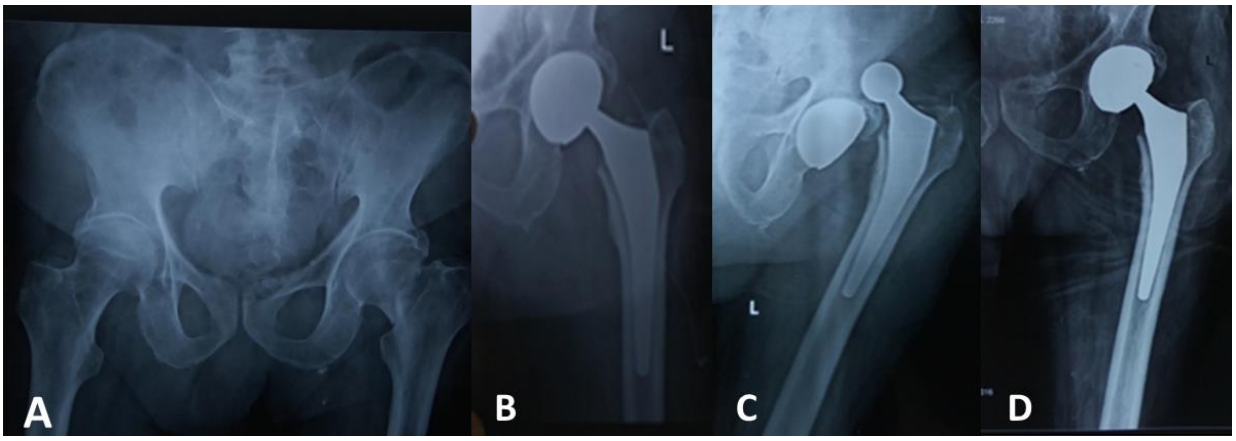


Figure 2:(A)Preoperative x ray- fracture of the left femoral neck,(B)Immidiate post-op x ray- treated with total hip arthroplasty using a dual mobility cup,(C) dislocation occurred after 1 month due to fall,(D)Immidiate after Post open reduction x ray.

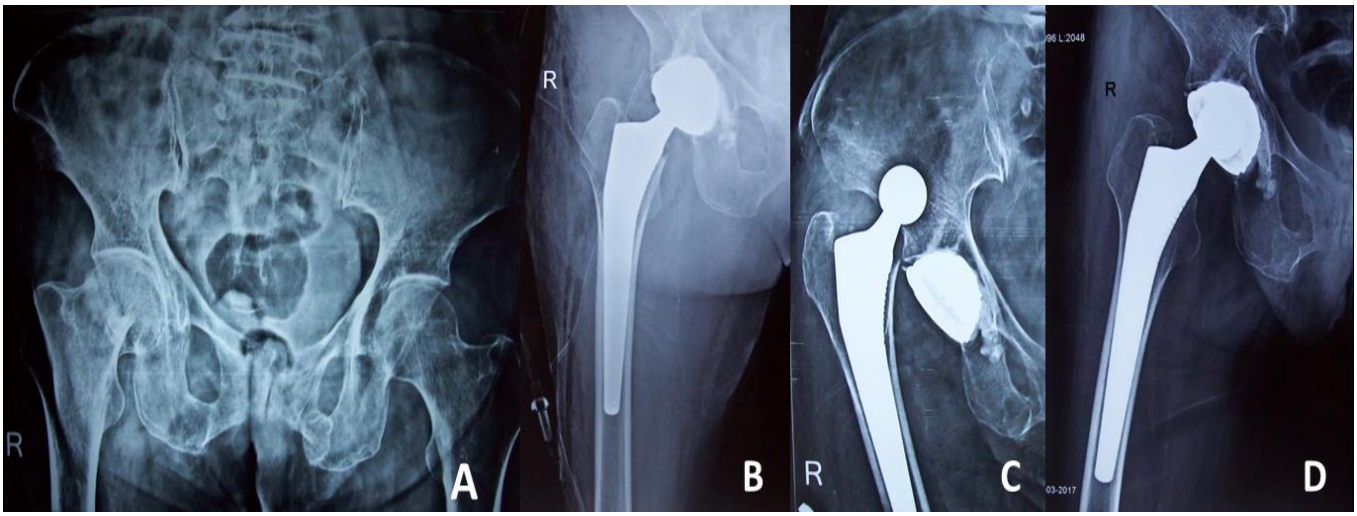


Figure 3: **(A)** Preoperative x ray- fracture of the right femoral neck,**(B)** Immidiate post-op x ray- treated with total hip arthroplasty using a dual mobility cup,**(C)** Uneventfullydislocation occurred after 3 month, **(D)** Immidiate after Post open reduction x ray.

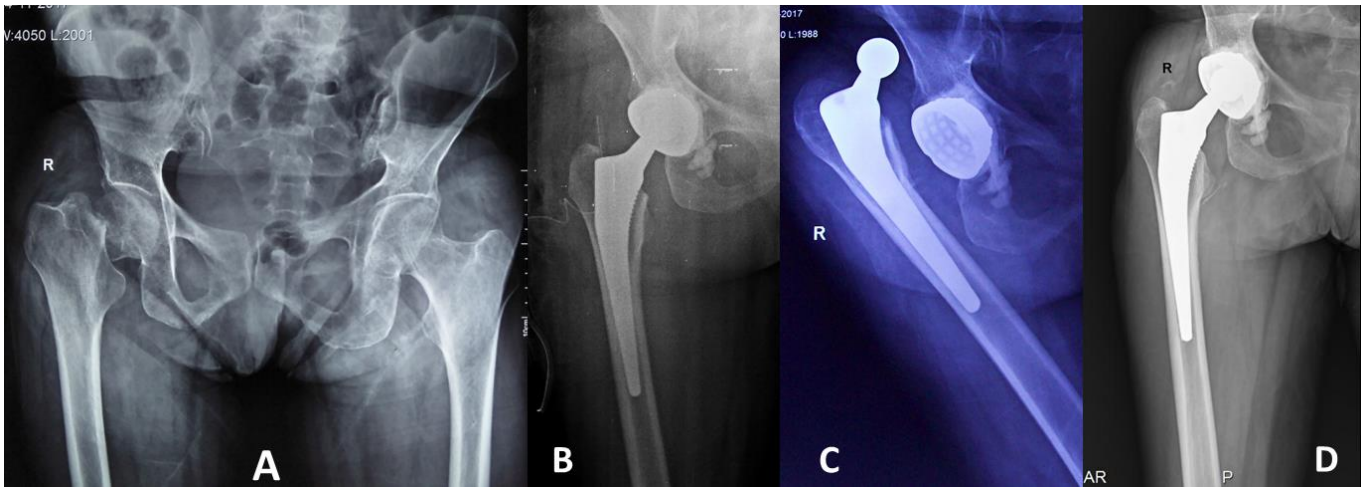


Figure 4: **(A)** Preoperative x ray- fracture of the right femoral neck,**(B)**Immidiate post-op x ray- treated with total hip arthroplasty using a dual mobility cup,**(C)** Uneventfully dislocation occurred after 3 month,**(D)** x ray after 1 year follow up without any sign of lessening.

## Discussion

The present study attempted to evaluate the dislocation rate following the usage of dual mobility cups with the posterior approach. The literature documented that dislocation mainly occurs within three months (early dislocation) or after five years of total hip arthroplasty. Woo and Morrey [14] reported that 59% (196 hips) of the dislocations occurred within the first three months after surgery and overall 77% (257 hips) within the first year. Another working group added that in their patient population (19680 primary hip replacements), THA dislocations occurred in 513 cases, of which 32% manifested as late dislocations more than five years postoperatively; the recurrent dislocation rate among these patients was 55% [15]. Prudhon and Delaunay et al. reported dislocation rates of 1.3–4% within 1–3 months of revision THA with the use of dual-mobility cups [16, 17].

Dual mobility cups are known for a low rate of early dislocation and high mobility range [18]. In our study, 240 patients were studied to establish the fact that the use of dual mobility cups decreases the rate of early dislocation following THR. This study reported the early dislocation noted within three months of the procedure, and a minimum of 3-year follow-up was used

in this study so that no early dislocation was missed. We evaluated the functional, radiological, survival, and dislocation rate of dual mobility cup for total hip arthroplasty.

A male preponderance was seen, and 101 (42.1%) out of 240 patients were female. In this study, analysis of age distribution showed a narrow range with a maximum number of patients in the 60-70 years' age group, constituting 58.3% of total subjects. The mean hospital stay of patients in our series was 8.85 ± 2.32 days with a variation of a minimum number of 4 -7days in 61 patients and more than ten days in 54 patients. 52.1% of patients had a stay duration of 8-10 days.

All patients were followed up for three years with pre-operative and post-operative Harris hip score and radiological assessment being calculated at three months, six months, one year, and at the time of completion of the study.

Regarding radiological loosening, Criteria for the diagnosis of loosening of either the femoral or the acetabular component have not been universally accepted. Some studies have shown failure as radiographic evidence of loosening despite continued satisfactory clinical performance. Others stress survivorship and define an endpoint as revision or removal of the prosthesis, some patients, despite having the prostheses still in place, have clear evidence of loosening, however, and maybe rated as clinical failures.

At each visit, radiographs were inspected for changes in the stem, the cement, the bone, and the interfaces between them. The anteroposterior and lateral radiographs were taken when patients were seen for periodic postoperative evaluation, included the entire length of the stem and were inspected carefully and compared with previous X-rays for changes indicating component loosening, stem failure, trochanteric problems, or infection. It was helpful to record the specific zones around acetabular and femoral components in which changes develop. These changes include sharply defined, widening radiolucency at the bone cement interface indicates loosening with progressive osteolysis. The femoral component and associated interfaces were divided into seven zones, as described by Gruen et al. [13] and Engh criteria [9] for Osseo integration of uncemented femoral stems. The acetabular component and surrounding bone were divided into three zones, as it was described by DeLee and Charnely [12].

Regarding instability of implant, an unstable implant is defined as one with definite evidence of progressive subsidence or migration within the canal and at least is partially surrounded by divergent radiopaque lines that are separated more widely from the stem at its extremities. Increased cortical density and thickening typically occur beneath the collar and at the end of the stem, indicating regions of local loading and lack of uniform stress transfer. We did not get any evidence of radiological loosening in our study.

Numerous factors influence the rate of dislocation after THA such as Old age, previously operated on the affected hip, neurological disorder, previous h/o excessive alcohol intake, and nonunion of the greater trochanter. All-cause soft-tissue imbalance and increase the risk of dislocation.

In our study, Harris hip score increased mainly in the first three months. The mean Harris hip score improved from 16.62 ± 6.34 preoperatively to 95.20 ± 1.82 at the final follow-up. Guyen et al. [18] reported improvement in HHS from a mean of 40 (range, 11–100) preoperatively to 83 (range, 25–100) at the latest follow-up.

Boyer et al. [19] reported a final follow-up mean HHS of 92 (SD, 1.9) in their retrospective study of 240 hips with a minimum follow-up of 18 years. Combes A et al. [20] reported meaning Harris's hip score increased from 39 ± 15 (range, 0–85) preoperatively to 91 ± 11 (range, 60–100) at the latest follow-up. Nabil M et al. [21] reported mean Harris hip score improved from 39.4 preoperative to 87.6 postoperative after two years of follow-up.

In this study, different types of cups were used. 82.5% of patients used a non-cemented cup, 17.5% used cemented cups, and no early radiographic loosening was seen at a follow-up of one year. 37.5% of patients had used press-fit, and dome spikes (Captive DM) cups, 16.7% ridges outer shape and dimples for adequate cement mantle (Cotyle DM) cups, 37.1% Cluster or solid-back shells with secure locking mechanism (Trident) cups, and 8.8% hemispherical shells utilize the screw hole pattern and locking mechanism (Tritanium) cups. 55.4% of patients had cup sizes between 52-58 mm, and 44.6% had cup sizes between 44-50mm.

No cup migration occurred in any patients in this study, and 95.4% of patients were found in the normal

cup positions after radiological evaluation, 2.9% in the vertical cup, and 1.7% in the horizontal cup. There were no intraoperative complications that occurred in any patients in this study.

All patients had used a polyethylene (poly) insert. 91.3% of patients' head materials were metal, and 8.8% ceramic. 89.2% of patients used non-cemented, and only 10.8% used cemented stem. There was no stem migration occurred in any patients in this study. 94.6% of patients were seen normal stem position after radiological evaluation, only 5.4% were found in the varus stem position, and no dislocation occurred in these patients. There was no stem loosening appeared in any patients according to radiological evaluation criteria used in this study.

One of the patients dislocated after one month of total hip arthroplasty due to a fall at home (figure 2). It might be difficult to appreciate whether the fall was due to dislocation or dislocation was due to fall. As per radiological criteria, his cup position was vertical and acetabular inclination of 55 degrees by visuospatial perception, which might be contributing factor to the instability. The other two patients dislocated uneventfully after three months of THA. As per radiological criteria, his cup position as standard, and his acetabular inclination was 55-60 degrees by visuospatial perception. In our study, one the other patients had a vertical cup position and acetabular inclination between 55-60 degrees by visuospatial perception, but no dislocation occurred in this patient. Therefore, the vertical cup position was not the only risk factor for dislocation in our study.

Mallory and Lombardi [22] reported a higher risk for dislocation when the THR was performed for femoral neck fracture, or congenital dislocation of the hip. Lee and Berry [23] reported a 10% rate of dislocation in a series of primary THR for acute femoral neck fracture at Mayo Clinic. Poorer or damaged muscles, greater propensity for falls, and altered proximal femoral anatomy may be contributing factors to explain the higher risk for dislocation in these diagnoses.

Lewinnek et al. [24] proposed a safe zone of 30–50 degrees of inclination and 5–25 degrees of anteversion as a means of minimizing postoperative dislocation. Given the association between excessive tendency and an increased rate of wear and edge loading, Callanan et al. [25] recommended that an inclination range of 30–45 degrees was ideal. Biedermann et al. [26] found a statistically significant reduction in dislocation risk for 35–55 degrees of inclination and 5–25 degrees of anteversion.

Iorio et al.[27] revealed that the mean dislocation rate was 10.7% in patients with FNF treated with THA, five times higher than THA for osteoarthritis. Adam et al. [28] reported three dislocations (1.4%) at 9-month follow-up in a series of 214 patients with FNF treated with DM implants.

Newington and Bannister [29] reported a rate of dislocation of 15.2% n primary hip replacements in patient over 80 years of age. Jolles and Zangger [30] observed a twofold risk of THR dislocation among octogenarians. Amstutz and Le Duff [31] reported a prevalence of dislocation of 4% in 57 primary THR. The authors did not mention whether patients were at higher risk for dislocation.

Postoperative dislocation is a critical 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 hemi arthroplasty.

The rate of dislocation after hemi arthroplasty was 3.8% in the surgical approach and 6.9% in the posterior approach, as reported in 2007 [32]. The relative risk of dislocation was 2.9 times less, although not statistically meaningful for using a dual mobility cup in the surgical approach, and the relative risk of dislocation was 3.9 times less in a Dual mobility cup and posterior approach, reaching statistical significance ($P < 0.05$) [32].Comparing the present series of dual mobility cups in the treatment of displaced fractures of the femoral neck to the recent sequence of bipolar hemi arthroplasties, the relative risk of dislocation appears 4—4.7 times higher for hemi arthroplasties [3,6-8,33]. 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 [32-34]. The difference is clear, especially when there is no additional patient selection than a displaced fracture of the femoral neck in the elderly. Johanson et al. [34] reported a 22% rate of dislocation after total hip replacement for fracture of the femoral neck in a population of non-selected elderly people of similar age (84 years) to the current series. The relative risk of dislocation reported by these authors with conventional total hip replacements was 15.5 times

higher than what was observed in this study using dual mobility cups ($P < 10-5$) [34].

The dislocation rate reported by Lu-Yao et al. [35] in a meta-analysis comprising 746 total hip replacements as a primary treatment for a displaced fracture of the femoral neck was 10.7%. The mean age at surgery was 72 years, potentially due to the selection of younger patients compared to the present series of dual mobility cups. Nevertheless, the relative risk of dislocation was 7.6 times higher for the conventional cups used in that meta-analysis when compared to the present series of dual mobility cups ($P < 10-4$) [35]. The good short-term results of implantation of a dual mobility cup as a part of a total hip arthroplasty following a displaced fracture of the femoral neck need to be followed for a longer time. Good long-term results with these implants have already been reported in the setting of primary hip replacement for osteoarthritis or avascular necrosis of the femoral head, the complication rate being extremely low for patients older than 70 years at the time of surgery [36]. Concerns about potential wear had already been ruled out, with a mean annual volumetric polyethylene wear of 54.3 $mm^3$ [37]. The use of cemented dual mobility cups, either directly in the host bone or in a reinforcement ring, has only recently been introduced, although good early results have been reported [38]. It might be an option in cases of severe osteoporosis, but questions remain regarding the quality of fixation over a more extended period. Using dual mobility cups makes total hip replacement a safe option in terms of postoperative dislocation. Improvements in postoperative pain and function are described as early as 1—2 years after surgery with the use of a total hip replacement instead of a hemi arthroplasty [39]. In addition, the use of dual mobility cups provides a significant decrease in postoperative dislocation compared to hemi arthroplasties when a posterior approach is chosen, with a relative risk of dislocation 3.9 times lower ($P < 0.05$). In the posterior approach, care should be taken not to retrovert the cup.

Nevertheless, a dislocation rate of 1.3% with a posterior approach, despite the unfavorable clinical setting of an intracapsular fracture of the proximal femur, is far less than previously reported after primary total hip arthroplasty with the use of 32 mm heads [40]. Further study is needed before extending the indications for total hip arthroplasty following a fracture of the femoral neck to assess the potential cost and complications of more elongated procedure with its possible acetabular difficulty and weigh them against the potential benefits of a low dislocation rate and improved bearing in comparison with hemi arthroplasties.

## Conclusion

In the current prospective study, the systematic use of dual mobility cups in the treatment of displaced fractures of the femoral neck had a low dislocation rate of 1.3%, even though a posterior approach had mainly been performed. The dual mobility cups should be applied to the low dislocation rate when treating a displaced intracapsular fracture of the proximal femur in an elderly patient.

## Acknowledgments

Not-applicable.

## Authors' contributions

DP: Collecting data and Manuscript writing.
AS & RV: Editing in manuscript and correcting mistake.
SC: Taking Consent and other article related help whenever required.

## Conflict of interest

Dharmesh Patel, Avtar Singh, Rajeev Vohra, and Sandeep Chauhan declare that they have no conflict of interest.

## Funding/support

Not applicable.

## Ethical consideration

Ethical approval taken from Amandeep hospital & clinics Institutional ethics committee.

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