

Management of fracture neck of femur in elderly patients using dual mobility cup total hip arthroplasty versus bipolar hemiarthroplasty

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Introduction

Fracture neck of femur (FNF) represents a major public health problem worldwide. The aim of this study is to evaluate the clinical, functional outcome and rate of complications of dual mobility cup total hip arthroplasty versus bipolar hemiarthroplasty in the management of displaced fracture neck femur in elderly patients.

Methods

A prospective Randomized control study was done in a university specialized unit between January 2018 and January 2021 on 40 elderly patients had a mean age of 70.5 years (range 60-91) with displaced intracapsular FNF. 20 patients were managed by Dual Mobility Cup Total Hip Arthroplasty (DMC THA group) and 20 patients underwent Bipolar Hemiarthroplasty (BHA group) for the treatment of their femoral neck fractures with a minimum 24 months follow-up (range 24-35). Rate of dislocation postoperatively was the primary outcomes while functional outcome (Harris Hip Score), intraoperative blood loss and length of operation were the secondary outcomes.

Results

The Harris hip score (HHS) was higher in the DMC THA group and was most significant after 6 and 12 months with P value ($P < 0.05$). The dislocation rate was less in the DMC THA group. The BHA group demonstrated less intraoperative blood loss ($P < 0.001$) and a shorter length of operation ($P < 0.001$). However, there was no significant difference in two-year mortality with P value ($P > 0.05$), blood transfusion rate with P value ($P = 0.471$) and infection rate with P value ($P = 1.000$).

Conclusion

In light of our results, the use of THA DMC did not seem to increase mortality, morbidity, or complications rate like infection or bleeding but it decreases dislocation rate and increase functional outcome when compared with BHA.

Keywords:

bipolar hip hemiarthroplasty, dual mobility cup total hip arthroplasty, fracture neck of femur

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Introduction

Fracture neck of femur (FNF) represents a major public health problem worldwide. Patients are often old and fragile and many have several medical co-morbidities. Sustaining a displaced femoral neck fracture is also associated with increased morbidity, mortality, impaired mobility and function for the patient [1].

Often hemiarthroplasty is the preferred treatment compared with total hip arthroplasty because of reduced dislocation rates, less complex surgery, shorter operation time, less blood loss, and lower initial costs [2].

On the other hand, total hip arthroplasty is associated with a lower rate of reoperation, less pain, a better functional outcome and mobility and lower long-term costs compared with hemiarthroplasty [3,4], but with high dislocation rate [5].

Back in the 1970s the dual mobility concept was invented in France by Prof. Gilles Bousquet, which consists of a combination of two apparent joints, one large unconstrained joint between the metal cup and the liner, and a smaller constrained joint between the liner and a standard metallic head that is attached to the femoral component [6].

For that total hip arthroplasty with a dual mobility cup should increase the range of motion and provide very stable articulation and also is associated with lower rates of dislocation procedures compared with total hip

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arthroplasty with a conventional cup and can be better alternative to bipolar hemiarthroplasty [7].

The aim of this study is to evaluate the clinical, functional outcome and rate of complications of dual mobility cup total hip arthroplasty versus bipolar hemiarthroplasty in the management of displaced fracture neck femur in elderly patients.

Materials and methods

A prospective Randomized control study was done in a specialized university arthroplasty unit between January 2018 and January 2021 on 40 elderly patients had a mean age of 70.5 years (range 60-91) with displaced fracture neck of femur and managed by either Dual mobility cup total hip arthroplasty (DMC THA) or bipolar hip hemiarthroplasty (BHA). The patients were informed of the study, and after written informed consent was obtained, we initiated the procedures. Inclusion criteria were as follows: patient aged 60 years or older with displaced intracapsular FNF (garden 3, 4). We excluded from the study: extracapsular FN fractures or trochanteric fractures, pathological fracture, any radiographic signs of ipsilateral hip arthritis (Tonnis classification) [8], and dysplastic hip or shallow acetabulum (LCEA of less than 25) [9]. For evaluation of the grade of osteoarthritis and acetabular dysplasia (by measuring the lateral center edge angle (LCEA)), preoperative radiographs were performed. LCEA is defined as the angle between a vertical line from the center of the head of femur and another line of the acetabular rim. This angle is used to evaluate acetabular coverage of the femoral head and acetabular dysplasia [9]. Acetabular dysplasia was excluded to avoid affecting the outcome of dislocation in BHA. Normally, the LCEA is between 25 and 39°; less than 20° is considered dysplastic, and more than 39° is considered protrusion acetabulii.

In order to eliminate bias in patient's selection for surgical procedures, Patients were randomized using a computer-generated sequence into 2 equal groups (20

patients each) based on the procedure: BHA group and DMC THA group. Patients were blinded to the modality of the surgical procedures in order to obtain the single-blinded status.

Methods of assessment

Patient's demographics (Table 1) were analyzed including sex, age and body mass index. Also, patient's co-morbidities in each group were reported and there was no statistical difference.

Rate of dislocation postoperatively was the primary outcome while functional outcome (Harris Hip Score), intraoperative blood loss (measured in the suction bottles minus lavage fluid in ml), and length of operation were the secondary outcomes.

The Primary and secondary outcomes were evaluated at 1, 3, 6, 12, and 24 months, by examinations mentioned above, together with anterior-posterior (AP) and lateral (LAT) plain radiograph.

Operative details

All surgeries were performed by senior surgeons specialized in HA and THA. Patients were all operated through modified direct lateral approach (Modified Harding) [10].

The following implants were used: DMC THA were from Zimmer Biomet. Femoral stems were cemented, and acetabular cups (Advantage Dual Mobility Cup System) were cemented (12 cases) or cementless (8 cases). BHA were from Zimmer Biomet and Orthomed E. All femoral stems were cemented.

All patients were treated with the same protocol: intraoperative third generation cephalosporin antibiotic for antimicrobial prophylaxis given 30 min before the incision and continued for 3 days postoperatively, intraoperative tranexiemic acid is given intravenously and locally on the wound to decrease postoperative blood loss. Thromboembolic prophylaxis was given 12 h after surgery as oral anticoagulant (Apixiban

Table 1 Comparison between DMC THA group and BHA group according to demographic data

| Demographic data | DMC THA Group (n=20) | BHA Group (n=20) | Total (n=40) | Test value | P-value |
|-----------------------------|----------------------|------------------|--------------|-----------------------|---------|
| Age (years) | | | | | |
| Mean±SD | 68.95±4.57 | 72.50±7.03 | 70.53±6.58 | t=1.893 | 0.066 |
| Range | 60–76 | 65–91 | 60–91 | | |
| Sex | | | | | |
| Female | 15 (75.0%) | 11 (55.0%) | 26 (65.0%) | χ ² =1.758 | 0.185 |
| Male | 5 (25.0%) | 9 (45.0%) | 14 (35.0%) | | |
| BMI [wt/(ht) ²] | | | | | |
| Mean±SD | 27.90±4.17 | 25.46±3.91 | 26.68±4.18 | t=1.909 | 0.064 |
| Range | 21.5–36.4 | 19.1–33.6 | 19.1–36.4 | | |

Using: t-Independent Sample t-test; χ²2: Chi-square test; -value < 0.05 is significant.

2.5 mg twice daily) to prevent DVT for 35 days. The patients were allowed partial weight bearing by walker first day after surgery when their general condition allowed it. Drain was removed 48 h after surgery and patients were discharged on the third postoperative day and follow-up was in outpatient clinic after 1 week. After 2 weeks postoperatively stitches were removed.

Statistical analysis

Recorded data were analyzed using the statistical package for social sciences, version 20.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were expressed as mean \pm standard deviation (SD). Qualitative data were expressed as frequency and percentage.

The following tests were done:

- (1) Independent-samples *t*-test of significance was used when comparing between two means.
- (2) Paired sample *t*-test of significance was used when comparing between related sample.
- (3) Chi-square (χ^2) test of significance was used in order to compare proportions between qualitative parameters.
- (4) The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the *P* value was considered significant as the following:
- (5) Probability (*P* value)

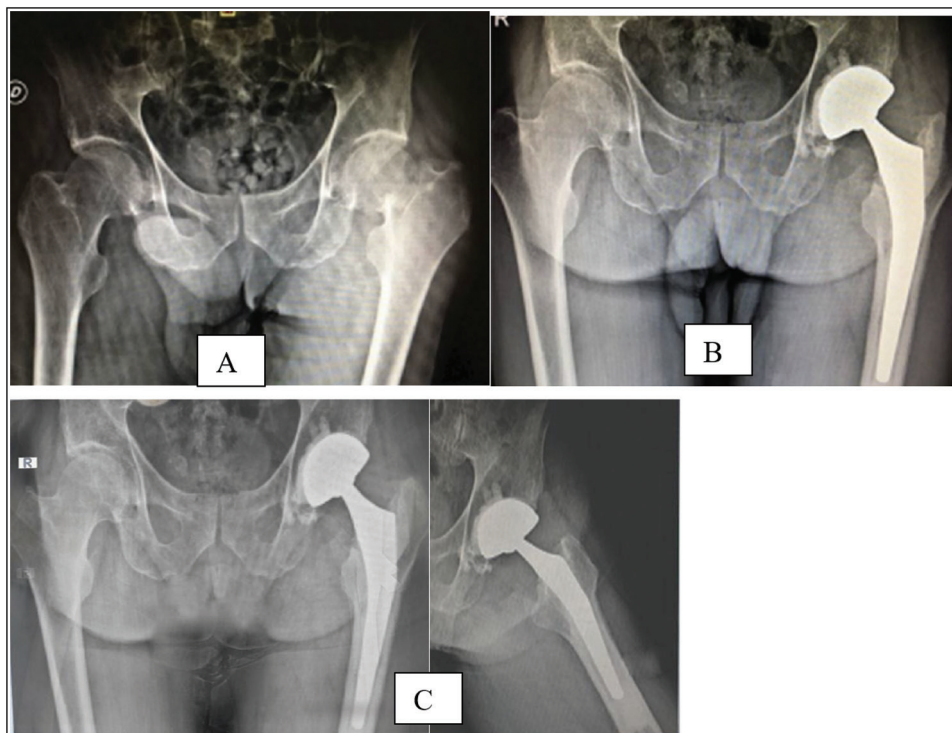
- (a) *P* value less than 0.05 was considered significant.
- (b) *P* value less than 0.001 was considered as highly significant.
- (c) *P* value greater than 0.05 was considered insignificant.

Results

We applied our study on 40 patients divided into two equal groups: DMC THA group (*n* = 20) (Fig. 1) and BHA group (*n* = 20) (Fig. 2), with the same inclusion and exclusion criteria. Patients' demographics were illustrated in (Table 1).

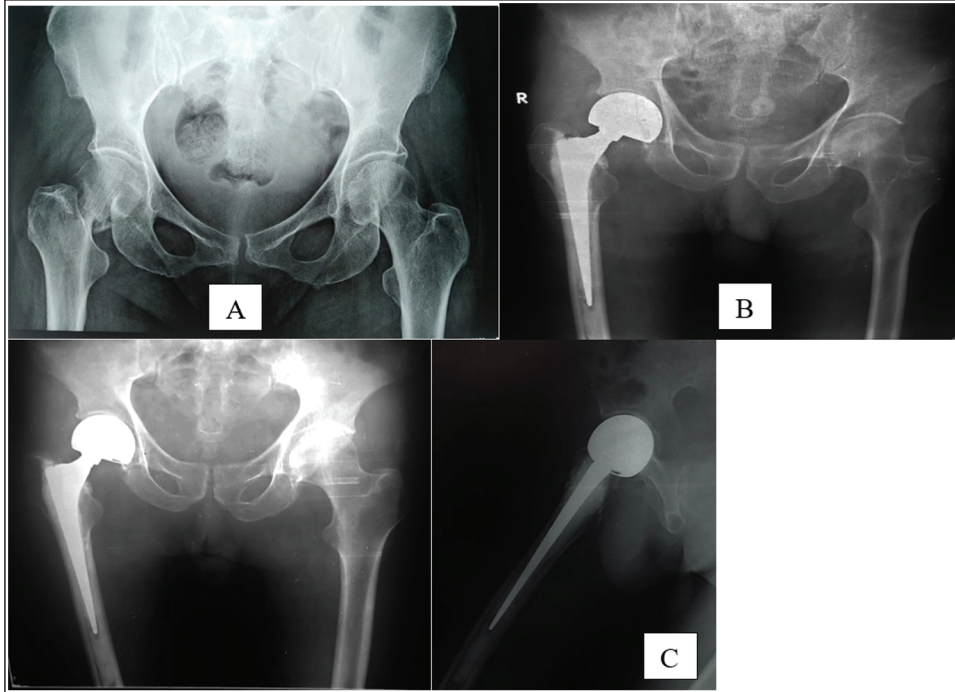
Regarding the dislocation rate, no dislocations were encountered in the DMC THA group compared with 2 dislocations (10%) in the BHA group. This rate is statistically insignificant between the two groups with *P* value (*P* = 0.147) (Table 2). The first dislocated case occurred 6 months postsurgery as the patient fell while walking. It was managed by closed reduction under general anesthesia but dislocated again after one month where the patient was planned for revision surgery, but the patient died from acute myocardial infarction. The other dislocated without history of trauma 45 days postsurgery and managed by closed reduction, but the prosthesis was highly unstable, and the patient underwent conversion to DMC total hip arthroplasty (Fig. 3).

Figure 1



(a) Preoperative radiograph for a female patient 65 years old with subcapital displaced left FNF. (b) Immediate Postoperative radiograph with cemented dual mobility cup total hip arthroplasty. (c) 1 year postoperative Radiograph

Figure 2



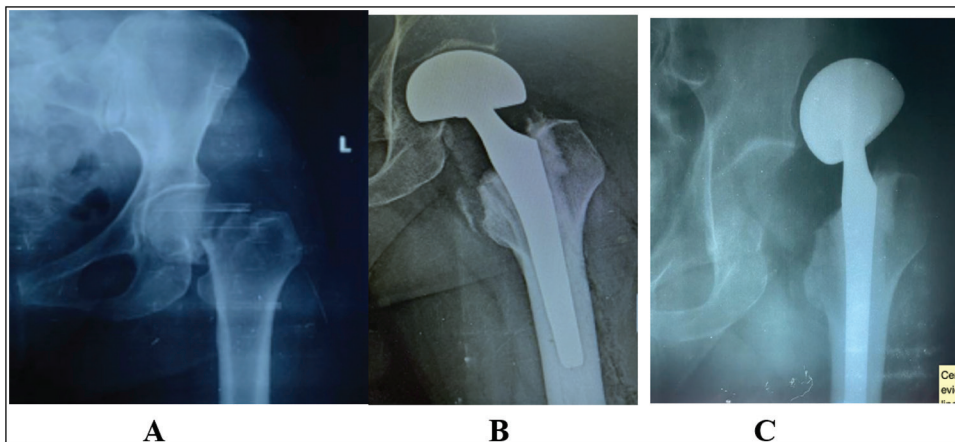
(a) Preoperative radiograph for a female patient 69 years old with subcapital displaced right FNF. (b) Immediate Postoperative radiograph with cemented bipolar hip hemi- arthroplasty. (c) one-year postoperative radiographs

Table 2 Comparison between DMC THA group and BHA group regarding the dislocation rate, length of the operation (min) and intra operative blood loss (ml)

| | Dislocation rate | Mean Length of the operation in min | Mean Intra-operative blood loss (ml) |
|----------------|------------------|-------------------------------------|--------------------------------------|
| DMC THA group | 0 (0.0%) | 81.75 ± 16.72 | 700.00 ± 197.35 |
| BHA group | 2 (5%) | 54.25 ± 12.38 | 430.00 ± 101.83 |
| <i>P</i> value | 0.147 | <0.001 | <0.001 |

P-value <0.001 is highly significant; *P*-value >0.05 is insignificant.

Figure 3



(a) Preoperative radiograph for a male patient 78 years old with transcervical displaced left FNF. (b) Postoperative radiograph with cemented bipolar hip hemi- arthroplasty. (c) Dislocation of the prosthesis

The mean length of operation in the BHA group was significantly shorter compared with the DMC THA group. Also, the mean intraoperative blood loss in the DMC THA group compared with the BHA group was significantly less. (Table 2).

Despite greater blood loss and more length of operation in the DMC THA group, the transfusion rate was not significantly high ($P = 0.471$), six patients (30%) in the DMC THA group compared with four patients (20%) in the BHA group.

Regarding HHS there was increase mean of HHS over periods in the two groups (Fig. 4), but the most significant increase was in the DMC THA Group compared with the Bipolar group mainly after 6 months and after 12 months, with *P* value ($P < 0.05$) (Table 3).

There was superficial wound infection in one patient (5%) in each group which is not statistically significant (*P* value = 1.000). No deep infection was encountered in any patient in both groups.

There was no significant difference between both groups in two years mortality with *P* value greater than 0.05, one patient (5%) died in each group.

Discussion

Total Hip Arthroplasty is the preferred treatment modality for healthy elderly patient with displaced neck of femur fracture because of its better functional

results and low revision rate but this procedure is commonly complicated by high dislocation rate Zhao and colleagues [11].

Several studies preferred BHA in healthy elderly patient because of low dislocation rate and good functional outcome but this procedure is complicated by high revision rate. Hence in active healthy elderly patients there is still controversy over whether total hip arthroplasty or bipolar hip arthroplasty should be selected for displaced neck of femur fracture Wang and colleagues [12].

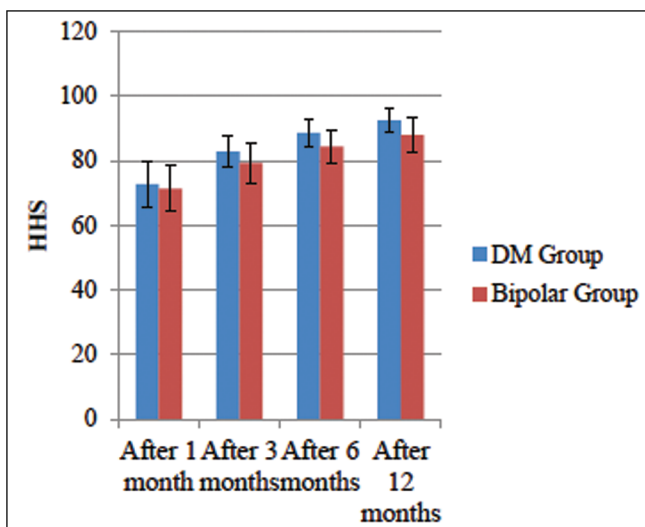
Dual mobility total hip reduces the risk of dislocation, causes less impingement, decreases friction and wear. It also increases range of motion. This construct combines the concepts of low friction arthroplasty with large head articulation Matsen and colleagues [13].

Dislocation after hip arthroplasty is a key issue. Compared with bipolar hemiarthroplasty, Dual mobility THA is associated with reduced risk of dislocation without increasing the mortality Boukebous and colleagues, Ma and colleagues [14–16].

Despite the increased effective head size, the stability of BHA may also be affected by other factors, including pelvic morphologic features (e.g., acetabular under-coverage or femoral head extrusion) which can also increase the risk of dislocation. The head coverage of DMC THA is based on the size of the cup and shell, which is not affected by native pelvis morphology Ma and colleagues [16].

Compared with bipolar hemiarthroplasty, DMC THA has the advantage of adjusting the acetabular side so the stability is improved and lower dislocation risk is found. So, bipolar hemiarthroplasty should be carefully considered when the acetabulum tends to be shallow and a total hip replacement should be performed if necessary Yang and colleagues [17].

Figure 4



Comparison between DMC THA group and BHA group according to HHS.

Table 3 Comparison between DMC THA group and BHA group according to HHS

| HHS | DMC THA Group (n=20) | BHA Group (n=20) | t-test | P value |
|-----------------|----------------------|------------------|--------|---------|
| After 1 month | | | | |
| Mean±SD | 72.75 ± 7.09 | 71.39 ± 6.95 | 0.597 | 0.554 |
| Range | 55-82 | 55-80 | | |
| After 3 months | | | | |
| Mean±SD | 82.80 ± 4.86 | 79.22 ± 6.25 | 1.981 | 0.055 |
| Range | 74-89 | 68-88 | | |
| After 6 months | | | | |
| Mean±SD | 88.55 ± 4.19 | 84.39 ± 5.16 | 2.742 | 0.009* |
| Range | 80-95 | 75-92 | | |
| After 12 months | | | | |
| Mean±SD | 92.50 ± 3.89 | 87.94 ± 5.26 | 3.056 | 0.004* |
| Range | 85-99 | 77-97 | | |

Using: t-Independent Sample t-test *P*-value >0.05 is insignificant; **P* value < 0.05 is significant; ***P* value < 0.001 is highly significant.

In our study the risk of dislocation was lower with DMC THA than bipolar HA also the reoperation rate was also lower in the DMC THA group, which can partly be explained by the decreased dislocation rate.

In this study, BHA showed the merits of a shorter operative time and less intraoperative blood loss, while DMC demonstrated a higher mean HHS. Both options revealed no significant differences in the blood transfusion and two-year mortality. The shorter operative time and reduced intraoperative blood loss compared with THA have been repeatedly confirmed in other studies Van Den Bekerom and colleagues, Kim and colleagues [18,19].

However, BHA is a simpler procedure involving only the femoral side of the hip joint, longer operative time and more intra-operative blood loss due to acetabular procedures are inherent in every THA DMC. Therefore, it is only logical to see if these differences affect more meaningful outcomes, such as transfusion rate or mortality.

A meta-analysis of six randomized controlled trials confirms no difference in the mortality between BHA and THA Burgers and colleagues [20]. Also, studies have compared BHA and DMC in terms of three-month and one-year mortality, and again showed no difference Kim and colleagues, Bensen and colleagues [19,21]. The present study adds more strength to this finding.

Although BHA procedure is less in operative time and less in blood loss than THA DMC but there is no effect on infection rate Ukaj and colleagues [22]. In our study it was one superficial infection in each group and managed with antibiotics and daily dressing.

Multiple studies with displaced fracture neck femur patients confirmed significantly higher postoperative clinical scores in the terms of HHS in the DMC groups than the BHA groups Ma and colleagues, Van Den Bekerom and colleagues, Ukaj and colleagues, Liu and colleagues [16,18,22,23]. As Ukaj S and colleagues found a significant difference between DMC and BHA groups in terms of HHS postoperatively at 1 and 3 years. The HHS increased progressively over time and was more significant in the third year of follow-up, suggesting that DM was a more reliable surgical technique [22].

Also, Kim YT and colleagues [19] though their study demonstrated a significantly higher HHS and its subdomain pain in the DMC group. These results are similar with the results in the current study.

In a cohort published by TM Makeen and colleagues [24] there was no difference in the dislocation rate between the two groups with significant increase in the postoperative functional outcome and the length of the procedure. These findings go hands in hands with the current study. DMC total hip arthroplasty is a technically demanding procedure and needs a learning curve, this explains the longer increase in the postoperative time. TM Makeen and colleagues [24] also recommended an algorithm for management of fracture neck of femur in elderly patients were they concluded that healthy active independent patients and/or patients with grade 3 hip OA and/or patients with LCEA less than 25° or greater than 39° are good candidates and better to be managed by DMC total hip arthroplasty rather than BHA.

In a multicentric retrospective study on 302 patients with fracture neck of femur managed by either DMC or BHA Marco Rotini and colleagues [25] concluded that DMC did not lead to an increase in mortality, morbidity, bleeding, or dislocation rate when compared with BHA and could be considered as treatment of choice for DFNFs especially in healthy and active patients. These findings match our results and conclusion in the current study.

Limitations

The relative short follow-up time for detection of postoperative functional outcome is one of the limitations of the current study, particularly in the BHA group. Follow-up for a longer time is needed to elicit any protrusion or advanced wear in the acetabulum. So, more prospective RCTs with longer follow-up and bigger sample size are needed. Another limitation of the study is the small sample size. So, a larger sample size is needed for proper assessment of the outcomes and complications.

Conclusion

In light of our results, the use of THA DMC did not seem to increase mortality, morbidity, or complications rate like infection or bleeding but it decreases dislocation rate and increase functional outcome when compared with BHA.

Acknowledgements

Ethical approval

All procedures performed in this study were in accordance with the ethical standards of the institutional and national research committee and with Helsinki declaration and its later amendments.

Informed consent: informed consent was obtained from all individual participants in this study.

Consent to publish: all authors are consented for publishing this study.

Authors contribution: all authors are contributed in the study.

Availability of data and materials: available when needed.

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Conflicts of interest

The authors declare that they have no conflict of interest.

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