ORIGINAL ARTICLE

Metaphyseal vs. diaphyseal fixed-stem hemiarthroplasty in treating unstable intertrochanteric fractures in elderly patients

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ABSTRACT

BACKGROUND: Various surgical techniques have been defined for hip hemiarthroplasty (HA), including metaphyseal vs. diaphyseal and short stem vs. long stem. The present study aims to compare outcomes of metaphyseal fixed short-stem vs. diaphyseal fixed long-stem HA in treating unstable intertrochanteric fractures in elderly patients.

METHODS: This study was conducted retrospectively and included 129 patients ≥65 years of age, having unstable intertrochanteric fractures and undergoing HA. Outcome measures were the 2-year Harris hip score and the mobility score of Parker and Palmer; comorbidities as well as mortality rates of the groups were compared.

RESULTS: Mean operation time and median full weight-bearing time were significantly shorter in group B ($p<0.05$ for both). As for the Harris hip scores, group B showed better outcomes for the third-month evaluation ($p=0.006$). However, 2-year assessments were similar ($p=0.067$). In addition, higher Parker and Palmer mobility scores were obtained in group B at the 2-year assessment ($p<0.001$). The frequencies of prosthetic dislocation, cortical porosis and subsidence were higher in group A ($p<0.05$ for all).

CONCLUSION: The findings obtained in this study suggest that diaphyseal fixed long-stem HA seems to be superior to the metaphyseal fixed short-stem HA because the former is related to better functional scores, earlier mobilization, and lower complication rates.

Keywords: Diaphyseal; hemiarthroplasty; intertrochanteric femoral fracture; metaphyseal.

INTRODUCTION

The optimal treatment for unstable intertrochanteric femoral fractures in elderly osteoporotic patients remains controversial.[1] Internal fixation has some disadvantages in elderly patients due to the lack of fixation associated with a calcar defect and extreme osteoporosis, and conversion to hip arthroplasty is a challenging problem in relevant patients.[2] Many factors should be considered when deciding on treatment. The most significant parameter is to provide early mobilization and return to preoperative activity levels as soon as possible. In this context, in elderly patients with low functional demands and an intact acetabulum, hemiarthroplasty (HA) is an appropriate option.[3]

Various surgical techniques have been defined for hip arthroplasty, including metaphyseal vs. diaphyseal, cemented vs. cementless and short stem vs. long stem.[4] Recent studies have shown that the use of acrylic cement in elderly people is associated with an increased risk of cardiopulmonary complications;[1,5] therefore, cementless arthroplasty is more frequently preferred.[1,2] In this sense, the femoral component design is a vital part of hip arthroplasty success.[6] There is also concern about the effects of longer stems on the lifetime risk of periprosthetic fracture, which can be minimized using anatomical or shorter stems.[4] However, for elderly osteoporotic patients, sufficient stability cannot be obtained if the stems are both cementless and shorter.[4] The ideal cementless stem design for unstable intertrochanteric frac-

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tures in elderly osteoporosis patients should have sufficient length and extensive surface coating to achieve optimum stability at the subtrochanteric level.[2] However, there are few studies comparing metaphysis-fixed and diaphyseal-fixed HA.[7] Therefore, the objective of the current study was to compare outcomes of the metaphyseal fixed short-stem and diaphyseal fixed long-stem HA methods in the osteoporotic intertrochanteric fractures of elderly patients.

MATERIALS AND METHODS

Study Design and Participants

After we obtained the approval of the local ethics committee (56-861/05.2020), we conducted this study in a retrospective manner. Patients diagnosed with intertrochanteric hip fracture and who underwent either a metaphyseal fixed short-stem or diaphyseal fixed long-stem HA in a tertiary hospital between January 2013 and December 2017 were enrolled in this study. Inclusion criteria were being ≥65 years of age, having intertrochanteric fractures for the first time, and undergoing an HA. Exclusion criteria were <65 years of age, having pathological fractures (e.g., from either primary or metastatic cancer), recurrent hip fracture, or multiple trauma. The patients were allocated into two groups, according to the stem design, as the metaphyseal fixed short-stem group (A) and diaphyseal fixed long-stem group (B). Then, the data of the two groups were compared.

Data Collection and Assessment Tools

The data were gained from the patient files. Clinical and demographic properties (age, sex, body mass index [BMI], anesthesia type, concomitant diseases, and perioperative or postoperative complications) were recorded.

Outcome measures and classification parameters were the Singh index,[8] AO/OTA classification,[9] Harris hip score,[10] and the mobility score of Parker and Palmer.[11]

Surgical Method

The procedures were administered using the posterolateral surgical approach and by the same surgical team (as well as the same senior surgeon) with the patient in the lateral decubitus position as described by Moore et al.[12] A metaphyseal porous-coated, tapered short stem was used in group A (Tip-med TCK prosthesis), and a fluted, tapered long-stem in group B (Tip-med mono-block prosthesis). All patients were encouraged to be mobilized one day after the surgery. Crutches were recommended, and weight-bearing was permitted as the patient could tolerate.

Statistical Analysis

The data were analyzed using SPSS software (SPSS Inc., version 16, Chicago, IL, USA). Descriptive data were given as mean, standard deviation, median, number, or percentage. Numerical data of the groups were compared using Student's t-test or the Mann-Whitney U test, according to the normal distribution. Either the chi-square test or Fischer's exact test was used to compare categorical data of the groups. Pearson analyses were performed for the correlation analyses; a value of $p<0.05$ was accepted as statistically significant.

RESULTS

The metaphyseal fixed HA group comprised 61 patients (21 males, 40 females), and the diaphyseal fixed HA group included 68 patients (23 males, 45 females). The mean age of group A was 78.10±5.6 years (range, 66 to 89), and the mean age of group B was 79.0±5.7 years (range, 66 to 89). The clinical and demographic properties of the groups are summarized in Table 1. The groups were similar concerning age, gender, BMI, type of anesthesia, Singh index, and comorbidities ($p>0.05$ for all).

Regarding the Harris hip scores, group B showed better outcomes for the earlier periods post-surgery. However, two-year assessments were similar (Fig. 1). In addition, higher

Table 1. Clinical and demographic features of the groups

Variables	Metaphyseal fixed (n=61)	Diaphyseal fixed (n=68)	p
Age (year)	78.10±5.6	79.00±5.7	0.371
Gender			
Male	21 (34.4)	23 (3.8)	
Female	40 (65.3)	45 (66.2)	0.582
Body mass index (kg/m^2)	22.15±3.1	21.85±2.9	0.921
Fracture Classification			
31-A2.2	32 (52.5)	22 (32.4)	0.036
31-A2.3	16 (26.2)	19 (27.9)	
31-A3.3	13 (21.3)	27 (39.7)	
Anesthesia			
Spinal	57 (93.4)	60 (88.2)	0.309
General	4 (6.6)	8 (11.8)	
Singh Index			
1	21 (34.4)	20 (29.4)	0.306
2	19 (31.1)	30 (44.1)	
3	21 (34.4)	18 (26.5)	
Comorbidities			
Cardiovascular disease	8 (13.1)	6 (8.8)	0.434
Diabetes mellitus	16 (26.2)	20 (29.4)	0.687
Neurological disease	3 (4.9)	3 (4.4)	0.892
Hypertension	31 (50.8)	33 (48.5)	0.795
Pulmonary disease	11 (18.0)	13 (19.1)	0.874
Chronic renal failure	7 (11.5)	7 (10.3)	0.829

Data are given as mean±standard deviation or n, (%).

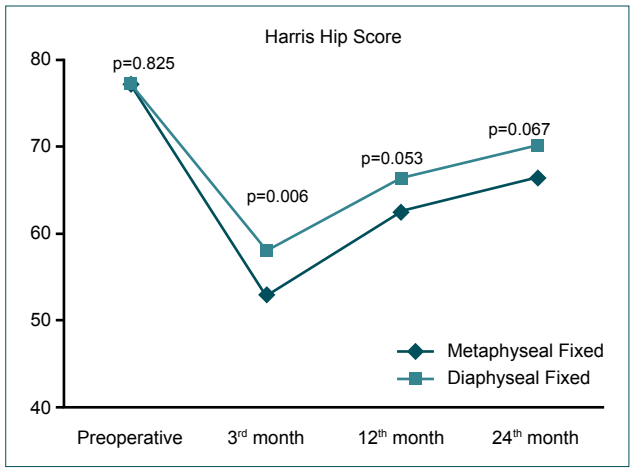

Figure 1. Harris Hip Scores of the groups.

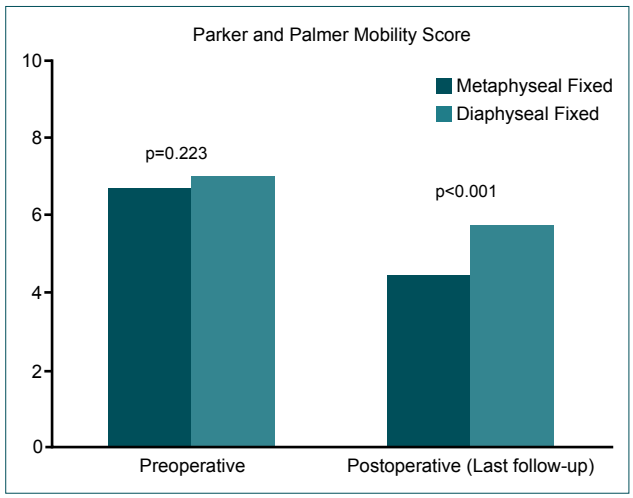

Figure 2. Parker and Palmer Mobility Scores of the groups.

Parker and Palmer mobility scores were obtained in group B for the two-year assessment (Fig. 2).

Mean operating time (78.56 min vs. 59.37 min) and median full weight-bearing time (40 days vs. 12 days) were significantly shorter in group B ($p<0.05$ for both). The frequencies of prosthetic dislocation, cortical porosis, and subsidence were higher in group A ($p<0.05$ for all). However, no significant difference was determined concerning mortality between the two groups ($p=0.133$; Table 2).

Table 2. Complications and mortality rates of the groups

Variables	Metaphyseal fixed (n=61)	Diaphyseal fixed (n=68)	p
Operation time (min)	78.56±15.6	59.37±11.7	**<0.001**
Blood transfusion			
None	16 (26.2)	19 (27.9)	0.825
1 unit	24 (39.3)	25 (36.8)	
2 unit	18 (29.5)	18 (26.5)	
3 unit	3 (4.9)	6 (8.8)	
Full weight-bearing (day)	40 (17.5–45)	12 (7–15)	**<0.001**
Complications			
Deep vein thrombosis	0 (0)	4 (5.9)	0.054
Prosthetic dislocation	4 (6.6)	0 (0)	**0.047**
Periprosthetic fracture	0 (0)	2 (2.9)	0.177
Prosthetic loosening	6 (9.8)	0 (0)	**0.008**
Wound infection	5 (8.2)	3 (4.4)	0.374
Osteolysis	5 (8.2)	2 (2.9)	0.188
Cortical porosis	4 (6.6)	0 (0)	**0.047**
Subsidence porosis	6 (9.8)	0 (0)	**0.008**
Leg length discrepancy	3 (4.9)	2 (2.9)	0.561
Heterotopic ossification	2 (3.1)	1 (1.5)	0.496
Mortality			
Yes	12 (19.7)	7 (10.3)	0.133
No	49 (80.3)	61 (89.7)	

Bold p-values denote significance, data are given as n, (%) or median (25%-75%).

DISCUSSION

In this study, we sought to compare outcomes of metaphyseal fixed short-stem and diaphyseal fixed long-stem HA in treating unstable intertrochanteric fractures in elderly, osteoporotic patients. The current study yielded three outcomes. First, the diaphyseal fixed HA group showed better improvement in the Parker and Palmer mobility scores. Second, more complications, that is, prosthetic dislocation, cortical porosis and subsidence, were more common in the metaphyseal fixed HA group. Complications related to diaphyseal fixed HA were observed as well. Third, no significant difference was determined concerning mortality between the two groups.

The generally accepted approach for treating intertrochanteric fractures in patients with low bone quality and comminuted fractures that cannot be fixated internally is the HA.[13–15] HA was previously administered in several studies, and most of them were as replacement surgery.[16] Of note, HA after a failed internal fixation is quite challenging and is associated with an increased risk for complications.[16] From this point of view, primary hip replacement surgery is an appropriate alternative to osteosynthesis surgery in the treatment of unstable intertrochanteric fractures.[17] Both proximally and distally fixed prostheses showed satisfactory outcomes concerning clinical scores, pain, activities of daily living, and mobilization.[4,13–16] Therefore, we prefer the HA approach primarily to avoid complications. These may be seen after replacement arthroplasty if internal fixation fails, also to mobilize elderly patients as soon as possible, a notion finding increasing acceptance.[14] Thus, the primarily applied cases of HA were included in our study, and to our knowledge, this is the first study comparing metaphyseal fixed short-stem and diaphyseal fixed long-stem prostheses in treating unstable intertro-

chanteric fractures in the literature. Furthermore, comparing short-stem and long-stem prostheses belonging to the same product and having similar biomechanical properties reinforces the results of our study. According to these results, although both methods showed positive results on the Harris hip score and mobility, we observed that the Parker and Palmer mobility score was better in the diaphyseal fixed-stem group at the two-year evaluation.

Biomechanically, stress applied to the hip joint is transferred through the cortical bone. However, with the insertion of the stem into the intramedullary canal, the stress is transferred distally via the implant.[4] Therefore, it is inevitable that short-stem and long-stem methods have different effects. While diaphyseal fixed long-stems transfer stress to the distal bone, metaphyseal short stems transfer stress to the proximal bone.[4,18,19] With its protective feature on stress shielding in the proximal region, diaphyseal fixed stems reduce the burden on possible trochanteric fixations, whereas increases the risk of intraoperative periprosthetic fractures in the distal bone segment.[4] In stems with a metaphyseal design, it is difficult to achieve strong stability in this region due to the anatomical feature of the proximal region with weaker cortical support and instability that arises from possible trochanteric fractures related to osteoporosis. Long stems with diaphyseal design provide stronger initial stability and long-term biological fixation, both by supporting the meta-diaphyseal zone and providing press-fitting cortical involvement distally.[20,21] Thus, it is not surprising that distal stem prostheses are expected to show stability earlier (or better) by allowing earlier mobilization and weight-bearing. Thus, in our study, the higher Harris hip scores in the diaphyseal, fixed long-stem HA group for the earlier periods, particularly at the three-month evaluation, can be attributed to the earlier mobilization and full weight-bearing times. It should again be emphasized that early mobilization is significantly associated with decreased mortality.[1,22–25] Likewise, in our study, although not statistically significant, the mortality rate was higher in the metaphyseal fixed-stem group than in the diaphyseal group (19.7% vs. 10.3%). In sum, early mobilization, shorter surgery time, lower mortality rates, and better clinical scores are the main advantages of the diaphyseal fixed prosthesis over the metaphyseal fixed stem.

Lower complication rates have been reported after HA. Complications may also differ according to prosthetic design: metaphyseal fixed or diaphyseal fixed.[26–28] Tsai et al.[7] compared prosthetic designs and reported that extensively coated diaphyseal locking stem might be better choices with a lower rate of stem complications. In our study, complications, such as dislocation, prosthetic loosening, cortical or subsidence porosis, and osteolysis were more common in metaphyseal-fixed designs. Since bone quality is lower in the metaphyseal region, it is not surprising that prosthesis-related complications were seen in this region. Again, because of the short length of the prosthesis, loosening and dislocations were more frequent in the metaphyseal fixed stems, as expected. However, it should also be considered that there may be complications in diaphyseal fixed designs.

The retrospective design and nonhomogeneous groups concerning fracture type were the main limitations of this study. As such selection bias in the choice of implants could have occurred. Our sample size was acceptable when compared with previous studies; however, larger sizes and longer follow-up periods and matched groups (more homogeneous) would be more noteworthy.

Conclusions

In the light of our preliminary results, both metaphyseal fixed and diaphyseal fixed HA seems to be effective surgical approaches in treating unstable intertrochanteric hip fractures in elderly patients with low bone quality. Cementless, diaphyseal fixed fluted long-stem HA seems to be superior to metaphyseal fixed short-stem HA because the former was related to better functional scores, earlier mobilization, and lower complication rates. Further studies comparing both prostheses in prospective, randomized, blinded-observer trials are definitely awaited.

Ethics Committee Approval: Approved by the local ethics committee (decision no: 56-861/05.2020).

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ORİJİNAL ÇALIŞMA - *ÖZET*

Yaşlı hastalarda stabil olmayan intertrokanterik kırıkların tedavisinde metafizyel sabit kısa saplı ile diyafizyel sabit uzun saplı hemiartroplasti sonuçlarının karşılaştırılması

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AMAÇ: Kalça hemiartroplastisi (HA) için metafizyel ile diyafizyel ve kısa sap ile uzun sap gibi çeşitli cerrahi teknikler tanımlanmıştır. Bu çalışmanın amacı, yaşlı hastalarda stabil olmayan intertrokanterik kırıkların tedavisinde metafizyel sabit kısa saplı ile diyafizyel sabit uzun saplı HA sonuçlarını karşılaştırmaktır.

GEREÇ VE YÖNTEM: Bu çalışma geriye dönük olarak yapıldı ve instabil intertrokanterik kırığı olan ve HA ameliyatı geçiren 65 yaş üzerinde olan 129 hastayı içeriyordu. Sonuçların ölçümü iki yıllık Harris kalça skoru ve Parker ve Palmer'ın hareketlilik skoru idi; komorbiditeler ve mortalite oranları karşılaştırıldı.

BULGULAR: Ortalama operasyon süresi ve tam ağırlık taşıma süresi grup B'de anlamlı olarak daha kısaydı (her ikisi için $p<0.05$). Harris kalça skorlarına gelince, B grubu üçüncü ay değerlendirmesi için daha iyi sonuçlar gösterdi ($p=0.006$). Ancak iki yıllık değerlendirmeler benzerdi ($p=0.067$). Ayrıca, B grubunda iki yıllık değerlendirmede daha yüksek Parker ve Palmer hareketlilik skorları elde edildi ($p<0.001$). Protez dislokasyonu, kortikal porozis ve çökme sıklığı grup A'da daha yüksekti (herkes için $p<0.05$).

TARTIŞMA: Diyafiz sabit uzun saplı HA, metafiz sabit kısa saplı HA'dan daha üstün görünmektedir, çünkü birincisi daha iyi fonksiyonel skorlar, erken mobilizasyon ve düşük komplikasyon oranları ile ilişkilidir.

Anahtar sözcükler: Diyafizyel; hemiartroplasti; intertrokanterik femur kırığı; metafizyel.

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