Cementless rectangular stems yield satisfactory results in osteoporotic bones

Abdulkadir Polat, M.D.,1 Fırat Fidan, M.D.,2 Feyzi Kılıç, M.D.,1 Harun Mutlu, M.D.,3 Cengiz Kazdal, M.D.,4 Ufuk Özkaya, M.D.5

1Department of Orthopedics and Traumatology, University of Health Sciences Gaziosmanpaşa SUAM, İstanbul-Turkey
2Department of Orthopedics and Traumatology, Sancaktepe Şehit Prof. Dr. İlhan Varank Training and Research Hospital, İstanbul-Turkey
3Department of Orthopedic, GOP Taksim Training and Research Hospital, İstanbul-Turkey
4Department of Orthopedics and Traumatology, Memorial Bahçelievler Hospital, İstanbul-Turkey
5Department of Orthopedics and Traumatology, Ağrı State Hospital, Ağrı-Turkey

ABSTRACT

BACKGROUND: The present study aims to investigate the effects of osteoporosis on prosthesis survival by comparing the femoral stem survival rates of patients with poor and relatively good bone quality.

METHODS: We retrospectively investigated 61 patients with collum femoris fractures who were treated with cementless rectangular stems between 2011 and 2015 in the Orthopaedics and Traumatology Clinic of Taksim Training and Research Hospital. The preoperative pelvic anterior-posterior radiographs of the patients were evaluated. The patients were evaluated according to the Dorr classification, and no case with a type A femur was found. The patients were divided into two groups as advanced osteoporotic type C and moderate osteoporotic type B. Thirty patients were type B according to the Dorr classification and 31 were osteoporotic type C.

RESULTS: The femoral component survival was evaluated using the Engh and ARA criteria. The relationship of the ARA score with type B and type C groups was evaluated. The median ARA score was five (min 3-max 6) for both types. These two groups were also statistically compared concerning the ARA scores using the Mann-Whitney U test, which revealed no statistically significant difference (p=0.24 >0.05). The Engh values, another criterion for the survival of femoral components, were also compared. The median Engh values were 16.5 (min 9-max 24) for the Dorr type B group and 14 (min 9-max 24) for the type C group. According to the Mann-Whitney U test, there was no significant difference between the Engh values of the two groups (p=0.061 >0.05). Lastly, no statistically significant difference was found in the ARA or Engh loosening scores between the type C advanced osteoporotic group and the type B moderate osteoporotic group.

CONCLUSION: Our study supports the conclusion that cementless hip arthroplasty can be applied even in advanced elderly and osteoporotic patients without additional intraoperative or postoperative risks.

Keywords: Cementless rectangular stems; femoral neck fracture; hemiarthroplasty.

INTRODUCTION

The incidence of femoral neck fractures has increased with the increasing elderly population in society. Even minor traumas may lead to fractures in the elderly due to osteoporosis. Arthroplasty is the preferred surgical method for these fractures to allow early mobilization and avoid non-union.[1–2] There is no consensus on the optimal method for the fixation of the femoral component in hip hemiarthroplasty. Although cemented hemiarthroplasty is considered to allow early mobilisation due to better primary stability in osteoporotic bones,[3] the use of cement has been reported to cause intraoperative side effects, such as cardiac arrest and sudden cardiac death. In addition, the reported rates of fat embolism.
performed using Orthosize®, a templating program developed
by Biomet® (Warsaw, Indiana). The program was calibrated
grit-blasted components (Biomet, Warsaw, IN). We modified
the Engh evaluation criteria since there is currently no other
criterion to evaluate the survival of press-fit stems. The high-
est scores were given in the presence of “a smooth interface”
and “particle shedding.”

Normality was determined using the Shapiro-Wilk test, Q-Q
plot, histogram, and box-plot graphs. The data were expressed
as median (minimum-maximum), frequency, and percentage
values. The correlations between the variables were analysed
by the Spearman correlation test. The Dorr classification sys-
tem was used to divide the patients into two groups: type B
and type C. The Engh and ARA loosening scores of the two
groups were compared using the Mann-Whitney U test. The
association between the Singh index and the Phillips acetabular
score was evaluated by the Kruskal-Wallis one-way ANOVA.
The significance level was set at p<0.05 in two-tailed tests. The
data were analysed using NCSS version 10.

RESULTS

Among the patients included in this study, 42 were female,
and 19 were male. The mean age was 87.55 (60–113) years.
In this study, the mean operating room time was 130 minutes,
and the mean operation time was 64 minutes. The mean pre-
and post-operative haemoglobin values were 11.8 and 10 g/
dL, respectively. An average of 0.7 units of erythrocyte suspen-
sion was perioperatively transfused per patient. The mean fol-
dow-up period was 56 (38–73) months. Five patients developed
postoperative dislocation within two months after the oper-
ation. The patients with dislocation underwent closed reduc-
tion under general anaesthesia. Three of these patients did not
have recurrent dislocations. The tomographic evaluation of the
remaining two patients with recurrent dislocations revealed
the fracture of the posterior wall of the acetabulum. These pa-
tients underwent osteosynthesis with posterior plate-screws.
No recurrent dislocation occurred after this operation.

In the sample, two patients developed stable fissures at the
level of the trochanter minor stem insertion and were treat-
ed with cable osteosynthesis. Postoperative weight bearing
did not reveal any instability in the stem. The postoperative
radiographs of one patient revealed the avulsion of the great-
er trochanter of the femur, which did not restrict abduction
and was observed to have healed without complications at
the sixth-month follow-up.

One patient was admitted to the clinic with signs of infection
in the early postoperative period after discharge from the
hospital. The patient had a high sedimentation rate and a high
CRP level, and there were Gram-positive cocci in the joint
aspiration fluid. Stage 1 revision operation was performed
due to early-stage diagnosis.

The mean Harris hip score of the patients was 68. According
to the Harris hip scores, two cases (3%) were evaluated to

are higher in cemented arthroplasty.[4] It has been shown that
low bone quality does not prevent osteointegration in ce-
mentless prosthesis.[5]

In this study, we retrospectively evaluated the clinical and ra-
diological results of patients who had femoral neck fractures
and were treated with hemiarthroplasty using cementless
press-fit stems and unipolar head prostheses. The patients
were divided into two groups according to the Dorr classifi-
cation criteria. We aimed to investigate the effects of oste-
oporosis on the survival of cementless rectangular femoral
stems by comparing patients with Dorr type C and those
with Dorr type B.

MATERIALS AND METHODS

In this study, we retrospectively evaluated 159 patients aged
≥60 years that were treated for femoral neck fractures be-
tween January 2011 and January 2015. The operations were
performed in a single centre. The exclusion criteria were
as follows: (a) pathological fractures (n=4), (b) total hip ar-
throplasty (n=24), (c) internal fixation (n=30), (d) mortality
(n=32), and (e) subject unavailability (n=8). The remaining 61
patients underwent hemiarthroplasty with cementless rect-
angular femoral stems and unipolar head prostheses.

The Harris and Oxford hip scores were used for the clinical
evaluation.[6,7] Pelvis AP and bilateral hip AP radiographs were
taken for the radiographic evaluation.

Kwok’s criteria were used to evaluate the technique of pros-
thesis application, including the size of the prosthesis head,
varus/valgus alignment of the prosthesis, calcar positioning,
and prosthetic height.[8] Radiographic measurements were
performed using Orthosize®, a templating program developed
by Biomet® (Warsaw, Indiana). The program was calibrated
according to the head size used and the early leg length dif-
fERENCE, lateral and vertical offsets, contralateral head diame-
ter, and varus-valgus angles between the stem femoral shaft,
which were measured on early postoperative radiographs.
These values were scored according to Kwok’s criteria.

The Dorr classification was used to evaluate the cortical
bone quality.[9] In addition, the Engh score[10] and Agora Ra-
diographic Assessment (ARA) criteria were used to evaluate
the survival of the femoral component.[11] The radiological
assessment was performed by an independent surgeon.

The preoperative cardiac status of the patients was assessed
by the American College of Cardiology and the American
Heart Association (ACC/AHA) guidelines.[12] Twenty-five pa-
tients were considered high risk (41%) and 36 intermediate
risk (49%).

The femoral stems used in all cases had a laterally straight
design and proximal press-fit design and comprised titanium

The femoral stems used in all cases had a laterally straight
design and proximal press-fit design and comprised titanium
poor, 19 (32%) moderate, 12 (19%) good, and 28 (46%) very good or excellent outcomes. The mean Oxford score of the patients was 19.5. While 30 patients scored 20 or lower, 31 patients had scores between 21 and 30.

According to the evaluation based on Kwok's criteria, the application of the prosthesis was considered to be excellent in 49% (30/61) of the patients, good in 27% (17/61), moderate in 21% (13/61), and poor in 2% (1/61).

The Harris, Oxford and Kwok values of the patients were statistically compared using the Spearman rho test. The correlations between the Harris and Oxford values ($rs=0.76$, $p<0.001$), Harris and Kwok values ($rs=0.33$, $p<0.001$), and Oxford and Kwok values ($rs=0.29$, $p<0.001$) were significant. The Harris and Oxford scores were highly correlated, while the correlations between the Harris and Kwok scores and the Oxford and Kwok scores were at a lower level.

Of the 61 patients included in this study, none required revision surgery for aseptic loosening during a mean follow-up period of 56 months (range: 38–73 months).

The Dorr classification was used to evaluate the cortical bone quality. There were no patients with type A according to the Dorr classification. Thus, the patients were evaluated in two groups as advanced osteoporotic type C ($n=31$) and moderately osteoporotic type B ($n=30$) (Figs. 1 and 2).

The survival of the femoral component was evaluated using the Engh and ARA criteria in patients who were classified according to the Dorr classification in terms of cortical bone quality. The ARA scores in type B and type C groups were compared. The median ARA was five (min 3-max 6) in both groups. When the two groups were statistically compared using the Mann-Whitney U test concerning the ARA scores, no statistically significant difference was observed ($p=0.24$).

The Engh values, another criterion for the survival of the femoral component, were also compared between the Dorr type B and C groups, and the median Engh values were found to be 16.5 (min 9-max 24) and 14 (min 9-max 24), respectively. The two groups were statistically compared using the Mann-Whitney U test, and no significant difference was found ($p=0.061$).

**DISCUSSION**

Hemiarthroplasty is widely used as the primary treatment method for femoral neck fractures. The initial stability of the
femoral stem is an important factor for the long-term survival of implants. Cemented femoral stems provide stability with the use of polymethylmethacrylate (PMMA), which acts as the grout between the spongy bone and the prosthesis. Uncemented stems achieve press-fit fixation with the bone growing into the microdovets in the grit-blasted surface. However, the superiority of any type of fixation is still debatable in hemiarthroplasty. The generally accepted opinion is the use of cemented femoral stems in osteoporotic bones. In the literature, the findings reported by some studies reveal that cemented hemiarthroplasty is generally preferred to cementless hemiarthroplasty, while others suggest performing cementless hemiarthroplasty in elderly patients.[13–15]

Cementless hip arthroplasty has become the primary choice in the treatment of younger patients due to its more physiological and stable nature compared to cemented systems, easier and lower-risk application, and high rates of long-term survival. The use of cementless stems in elderly osteoporoctic patients remains controversial; however, studies have confirmed its feasibility in patients with Dorr type C bones.[15–18] One study followed-up 114 patients aged ≥80 years after cementless total hip arthroplasty with the use of proximally coated stems and found that after two years, all patients had stable osseointegration without any requirement of revision surgery.[16]

Another study reported that among the 72 hip arthroplasties (all with conical cementless stem) performed in 62 patients aged ≥65 years with an average follow-up duration of 13.2 years, there was no case requiring loosening-related revision, and only four patients developed mild anterior thigh pain. The Dorr femoral classification of these patients was as follows: type A, 20; type B, 19; and type C, 33.[17] In the current study, we divided the patients with cementless femoral stems and unipolar head prostheses into two groups according to the Dorr classification, and we compared the survival of their femoral stems. Of the patients in our sample, 30 had Dorr type B and 31 had Dorr type C bones. There were no Dorr type A cases due to the sample consisting of elderly patients. We evaluated the survival of the femoral components according to the ARA and Engh criteria and found no statistically significant difference between the two groups.

One of the most important issues to consider in treating elderly patients with femoral neck fractures is the possible requirement of revision surgery for any reason. The particulate debris from the wear of arthroplasty components and cement can create a foreign body response and lead to osteolysis. If the patient is already osteoporotic, osteolysis can reduce the femur to an eggshell-like thickness, making it even more susceptible to fractures. As mentioned earlier, the cementless surgical technique is recommended for the revisions of cemented prostheses.[19–21] In the case of femoral stem loosening, a periprosthetic fracture, or acetabular protrusion, the revision hip replacement will be more difficult if the initial treatment is cemented.[19,22] Clearing the cement from the femur and replacing it with a cementless prosthesis will lead to extremely high blood loss and is associated with a high risk of perioperative complications, especially among elderly patients with various comorbidities.[19,22]

In the literature, researchers also criticize the use of cementless prostheses due to the possibility of several perioperative complications. The most important obstacle seems to be the insertion of press-fit femoral stems, especially among elderly patients with osteoporosis. Although diligence and surgeon experience reduce the technical risk, it does not eliminate the perioperative complications.[15,23] A study compared 33,205 patients with cemented or cementless femoral stems using the data obtained from the Norwegian Hip Fracture Register and the Swedish Hip Arthroplasty Register and found that the risk of intraoperative fractures and subsequent reoperation was higher in the cementless group. Although the surgical learning curve in the cementless press-fit stem application is longer than in the cemented groups, the long-term loosening-related revision rate is lower in careful and accurate applications.[24] In the current study, only two patients had fractures at the level of the trochanter minor stem intraoperatively and were treated with cable osteosynthesis. No complications occurred during the follow-up.

A 2006 study of 60 patients with severe osteoporosis aged ≥80 years compared rectangular-stem cementless implants with cemented implants and found that the latter had superior results regarding early complications and clinical scores.[25] In our study, 40 of 61 patients had good or excellent Harris hip scores.

Our findings support recent findings suggesting that cementless hip arthroplasty can provide satisfactory radiologic and clinical results without any additional intra- or postoperative risk, even in the elderly population and among osteoporotic cases.

The limitations of this study are as follows: (a) small sample size, (b) the relatively short follow-up period, (c) variability in age, gender, body mass index, and physical activity of the sample and d) lack of a control group that underwent cemented hemiarthroplasties.

Conclusion

Cementless hemiarthroplasty applications can reduce the duration of surgery and the trauma caused by the operation while avoiding many side effects that cement may cause that could increase morbidity and may even lead to mortality. We recommend using stems with a rectangular cross-section in cementless applications with early intramedullary press-fit anchorage and good rotational stability, which will enable the patient to put weight on the leg soon after surgery and provide biological fixation later on.

Stems with a rectangular cross-section are a good treatment option, even in Dorr type C bones with advanced osteopo-
rosis, given that they have more rotational stability and less likely to loosen or require revision surgery.

**Ethics Committee Approval:** Approved by the local ethics committee.

**Peer-review:** Internally peer-reviewed.


**Conflict of Interest:** None declared.

**Financial Disclosure:** The authors declared that this study has received no financial support.

**REFERENCES**

1. Thorngren KG, Hommel A, Norman PO, Thorngren J, Wingstrand H. Epidemiology of femoral neck fractures. Injury 2002;33:C1–C7. [CrossRef]
Sementsiz karekesit stemler osteoporotik zeminde de oldukça iyi sonuçlar verir

Dr. Abdulkadir Polat,¹ Dr. Fırat Fidan,² Dr. Feyzi Kılıç,¹ Dr. Harun Mutlu,³ Dr. Cengiz Kazdal,⁴ Dr. Ufuk Özkaya⁵

¹Sağlık Bilimleri Üniversitesi Gaziosmanpaşa SUAM, Ortopedi ve Travmatoloji Kliniği, İstanbul
²Sancaktepe Şehit Prof. Dr. İlhan Varank Eğitim ve Araştırma Hastanesi, Ortopedi ve Travmatoloji Kliniği, İstanbul
³GOP Taksim Eğitim ve Araştırma Hastanesi, Ortopedi Kliniği, İstanbul
⁴Memorial Bahçelievler Hastanesi, Ortopedi ve Travmatoloji Kliniği, İstanbul
⁵Ağrı Devlet Hastanesi, Ortopedi ve Travmatoloji Kliniği, Ağrı

AMAÇ: Kemik kalitesi ileri derecede bozuk olan ve nispeten iyi olan hastaların femoral stem sağkalımı oranlarını karşılaştırarak osteoporozun protez sağkalımı üzerindeki etkisini araştırmak.


TARTIŞMA: Çalışmamız sementsiz kalça artroplastisinin ileri yaşlı, osteoporotik hastalarda da hem radyolojik ve klinik sonuçları bakımından da yüz güldürücü bir şekilde uygulanabilirliği sonucunu desteklemektedir.

Anahtar sözcükler: Femur boyun kırığı; hemiartroplasti; karekesit sementsiz stem.