Acta Orthop. Belg., 2022, **88**, 599-608

ORIGINAL STUDY

doi.org/ 10.52628/88.3.9875

Distal fixation modular stem hemiarthroplasty versus proximal femoral nailing for unstable intertrochanteric fractures: a retrospective cohort study

Zekeriya Ersin Çelen, Oktay Gazi

From the Yalova State Hospital, Yalova, Turkey

The treatment of unstable intertrochanteric fractures (UITF) is a controversial issue in the current literature. The aim of this study was to compare the curative effects of distal fixation modular stem (DFMS) hemiarthroplasty with proximal femoral nailing (PFN) on UITFs in the elderly. From February 2017 to November 2019, 98 elderly (≥65 years) patients with UITF were included in this single-center retrospective cohort study. Mean follow-up duration was 24.1±11.9 months. Patients were divided into the DFMS group (52 patients) and the PFN group (46 patients). In the DFMS group, trochanteric fixation was performed using a trochanteric cable plate system. Primary outcome measures included Harris hip score (HHS), mobility score, implant related complications and mortality. Secondary outcome measures included hospitalization duration, surgical time and transfusion rate. Mean age of the patients was 78.7±7.2 years (65-96 years). DFMS group had longer surgical time, higher transfusion rates and longer hospital stays (p<0.05). Mean HHS was 80.7±10.5 and 81.9±12.2 in the DFMS group and PFN group, respectively. There was no statistically significant difference between the two groups in terms of HHS, mobility score and mortality. Implant failure rates were significantly higher in the PFN group (p=0.015). Implant failure, one year mortality and overall mortality rates were 0%, 15.4% and 17.3% in DFMS group and 10.9%, 15.2% and 19.5% in PFN group, respectively. Both surgical methods can be effectively used in the treatment of UITFs with similar satisfactory functional results and similar mortality rates. In addition, the DFMS group exhibited significantly lower implant failure rates and PFN group provided significantly lower surgical time duration, transfusion rate and hospital stay duration.

Keywords : Hemiarthroplasty; proximal femoral nail; unstable intertrochanteric fracture; modular stem; distal fixation stem.

INTRODUCTION

Unstable intertrochanteric fractures (UITF) cause substantial morbidity and mortality in elderly patients. Studies have shown that these fractures are associated with very high mortality rates ranging from 8.4% to 36% *(1)*.

Both extramedullary and intramedullary fixation of UITFs can cause many mechanical complications such as cut-out of femoral head, cut-through phenomenon, the "Z" and "reverse Z" effects and femoral head collapse, especially in elderly patients with poor bone quality *(2)*. On the other hand, fixation modalities provide a relatively lower incidence of intraoperative blood loss and significantly faster surgery *(3)*.

Bipolar hemiarthroplasty (HA) has been popularised as an alternative treatment method

■ Zekeriya Ersin Çelen[1], MD,
■ Oktay Gazi[1], MD,
[1]*Department of Orthopaedics and Traumatology, Yalova State Hospital, Yalova, Turkey*
Correspondence: Zekeriya Ersin ÇELEN, Department of Orthopaedics and Traumatology, Yalova State Hospital, Yalova, Turkey. Telephone number: +9 0505 087 87 96. Fax: +9 0226 811 52 30.
E-mail: drersincelen@gmail.com

nowadays *(4)*. HA has the advantage of immediate mobilisation with full weight bearing, especially in elderly patients with lower life expectancy and who need to be mobilised earlier *(5)*. These patients often have low mental capacity and physical strengths, and may also be less compliant with specific instructions including partial or non-weight bearing, which may be needed after internal fixation methods in the early postoperative period *(3)*.

Various femoral stem options are available for these fractures. Prior studies have shown adequate survival and acceptable complication rates when using modular femoral stems in patients with proximal femoral bone deficiency in revision hip arthroplasty *(6,7)*. The first advantage of these stems is that distal fixation of the femur provides axial and rotational stability. Proximal body and trochanteric cable plate system provide additional stability from the proximal part of the femur. Better implant stability results in less loosening and subsidence. This is important especially for elderly osteoporotic patients that have inadequate proximal bone quality. Furthermore, distal and proximal stem stability is crucial for earlier weight bearing in UITF patients. Secondly, modularity with the proximal body offers a wide range of possible combinations to accommodate various fracture types and anatomical variations, providing optimal leg length, femoral version and offset, so that better soft tissue tension around the hip joint can be achieved. The third important advantage of modularity is that when intraoperative or postoperative instability occurs, exchange of the proximal body can be enough while retaining the distal stem. In the setting of a non-modular stem choice, more extensive surgical procedures can be required, such as the use of an extended trochanteric osteotomy. Despite the most commonly used implant in hip revision arthroplasty is a cementless modular prosthesis worldwide *(8)*, there are limited studies in the literature regarding the use of this type of stems in primary HA. Therefore, this study was conducted to investigate whether a primary modular distal fixation stem is useful in elderly patients with UITFs and compare the results with intramedullary fixation.

MATERIALS AND METHODS

From February 2017 to November 2019, a total of 120 consecutive elderly (≥65 years) patients were identified who were diagnosed as having UITFs (31-A2.2 and 31-A2.3 of AO/OTA classification) and treated in our hospital in this retrospective cohort study. Of these, patients were excluded for reasons including previous contralateral hip fracture, pre-existing coxarthrosis of the same hip, pathological fracture, multiple trauma, not to able to walk independently before the injury with or without crutches, loss of patient data and refusal to participate in the study. Out of the remaining 98 patients, 52 patients were treated with distal fixation modular stem (DFMS) hemiarthroplasty and 46 patients with proximal femoral nailing (PFN). This research has been approved by the institutional review board of the authors' affiliated institutions (IRB reference number: 2021-6/4) and all patients or their families provided written informed consent.

The patients were followed up at 6 weeks, 3 months, 6 months, 1 year, and annually thereafter for clinical and radiological examinations. Follow-up patients were assessed according to the Harris hip score (HHS) *(9)* and mobility score. Preoperative patient data and follow-up radiographs were collected from the hospital archive and patients' electronic medical records. Primary outcome measurements included HHS, mobility score of Parker and Palmer *(10)*, implant related complications and mortality. Secondary outcomes included transfusion rate, surgical time and length of hospital stay. The radiographs were evaluated in terms of osteolysis *(11)*, subsidence *(12)* and stability of the femoral stem *(13)* in the DFMS group. A subsidence of ≥5 mm was considered significant *(12)*. The Singh index *(14)* was used to assess the degree of osteoporosis. The integrity of the hip abductor mechanism was evaluated postoperatively with the Trendelenburg test and the presence or absence of Trendelenburg gait. Postoperative radiographs of all patients were assessed in terms of trochanteric fragment union. We also investigated postoperative in-hospital medical complications.

All operations were performed by the senior author. Before the surgery, the senior surgeon gave

a full explanation to the patient about both surgical methods and it was decided as a result of a joint decision on which procedure to be performed.

HA operations were performed in lateral decubitus position through a lateral approach. Layer by layer incisions were made to expose the fracture site. Femoral head and neck removed and femoral canal prepared. A suitable cementless modular distal fixation stem (Figure 1) (Tipmed, Izmir, Turkey) was applied according to the preoperative radiograph and intraoperative status of the medullary cavity. The distal stem was rotated internally-externally, thus press-fit fixation was checked. Leg length was adjusted according to the healthy leg and the appropriate proximal body was applied to equalise. After adjusting femoral anteversion between 15°-20°, the proximal body was locked to the distal stem with a locking screw and the femoral head with appropriate diameter was inserted. The hip joint was reduced. Trochanteric fixation was achieved using a trochanteric cable plate system (Tipmed, Izmir, Turkey). The length of the trochanteric plate was adjusted according to the size of the trochanteric part. Since the femur was stabilised both proximally and distally, no additional calcar reconstruction was performed. Fluoroscopy check was performed intraoperatively. Hip range of motions were checked. The wound was closed in layers and a closed suction drain was inserted. The drain was removed 24 hours after the operation. The patients were allowed full weight bearing on the first postoperative day and mobilised with a walker (Figure 2).

PFN (Tipmed, Izmir, Turkey) operations were performed in supine position on the fracture table. The leg was internally rotated to 15°, fracture reduction was performed under the guidance of C-arm fluoroscopy. An approximately 5 cm incision was made from the tip of the greater trochanter towards the proximal side. The medullary cavity was reamed progressively. An appropriate nail was placed in the femoral cavity. The type of nail used in each patient was short nail. Femoral neck screws and then distal screws were inserted under fluoroscopy. Toe-touch weight bearing with walker support was started on the postoperative first day. Full weight bearing was allowed after the 4th week (Figure 3).

The method of anaesthesia was spinal anaesthesia for all patients. A perioperative dose of cefazolin (2 g) was administered 30-60 minutes before surgery and every 8 hours for 24 hours postoperatively.

Fig. 1. — Distal fixation modular stem.

Fig. 2. – Preoperative (a) and postoperative (b) anteroposterior radiograph of our 69-years-old male patient with unstable intertrochanteric fracture. The patient was treated with hemiarthroplasty using distal fixation modular stem and trochanteric cable plate system.

Fig. 3. – Preoperative (a) and postoperative (b) anteroposterior radiograph of our 67-years-old male patient with unstable intertrochanteric fracture. The patient was treated with proximal femoral nailing.

Subcutaneous low molecular weight heparin was administered for 4 weeks for deep vein thrombosis and pulmonary embolism prophylaxis.

Data were collected in a database created by the Excel 2007 programme by Microsoft (Microsoft Corporation, Redmond, Washington, USA). Statistical analysis was performed using PASW statistics for Windows (version 18, USA). Descriptive statistical analysis of the frequencies was performed via calculating the distribution of frequencies for qualitative variables and mean and standard error of mean for the quantitative variables. Normal distribution of the parameters in each group was screened with Shapiro-Wilk test. The data were compared using Mann-Whitney U test for quantitative measurements, and Chi-square test for categorical measurements. A p-value <0.05 was considered statistically significant.

RESULTS

The mean age of the cohort at the time of surgery was 78.7±7.2 (range, 65-96) years. 67.3% of the study group comprised women. Seventy-seven (78.6%) of the patients were injured after a simple fall from a standing height at home. Mean BMI was 27.8±4.9 (range, 19.5-35.6). Mean Singh index was 2.5±0.7 (range, 2-4). The most commonly encountered medical comorbidity was cardiovascular disease. Mean American Society of Anesthesiologists (ASA) grade of the patients was 2.8±0.7 (range, 2-4). Mean mobility score before fracture was 3.9±1.6 (range, 2-9). Preoperative waiting time was 2.2±1.3 (range, 1-5) days in the DFMS group and 1.9±1.2 (range, 1-4) days in the PFN group (p>0.05). The groups were comparable in terms of preoperative patient characteristics (Table I).

Table I. – Baseline features of the patients (n=98)

	DFMS group (n=52)	PFN group (n=46)	p value
Male gender	16 (30.8%)	16 (34.8%)	0.672
Age, years	80.0±6.9	77.3±7.3	0.066
Body Mass Index, kg/m2	27.4±4.4	28.3±5.4	0.519
Singh Index	2.5±0.7	2.6±0.7	0.301
Mean mobility score before fracture	4.0±1.7	3.8±1.4	0.699
Mean ASA score	2.9±0.8	2.7±0.7	0.236
Preoperative waiting time, days	2.2±1.3	1.9±1.2	0.347
Fracture type			
AO/OTA 31A-2.2	39 (75.0%)	37 (80.4%)	0.520
AO/OTA 31A-2.3	13 (25.0%)	9 (19.6%)	
Accompanied medical diseases[a]			
Hypertension	20 (38.5%)	16 (34.7%)	0.706
Cardiac disorder	16 (30.8%)	12 (26.1%)	0.609
Neurological	11 (21.2%)	10 (21.7%)	0.944
Diabetes mellitus	8 (15.4%)	11 (23.9%)	0.287
Mechanism of injury			
Falling at home	43 (82.7%)	34 (73.9%)	0.290
Pedestrian	6 (11.5%)	6 (13.0%)	0.821
Traffic accident	3 (5.8%)	6 (13.0%)	0.213

*The levels are expressed as mean±standard error of the mean; a Sum greater than 100% because of combined comorbidities; DFMS: Distal fixation femoral stem, PFN: Proximal femoral nail, ASA: American Society of Anesthesiologists

Table II. – Intraoperative and postoperative outcomes (n=98)

	DFMS group (n=52)	PFN group (n=46)	p value
Distal stem length			
140 mm	23 (44.2%)	-	
170 mm	29 (55.8%)	-	
Proximal body length			
40 mm	36 (69.2%)	-	
50 mm	15 (28.8%)	-	
60 mm	1 (1.9%)	-	
Avarage total stem length, mm	200±16.8	-	
Transfusion rate	31 (59.6%)	16 (34.8%)	<0.05
Mean transfused units	1.1±1.2	0.4±0.5	=0.001
Surgical time, minutes	53.6±10.2	41.5±12.8	<0.001
Hospital stay, days	9.9±5.4	8.2±4.0	<0.05
Mean follow-up time	22.3±9.4	26.2±14.1	0.120
Mean Harris hip score	80.7±10.5	81.9±12.2	0.613
Mean reduction in mobility score	1.5±0.9	1.6±1.0	0.730
Implant failure rate	0 (0%)	5 (10.9%)	<0.05
One year mortality	8 (15.4%)	7 (15.2%)	0.982
Overall mortality	9 (17.3%)	9 (19.5%)	0.773

*The levels are expressed as mean±standard error of the mean; DFMS: Distal fixation femoral stem, PFN: Proximal femoral nail

Mean follow-up time was 24.1±11.9 months (range, 3-47). Distal stem length was 140 mm in 23 (44%) patients and 170 mm in 29 (56%) patients in the DFMS group. HHS was 80.7±10.5 and 81.9±12.2 in the DFMS group and PFN group, respectively. There was no significant difference between two groups in terms of mean HHS (p>0.05). The groups were similar in terms of mean reduction in mobility score (p>0.05). The DFMS group had statistically longer surgical times, higher transfusion rates, and longer hospital stays (Table II).

In DFMS group, no patient had significant subsidence or osteolysis. The result regarding the stability of the femoral stem, assessed according to the method of Engh et al. *(14)*, showed that 38 cases (73%) had bony fixation, while 14 cases (27%) showed fibrous stable fixation. We detected early postoperative superficial infection and wound dehiscence in two patients that accounted for 4% of patients. The patients were treated successfully with vacuum assisted closure (VAC) and antibiotic therapy. VAC therapy was performed in the operating room for both patients and surgical debridement with detailed wound exploration was performed to ensure the infections were superficial. Two patients (4%) suffered from moderate groin pain during ambulation. There were no complications associated with modular junction failure, stem fracture, periprosthetic fracture, or dislocation. None of the patients were revised. Eight (15.4%) patients died within one year.

Five out of 46 (10.9%) patients in the PFN group experienced implant failure, all of which underwent conversion to HA consecutively. Of these patients, reverse Z-effect occurred in one case with cut out and back out of screws. In two of these cases, cut out of the neck screws occured and other two cases had back out of the screws. One patient had superficial infection and was treated with surgical debridement and antibiotherapy. Seven (15.2%) patients died within one year.

The PFN group had statistically higher implant failure rates (p=0.015). The groups were similar in terms of one year mortality and overall mortality (p>0.05) (Table II).

Postoperative medical complications included two cases of pneumonia, one case of pulmonary embolism and one case of decubitus ulcer in the DFMS group; two cases of decubitus ulcer and one case of pneumonia in the PFN group. No significant difference was observed between groups (p>0.05).

DISCUSSION

The main finding of the present study was that the patients treated with HA using DFMS and trochanteric cable plate system exhibited lower implant failure and revision rates compared to PFN in the specific group of elderly UITF patients. In addition, functional results and mortality rates were similar between the groups. To the best of our knowledge, there is only one study in the literature which compared the DFMS with different treatment modalities *(15)*. In their study, investigators compared cementless distal intramedullary stems with InterTan nails. They reported no significant difference between the groups in terms of mobilisation status and one-year mortality rates. They did not perform trochanteric plating in the majority (91.5%) of HA patients and they reported trochanteric problems such as nonunion on the radiographs of seven (9.9%) cases. Differently from their study, we fixated greater trochanter of each patient in the DFMS group with the trochanteric cable plate system to ensure trochanteric stability and restore abductor hip functions. We didn't observe any abductor insufficiency clinico-radiologically in the DFMS group. In addition, in their study, no functional hip score evaluation was performed. In our study, we evaluated the patients in terms of

Table III. – Different treatment methods in the treatment of unstable intertrochanteric fractures. Recent literature and comparison with the current series

	Treatment	Year	N	Age (years)	Surgical time (mins)	Hospital stay (days)	One year mortality	HHS	Implant failure
Current series	DFMS	2021	52	80.0	53.6	9.9	15.4%	80.7	0%
Seyran et al. *(15)*	DFMS	2021	71	82.2	66.4	10.4	26.8%	NA	0%
Zha et al. *(16)*	DFMS	2019	37	83.9	90.9	8.2	10.8%	84.6	0%
Zhou et al. *(5)*	NMHA	2019	47	83.8	77.5	6.9	0%	88.3	0%
Jolly et al. *(23)*	NMHA	2019	46	78.7	60.4	NA	25%	70.3	21.7%
Gashi et al. *(29)*	NMHA	2018	60	76.2	NA	NA	16.7%	77.9	1.7%
Esen et al. *(24)*	NMHA	2017	58	80.2	74.6	9.4	29.2%	78.3	6.9%
Gormeli et al. *(25)*	NMHA	2015	75	77.4	48.7	4.4	14.6%	74.7	2.6%
Current series	PFN	2021	46	77.3	41.5	8.2	15.2%	81.9	10.9%
Seyran et al. *(15)*	PFN	2021	46	80.2	58.3	11.9	23.9%	NA	4.3%
Jolly et al. *(23)*	PFN	2019	48	81.2	48.4	NA	21.7%	86.7	12.5%
Mallya et al. *(26)*	PFN	2019	41	70.8	44.0	7.3	NA	69.9	9.7%
Esen et al. *(24)*	PFN	2017	34	80.2	54.8	5.9	24.4%	82.3	0%
Gormeli et al. *(25)*	PFN	2015	68	76.2	32.4	3.8	8.8%	79.7	11.8%
Zhou et al. *(5)*	PFNA	2019	61	83.5	53.7	7.6	0%	87.7	1.6%
Mallya et al. *(26)*	PFNA	2019	37	69.5	34.4	6.6	NA	74.5	5.4%
Gashi et al. *(29)*	DHS	2018	38	79.3	NA	NA	15.8%	52.3	15.8%
Li et al. *(30)*	DHS	2018	40	75.5	43.6	NA	NA	72.3	40%

N: Number, HHS: Harris hip score, DFMS: Distal fixation modular stem, NMHA: Non modular hemiarthroplasty, PFN: Proximal femoral nail, PFNA:Proximal femoral nail antirotation, DHS: Dynamic Hip Screw, NA: Not available

HHS and both groups exhibited good functional scores and there was no difference between the groups. In another study, which consisted of a case series, investigators used MP-link cementless distal fixation modular prosthesis for treatment of UITFs in elderly patients and reported satisfactory clinico-radiological results and good ambulatory status *(16)*.

Treatment of UITFs is still a controversial topic in orthopaedic literature. PFN, DHS and HA are available options for intertrochanteric fractures *(4)*. The choice of treatment depends on the stability of the fracture *(17,18)*. For unstable fracture patterns, PFN and HA are popular treatment methods and there is no consensus on the superiority of these two methods *(3,4,19)*. Recently, to our knowledge, three metaanalysis studies have compared arthroplasty and fracture fixation for the treatment of UITFs *(3,4,19)*. In a meta-analysis including seven randomised controlled trials (RCTs) (n=528), investigators concluded that HA may be the best treatment method for UITFs in terms of lower failure and reoperation, and they reported highest HHS during short to intermediate period compared to PFN and DHS *(4)*. Another meta-analysis, involving two RCTs and eight non-RCTs, earlier weight-bearing was reported in the arthroplasty group compared to fracture fixation without significant difference in terms of overall mortality, reoperation and complication rates *(19)*. In contrast to these two studies, in another meta-analysis including three RCTs and four non-RCTs, investigators reported better outcomes in the PFN group in terms of overall mortality and HHS *(3)*. Table III presents a comparison between our study and the literature.

Monoblock long stems have also been used and good clinical outcomes have been reported in the treatment of intertrochanteric fractures. One such study reported good prognosis, early weight-bearing, early rehabilitation, diminished complications, and improvement in quality of life with cementless monoblock long stem *(20)*. In another study, researchers reported that using a hydroxyapatite-coated monoblock long stem is a useful choice for unstable intertrochanteric fractures in elderly patients with severe osteoporosis *(21)*. On the other hand, monoblock stems do not offer modularity and therefore supply fewer stem options.

In a different study, investigators used cementless modular stem in salvage operation for failed internal fixation of trochanteric fractures and described the stem as reliable and suggested the use of this stems in markedly unstable fractures and in osteoporotic elderly patients *(22)*.

Low complication and revision rates were reported with the DFMS in the primary treatment of UITFs previously *(15,16)*. In one of these studies, one deep, three superficial infections, one heterotopic ossification, one intraoperative fracture, and seven (9.9%) radiological trochanteric problems were reported. However, no revision surgery was reported in their study *(15)*. In another study, investigators reported no complications other than mild groin pain (5.4%) and heterotopic ossification (16.2%) *(16)*. We used a modular distal fixation stem in the DFMS group for UITFs and our results were satisfactory. We detected early postoperative superficial infection in two patients, which constitute 3.8% of patients. Two patients (3.8%) suffered from moderate groin pain during ambulation. No dislocation, modular junction failure, aseptic failure, or significant subsidence occurred in our series. In our PFN group, implant failure rate was 10.9% and this was consistent with previous literature *(15,23-26)*. All these patients were treated with DFMS hemiarthroplasty and trochanteric cable plate system, and no additional surgery was required in these patients within the follow-up period. We attributed the possible cause of mechanical failure in these patients to poor bone quality and poor compliance of these elderly patients with instructions, including partial weight-bearing.

It is well known that early weight bearing can reduce the incidence of early medical complications after hip fracture surgery *(27,28)*. In our study, although full weight bearing was initiated earlier in the DFMS group, the incidence of in-hospital medical complications was not lower than in the PFN group. This may be secondary to the invasiveness of the procedure, including longer operative times and higher transfusion rates, as more invasive surgery can cause serious blows to the fragile bodies of these elderly patients and predispose them to medical complications.

The scarcity of similar data evaluating the use of DFMS for the treatment of UITFs can be considered as the strength of this study. However, this study has some limitations. The first limitation was the retrospective nature and lack of randomisation. The second limitation was the mid-term follow-up time. Nevertheless, long-term analyses are barely possible in an elderly patient population due to the short remaining life expectancy.

CONCLUSION

In conclusion, both surgical methods can be effectively used in the treatment of UITFs with similar satisfactory functional outcomes and similar mortality rates. In addition, the DFMS group exhibited significantly lower implant failure rates and the PFN group provided significantly lower surgical time duration, transfusion rate and hospital stay duration. We suggest the combined use of DFMS and trochanteric cable plate system as an alternative treatment modality to PFN in elderly UITF patients in selected cases. Each patient should be evaluated individually and the appropriate treatment method should be selected according to the surgeon's preference and experience. Additionally, this arthroplasty technique should be performed by an experienced hip arthroplasty surgeon, as the technique is more challenging than PFN.

REFERENCES

1. **Abrahamsen B, van Staa T, Ariely R, Olson M, Cooper C.** Excess mortality following hip fracture: a systematic epidemiological review. *Osteoporos Int.* 2009;20(10):1633–50.
2. **Socci AR, Casemyr NE, Leslie MP, Baumgaertner MR.** Implant options for the treatment of intertrochanteric fractures of the hip: rationale, evidence, and recommendations. *Bone Joint J.* 2017;99-B(1):128–33.
3. **Kumar P, Rajnish RK, Sharma S, Dhillon MS.** Proximal femoral nailing is superior to hemiarthroplasty in AO/OTA A2 and A3 intertrochanteric femur fractures in the elderly: a systematic literature review and meta-analysis. *Int Orthop.* 2020;44(4):623-33.
4. **Hongku N, Woratanarat P, Nitiwarangkul L, Rattanasiri S, Thakkinstian A.** Fracture fixation versus hemiarthroplasty for unstable intertrochanteric fractures in elderly patients: A systematic review and network meta-analysis of randomized controlled trials. *Orthop Traumatol Surg Res.* 2021;30:102838.
5. **Zhou S, Liu J, Zhen P, *et al.*** Proximal femoral nail anti-rotation versus cementless bipolar hemiarthroplasty for unstable femoral intertrochanteric fracture in the elderly: a retrospective study. *BMC musculoskeletal disorders.* 2019;20(1):500.
6. **Pelt CE, Madsen W, Erickson JA, Gililland JM, Anderson MB, Peters CL.** Revision total hip arthroplasty with a modular cementless femoral stem. *J Arthroplasty.* 2014;29(9):1803-7.
7. **Abdel MP, Cottino U, Larson DR, Hanssen AD, Lewallen DG, Berry DJ.** Modular fluted tapered stems in aseptic revision total hip arthroplasty. *J Bone Joint Surg Am.* 2017;99(10):873-881.
8. **Dyreborg K, Petersen MM, Balle SS, Kjersgaard AG, Solgaard S.** Observational study of a new modular revision system. *World J Orthop.* 2020;11(3):167-176.
9. **Harris WH.** Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. *J Bone Joint Surg Am.* 1969;51(4):737-55.
10. **Parker MJ, Palmer CR.** A new mobility score for predicting mortality after hip fracture. *J Bone Joint Surg Br.* 1993;75(5):797-8.
11. **Gruen TA, McNeice GM, Amstutz HC.** "Modes of failure" of cemented stem-type femoral components: a radiographic analysis of loosening. *Clin Orthop Relat Res.* 1979;(141):17-27.
12. **Kim YS, Hur JS, Hwang KT, Choi IY, Kim YH.** The comparison of compression hip screw and bipolar hemiarthroplasty for the treatment of AO type A2 intertrochanteric fractures. *Hip Pelvis.* 2014; 26(2):99-106.
13. **Engh CA, Bobyn JD, Glassman AH.** Porous-coated hip replacement. The factors governing bone ingrowth, stress shielding, and clinical results. *J Bone Joint Surg Br.* 1987;69:45-55.
14. **Singh M, Nagrath AR, Maini PS.** Changes in trabecular pattern of the upper end of the femur as an index of osteoporosis. *J Bone Joint Surg Am.* 1970;52:457-67.
15. **Kılınç S, Pazarcı Ö.** Hemiarthroplasty with cementless intramedullary stem versus proximal femoral nail in the treatment of unstable intertrochanteric fractures in elderly patients. *Acta Orthop Belg.* 2021;87 e-Supplement 1:36-43.
16. **Zha GC, Liu J, Wang Y, *et al.*** Cementless distal fixation modular stem without reconstruction of femoral calcar for unstable intertrochanteric fracture in patients aged 75 years or more. *Orthop Traumatolog Surg Res.* 2019;105(1):35–39.
17. **Fischer H, Maleitzke T, Eder C, Ahmad S, Stöckle U, Braun KF.** Management of proximal femur fractures in the elderly: current concepts and treatment options. *Eur J Med Res.* 2021;26(1):86.
18. **Lu Y, Uppal HS.** Hip Fractures: Relevant Anatomy, Classification, and Biomechanics of Fracture and Fixation. *Geriatr Orthop Surg Rehabil.* 2019;10:2151459319859139.
19. **Yoo JI, Ha YC, Lim JY, Kang H, Yoon BH, Kim H.** Early Rehabilitation in Elderly after Arthroplasty versus Internal

Fixation for Unstable Intertrochanteric Fractures of Femur: Systematic Review and Meta-Analysis. *J Korean Med Sci.* 2017;32(5):858-867.

20. **Dung TT, Hieu ND, Son LM, Dinh TC, Dinh TC.** Primary cementless bipolar long stem hemiarthroplasty for unstable osteoporotic intertrochanteric fracture in the elderly patients. *Open Access Maced J Med Sci.* 2019;7(24):4342-6.
21. **Lee YK, Ha YC, Chang BK, Kim KC, Kim TY, Koo KH.** Cementless bipolar hemiarthroplasty using a hydroxyapatite-coated long stem for osteoporotic unstable intertrochanteric fractures. *J Arthroplasty.* 2011;26(4):626-32.
22. **Laffosse JM, Molinier F, Tricoire JL, Bonnevialle N, Chiron P, Puget J.** Cementless modular hip arthroplasty as a salvage operation for failed internal fixation of trochanteric fractures in elderly patients. *Acta Orthop Belg.* 2007;73(6):729-36.
23. **Jolly A, Bansal R, More AR, Pagadala MB.** Comparison of complications and functional results of unstable intertrochanteric fractures of femur treated with proximal femur nails and cemented hemiarthroplasty. *J Clin Orthop Trauma.* 2019;10(2):296-301.
24. **Esen E, Dur H, Ataoğlu MB, Ayanoğlu T, Turanlı S.** Evaluation of proximal femoral nail-antirotation and cemented, bipolar hemiarthroplasty with calcar replacement in treatment of intertrochanteric femoral fractures in terms of mortality and morbidity ratios. *Eklem Hastalik Cerrahisi.* 2017;28(1):35-40.
25. **Görmeli G, Korkmaz MF, Görmeli CA, Adanaş C, Karataş T, Şimşek SA.** Comparison of femur intertrochanteric fracture fixation with hemiarthroplasty and proximal femoral nail systems. *Ulus Travma Acil Cerrahi Derg.* 2015;21(6):503-8.
26. **Mallya S, Kamath SU, Madegowda A, Krishnamurthy SL, Jain MK, Holla R.** Comparison of radiological and functional outcome of unstable intertrochanteric femur fractures treated using PFN and PFNA-2 in patients with osteoporosis. *Eur J Orthop Surg Traumatol.* 2019;29(5):1035-42.
27. **Ottesen TD, McLynn RP, Galivanche AR, *et al.*** Increased complications in geriatric patients with a fracture of the hip whose postoperative weight-bearing is restricted: an analysis of 4918 patients. *Bone Joint J.* 2018;100-B(10):1377-84.
28. **Warren J, Sundaram K, Anis H, *et al.*** The association between weight-bearing status and early complications in hip fractures. *Eur J Orthop Surg Traumatol.* 2019;29(7):1419-27.
29. **Gashi YN, Elhadi AS, Elbushra IM.** Outcome of Primary Cemented Bipolar Hemiarthroplasty compared with Dynamic Hip Screw in Elderly Patients with Unstable Intertrochanteric Fracture. *Malays Orthop J.* 2018;12(1):36-41.
30. **Li H, Wang Q, Dai GG, Peng H.** PFNA vs. DHS helical blade for elderly patients with osteoporotic femoral intertrochanteric fractures. *Eur Rev Med Pharmacol Sci.* 2018;22(1 Suppl):1-7.