ORIGINAL ARTICLE

The effectiveness of fixation of hydroxyapatite-coated helical blade in preventing of the cut-out observed in treatment with proximal femoral nail of fractures of the femur intertrochanteric in elderly

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ABSTRACT

BACKGROUND: This study aimed to retrospectively evaluate the effectiveness of hydroxyapatite-coated (HA-coated) implants and other caput–collum implants in preventing cut-out observed in treatment with proximal femoral nail (PFN) of intertrochanteric femur fractures in elderly patients.

METHODS: A total of 98 consecutive patients (56 males and 42 females; mean age: 79.42 (61–115) years) treated with three different PFNs for intertrochanteric femoral fractures were retrospectively examined. The mean of the follow-up period was 7.87 (4–48) months. It was used a threaded lag screw in 40 patients, an HA-coated helical blade in 28 patients and a non-coated helical blade in 30 patients for PFN. The reduction quality, fracture type, and radiological outcomes among all groups were evaluated.

RESULTS: Unstable type was seen in 50 (52.1%) patients according to AO Foundation/Orthopedic Trauma Association fracture classification. An acceptable-good reduction quality was seen in 87 (88.8%) of all patients. The average of tip-apex distance (TAD) value was 27.61 mm, calcar-referenced TAD (CalTAD) value was 28.72 mm, caput-collum diaphyseal angle was 128,° Parker's anteroposterior ratio was 46.36%, and Parker's lateral ratio was 46.82%. The best suitable implant position was observed in 49 (50%) patients. Cut-out was observed in 7 (7.14%) patients, and secondary varus displacement of more than 10° was observed in 12 (12.24%) patients. Correlation analysis and multivariate logistic regression analysis showed a significant difference between HA-coated and other implants in cut-out. Furthermore, implant type was the strongest predictive factor for cut-out complications in the multivariate logistic regression analysis.

CONCLUSION: HA-coated implants may reduce the long-term cut-out risk due to increased osteointegration and bone ingrowth in elderly patients with intertrochanteric femoral fractures with poor bone quality. However, this alone is not enough; a suitable screw position, optimal TAD values, and excellent reduction quality are other important factors.

Keywords: Caput-collum implant; cut-out; hydroxyapatite-coated; intertrochanteric femur fractures; proximal femoral nail.

INTRODUCTION

Osteosynthesis with an intramedullary proximal femoral nail (PFN) is mainly used in the treatment of intertrochanteric femur fractures. Treatment aims to provide stable fixation and early mobilization and return to activities. The most common mechanical complication in treating these fractures is cut-out, which is defined as the varus collapse of the femoral head–

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neck fragment due to the extrusion of the cephalic screw or blade, with an observed incidence of 1.8–7.1%.[1–3] Cut-out is the most common cause of morbidity after surgical treatment.[4] Risk factors associated with cut-out after osteosynthesis are advanced age, unstable fracture, poor reduction quality, high-angle screw placement, tip-apex distance (TAD) >25 mm, reduction in varus, and poor blade position.[5–8]

Serious clinical and mechanical complication rates of up to 20% are still found, despite improved surgical techniques and implant modifications in the treatment of proximal femur fractures.[5–7] Many reasons have been identified for complications, such as implant selection, surgical technical errors, osteoporotic bone structure, older age, lack of experience, and the surgical approach.[1,5,9] Complications after surgical treatment lead to different future complications, long rehabilitation, social problems, and increased health-care system costs.[3]

Different implant designs have been created to eliminate implant failure and reduce complications in elderly and osteoporotic patients. For this purpose, Aksakal et al.[10] and Moroni et al.[11] reported implant designs with hydroxyapatite (HA) coating to increase bone ingrowth and osteointegration. These are preferred to provide early bone formation and stronger fixation due to their osteoconductive and bioactive properties.[10–12] We thought that a caput-collum implant with HA-coated would solve the problem of implant failure observed in such fractures by providing earlier and better osteointegration. Although HA coating has been used for dynamic hip screws (DHSs).[11] An HA-coated blade for PFN has not been reported in the English literature.

This study aimed to retrospectively evaluate the effectiveness of HA-coated implants and other caput-collum implants in preventing cut-out observed in treatment with PFN of intertrochanteric femur fractures in elderly patients.

MATERIALS AND METHODS

Between January 2016 and June 2018, a total of 98 consecutive patients treated with three different PFNs for intertrochanteric femoral fractures were retrospectively examined (Fig. 1). The study was approved by the local University Hospital Human Subject Research Ethics Committee (2017/3-11), and data collection and analysis were performed in compliance with the Declaration of Helsinki. All patients were informed about the surgery procedure, and an informed consent was signed. Patients with pathologic fractures, <60 years of age, double screws (or blades) and/or anti-rotation screw, long PFN, history of previous proximal femoral fractures, and patients with a follow-up of <3 months were excluded from the study.

The first 40 patients underwent treatment with a PFN with a threaded lag screw (Stryker, Gamma3 Trochanteric Nail, Schoenkirchen, Germany), 28 patients underwent treatment with a PFN with an HA-coated helical blade (Sanatmetal, SpectruM Trochanter Spiral, Hungary), and the final consecutive 30 patients underwent treatment with a PFN with a non-coated helical blade (Sanatmetal, SpectruM Trochanter Spiral, Hungary). Helical blades are spiral cephalic implants designed to "ream" less bone, compact the surrounding cancellous bone, and avoid rotation of the head.[4,13] In this study, some were coated with HA by plasma spray technique in air (Sanatmetal, SpectruM Trochanter Spiral, Hungary) (Fig. 2).

All imaging and medical records were extracted from electronic patient records (Picture Archiving and Communication System-PACS software) in our hospital. Pre-operative radiographs were evaluated to determine the type of fracture according to the AO Foundation/Orthopedic Trauma Association (AO/OTA) fracture classification[14] and Evans classification.[15]

The elective surgery was performed as soon as possible after pre-operative preparation. In the supine position and using a radiolucent operating table, closed reduction was applied to all fractures under C-arm fluoroscopy control. In seven patients with basicervical fractures, percutaneous reduction was performed using Volkmann Orthopedic Hook Retractors (Fig. 3). The reduction of the fractures and insertion of the implants were controlled by C-arm fluoroscopy (Fig. 4).

Figure 1. Appearance of three different caput-collum implants used for proximal femoral nail.

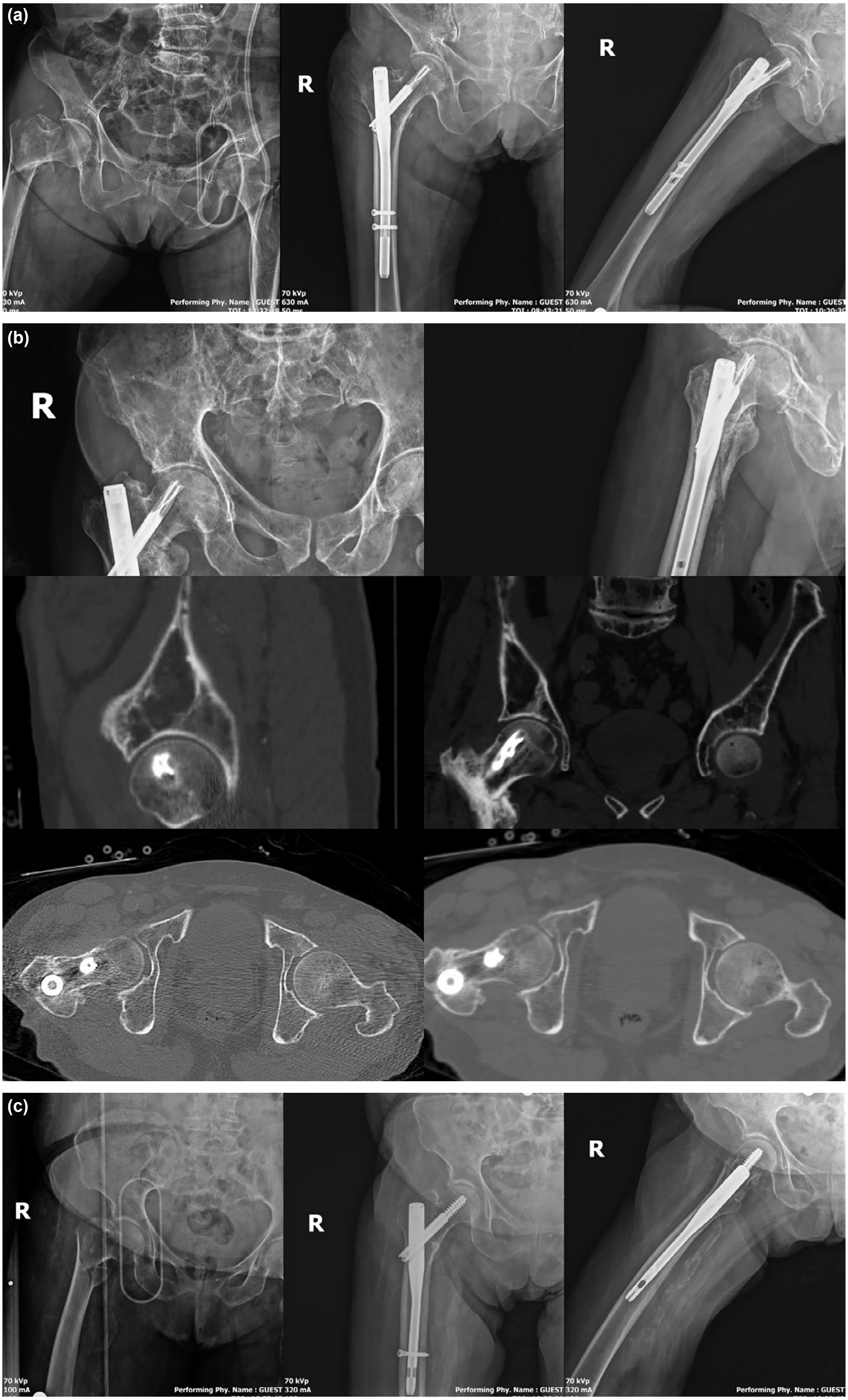

Figure 2. (a) Radiography appearance of AO/OTA type 31.A1.2 fracture treated with non-coated blade, **(b, c)** radiography appearance of AO/OTA type 31.A1.3 fracture treated with HA-coated blade, and radiography appearance of AO/OTA type 31.A2.2 fracture treated with threaded lag screw

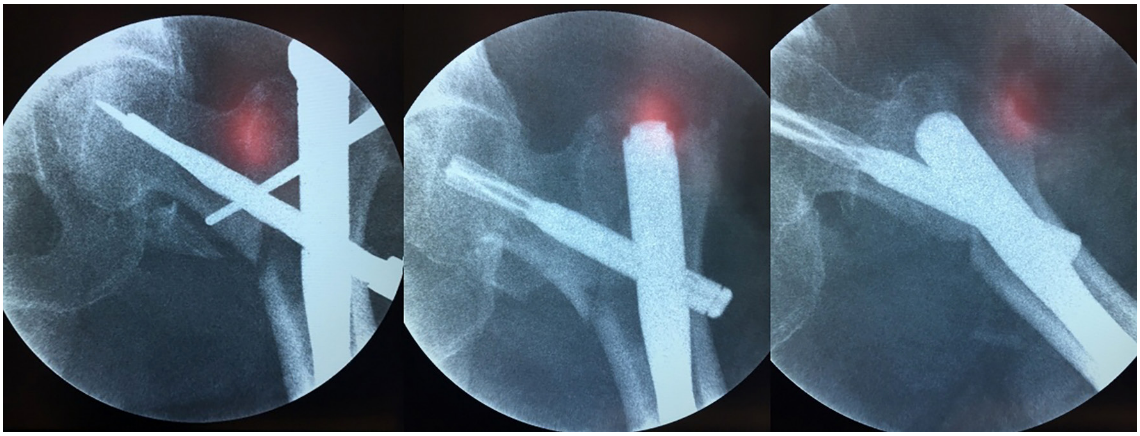

Figure 3. Intraoperative appearance of the reduction maneuver performed with Volkmann orthopedic hook retractors.

All patients received antithrombotic prophylaxis using low-molecular-weight heparin (enoxaparin) and antibiotic prophylaxis with second-generation cephalosporin (cefazolin). Active and passive exercises were begun on the 1st post-operative day. All patients were mobilized during the 1st month with partial or touchdown weight-bearing using a walker, depending on the fracture type, and allowed to walk with full weight-bearing after the 1st month.

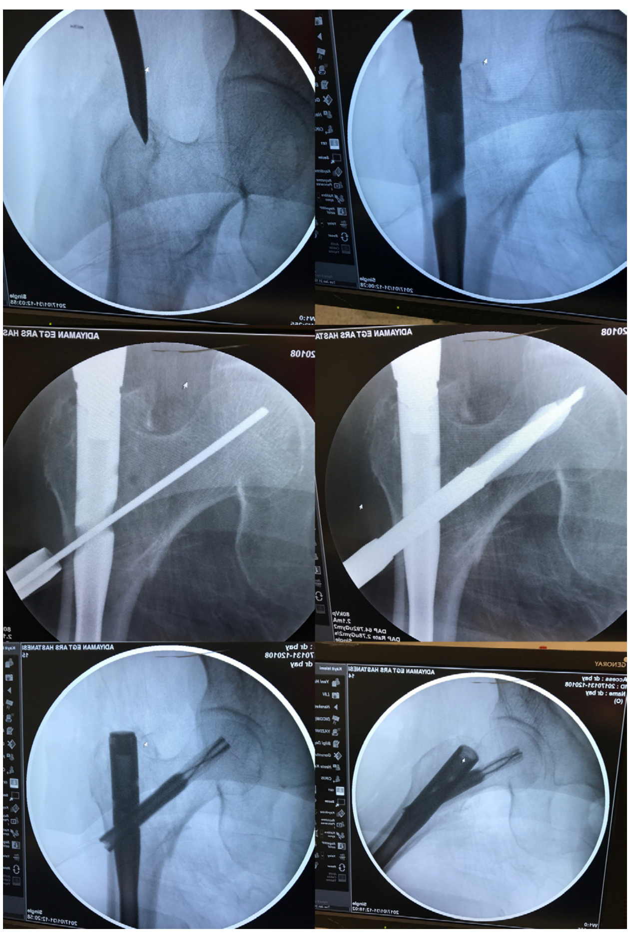

Figure 4. The controlling of the reduction and insertion of the implants by C-arm fluoroscopy.

In pre-operative radiographs, AO/OTA types 31-A1 and A2.1 were considered stable fracture patterns, whereas AO/OTA types A2.2, 2.3, and A3 were considered unstable.[16] According to the Evans classification, types 1–2 were considered stable, and types 3–5 were considered unstable.[15]

The post-operative alignment was grouped as varus position for a caput-collum diaphyseal angle (CCD) <125,° neutral for 125°–135,° and valgus for >135.° Correct angular reduction criteria were met when the CCD on the anteroposterior (AP) radiographs was normal or slightly valgus (130°–150°) and <20° of angulation were seen on the lateral radiographs. The displacement criteria were defined as more than 4 mm of displacement of any fragment, on either the AP or lateral radiograph. The reduction quality and adequacy as described by Baumgaertner et al.[8] were categorized as good when both criteria were met, acceptable when one criterion was met, and poor if neither criterion was met.[7,8] Post-operative radiographs were analyzed for reduction quality, TAD, calcar-referenced tip–apex distance (CalTAD), Parker's ratio, CCD, and Cleveland–Bosworth zone (Fig. 5). Furthermore, fixation failures were identified, such as nonunion, redisplacement of the fracture or fracture collapse, breakage of the implant, and cut-out of the implant.[3–8,17–19] Each radiographic measurement was standardized using the known diameter of the nail.

The patients were discharged after three post-operative days according to their general clinic condition. Follow-up of the patients was usually carried out at 2 and 6 weeks, 3 and 6 months, and 1 year after surgery. During the follow-up period, radiological evaluation was made of all patients.

Statistical Analysis

Data were analyzed using SPSS statistical software version 21.0 (IBM Corp., Armonk, NY, USA). Categorical data are expressed using frequencies and percentages, and continuous data are expressed using mean and standard deviation. The normality of data was tested with the Shapiro–Wilk test. Categorical data were compared using the Chi-squared test or Kruskal–Wallis test. Continuous data were compared using Student's t-test or

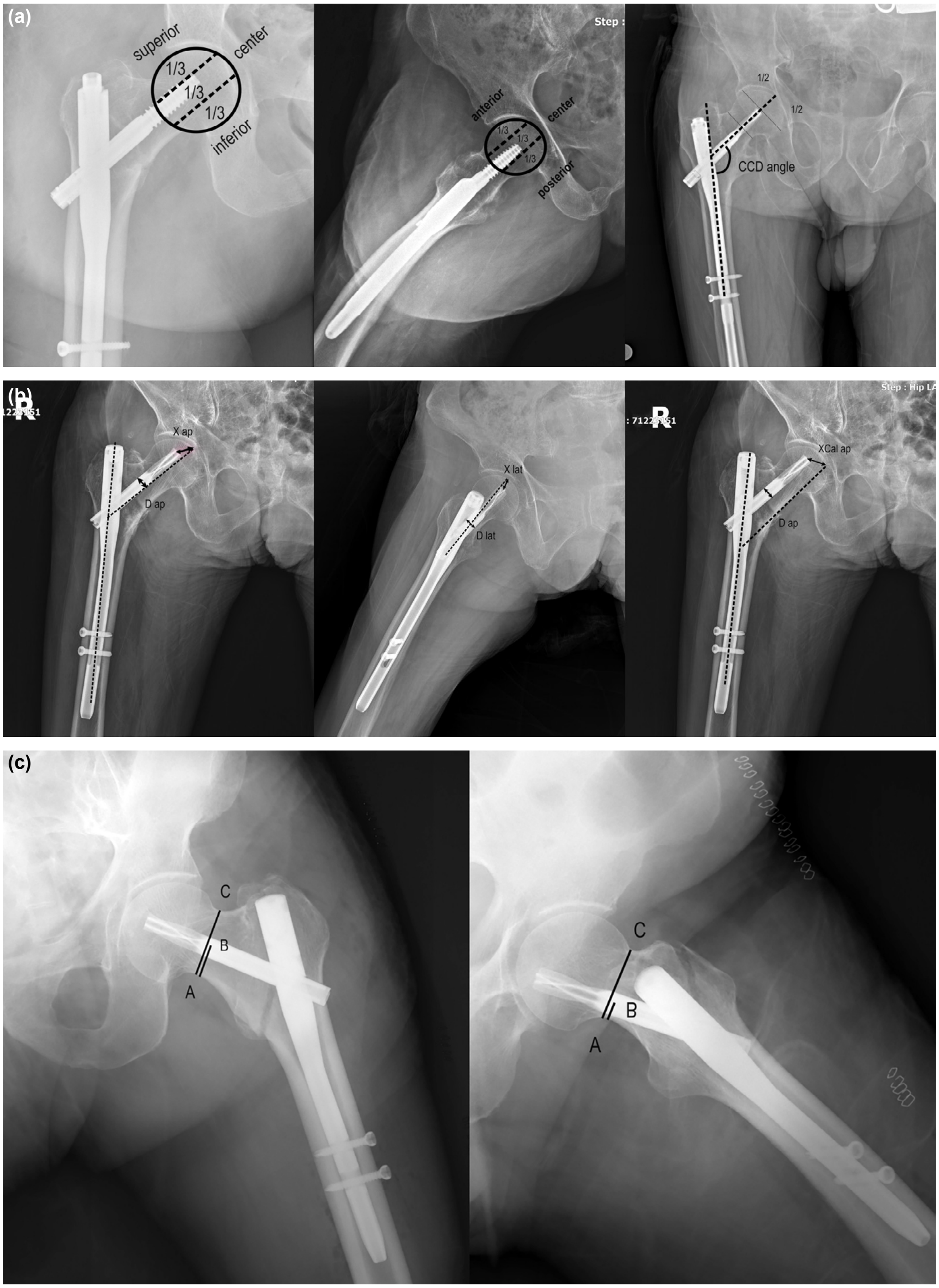

Figure 5. (a) Determining of the quadrants and measuring of the CCD angle, **(b)** Measurement methods of TAD and CalTAD; TAD = [Xap × (D true/Dap)] + (Xlat × (D true/ Dlat)]; CalTAD = [XCalap × (D true/Dap)] + (Xlat × (D true/ Dlat)]; (D) true known true diameter of the helical blade), and **(c)** the calculating the Parker's ratio in both the AP and Lat views (The represented by the percentage AB/AC x 100).

one-way ANOVA tests, and post hoc analysis was performed with the Bonferroni correction. Correlation analysis with cut-out was performed with the Spearman correlation test. Parameters with $p<0.05$ in univariate analysis were included in the multivariate analysis. Multivariate logistic regression analysis was used to predict the independent predictors of cut-out. $P<0.05$ was considered statistically significant.

RESULTS

A total of 98 intertrochanteric femur fractures were treated with three different PFNs: 40 patients received a threaded lag screw, 28 patients received an HA-coated helical blade, and 30 patients received a non-coated helical blade for a PFN. There was not a statistically significant difference among all

Table 1. Baseline characteristics and demographic data

Variable	Total (n=98)	Lag screw (n=40)	HA-coated (n=28)	Non-coated (n=30)	ANOVA p-value
Sex (female), n (%)	42 (42.9)	17 (42.5)	10 (35.7)	15 (50.0)	
Age (year), mean	79.42	79.9±11.8	81.1±10.2	77.2±7.7	0.311
60–70 y, n (%)	19 (19.4)	7 (17.5)	6 (21.4)	6 (20.0)	0.444
70–80 y, n (%)	34 (34.7)	13 (32.5)	7 (25.0)	14 (46.7)	
>80 y, n (%)	45 (45.9)	20 (50.0)	15 (53.6)	10 (33.3)	
Affected side (L), n (%)	51 (52.1)	21 (52.5)	13 (46.4)	17 (56.7)	0.736
Follow-up (mo), mean	7.87	7.6±2.7	8.8±8.1	7.4±2.7	0.478
Surgery time, mean	46,12	48.4±9.5	43.3±9.1	45.8±6.9	0.065$^{\alpha}$
Evans Classification, n (%)					
Stable fractures (Type 1–2)	30 (30.6)	15 (37.5)	7 (25.0)	8 (26.7)	0.466
Unstable fractures (Type 3–5)	68 (69.4)	25 (62.5)	21 (75.0)	22 (73.3)	
AO/OTA classifications, n (%)					
Stable fractures (31.A1.1,2,3 and 31.A2.1	48 (48.9)	17 (42.5)	15 (53.6)	16 (53.3)	0.567
Unstable fractures (31.A2.2,3 and 31.A3.1,2,3)	50 (52.1)	23 (57.5)	13 (46.4)	14 (46.7)	

$^{\alpha}$P<0.05 between Lag screw vs HA-coated. HA: Hydroxyapatite; AO/OTA: AO Foundation/Orthopaedic Trauma Association.

groups in age, follow-up period, operation time, or stability of fractures according to OTA/AO and Evans classifications (p=0.311, p=0.478, p=0.065, p=0.567, and p=0.466, respectively). The baseline and demographic data of the patient groups are given in Table 1.

There was not a statistically significant difference among all treatment groups in the variables of implant type, age, fracture stability, CalTAD, AP Parker's ratio, quality of reduction, or Cleveland lag position (p>0.05). There was a statistically significant difference between the groups in the mean TAD value, TAD >25 mm value, and lateral (Lat) Parker's ratio ≥45% after performing the Kruskal–Wallis and one-way ANOVA tests (p<0.05). An acceptable-good reduction quality was seen in 87 (88.8%) of all patients. An unstable fracture pattern was seen in six patients, and three patients showed cut-out, according to the Evans and AO/OTA classifications, respectively.

Cut-out was observed in 7 (7.14%) patients, and secondary varus displacement of more than 10° was observed in 12 (12.24%) patients, during follow-up (Fig. 6). Five patients with cut-out showed secondary varus displacement of more than 10°, but there was not a statistically significant difference (p>0.05). Although TAD was >25 mm in all patients with cut-out, there was no statistically significant difference in terms of cut-out between the groups (p=0.143) (Table 2).

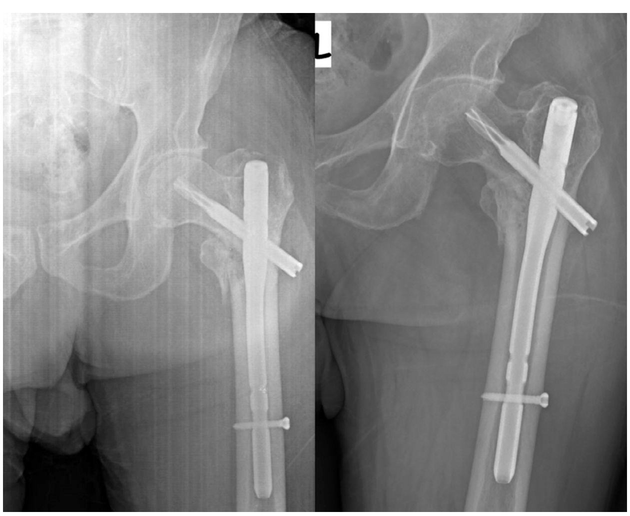

Figure 6. Healing of the secondary varus displacement in the patients with HA-coated.

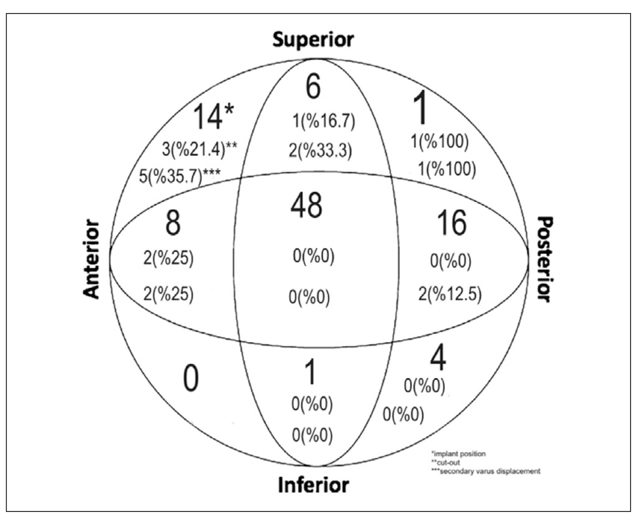

Figure 7. Position of the lag screw according to Cleveland quadrant.

Table 2. Surgery outcome measures

Variable	Total	Lag screw (n=40)	HA-coated (n=28)	Non-coated (n=30)	p-value$^{\alpha}$
TAD (mm), mean	27.6	29.3±8.3	28.7±6.2	24.3±3.2	**0.005**$^{\beta,*}$
CalTAD (mm), mean	28.7	28.1±8.7	28.9±7.0	26.7±4.7	0.512
TAD >25 mm, n (%)	48 (48.9)	21 (52.5)	18 (64.3)	9 (30.0)	**0.028**$^{\beta,*}$
Proper Cleveland position#, n (%)	49 (50.0)	17 (42.5)	15 (53.6)	17 (56.7)	0.455
CCD (Normal value: 125°–135°), mean	128	127.9±6.9	129.4±5.5	126.1±6.1	0.130*
Postoperative varus aligment (CCD <125°), n (%)	18 (18.4)	7 (17.5)	3 (10.7)	8 (26.7)	0.286
Postoperative valgus aligment (CCD >135°), n (%)	6 (6.1)	3 (7.5)	3 (10.7)	0	
Secondary varus displacement (CCD >10°), n (%)	12 (12.2)	5 (12.5)	3 (10.7)	4 (13.3)	0.953
AP Parker's Ratio (%), mean	46.4	46.2±10.1	45.5±10.4	47.3±7.4	0.758
Lateral Parker's Ratio (%), mean	46.8	45.8±16.4	44.2±11.6	50.6±8.7	0.156
AP Parker's Ratio ≥%45, n (%)	57 (58.2)	23 (57.5)	14 (50.0)	20 (66.7)	0.435
Lateral Parker's Ratio ≥%45, n (%)	55 (56.1)	19 (47.55)	13 (46.4)	23 (76.7)	**0.025**$^{\alpha,\beta}$
Cut-out, n (%)	7 (7.1)	3 (7.5)	0	4 (13.3)	0.143
Reduction Quality-poor, n (%)	11 (11.2)	5 (12.5)	2 (7.1)	4 (13.3)	0.716
Reduction Quality acceptable-good, n (%)	87 (88.8)	35 (87.5)	26 (92.9)	26 (86.7)	

#Center-center or center-inferior, $^{\alpha}$p<0.05 between Lag screw vs HA-coated, $^{\beta}$p<0.05 between Lag screw vs Non-coated, *p<0.05 between HA-coated vs Non-coated. Bold values indicate statistical significant in aone-Way ANOVA test. TAD: Tip–apex distance; HA: Hydroxyapatite; CalTAD: Calcar-referenced tip–apex distance; CCD: Caput–collum diaphyseal.

All patients with cut-out showed an unsuitable lag position according to the Cleveland quadrant. Implant placement was according to the Cleveland quadrant, as shown in Figure 7.

The results of the Pearson's Chi-square test showed statistically significant relationships between cut-out and TAD >25 mm, AP Parker's ratio ≥45%, unsuitable Cleveland position, varus alignment, and poor reduction quality (p<0.05) (Table 3).

The Spearman correlation analysis showed positive correlations between increased cut-out complications and TAD >25 mm, CCD <125°, poor reduction quality, and increased surgical time, as well as negative correlations between increased cut-out and suitable Cleveland lag positions and HA-coated implants (p<0.05). Implant type was the strongest predictive factor for cut-out complications in the multivariate logistic regression analysis (p=0.031, OR: 0.075). The reason why other variables were not predictive factors for cut-out complications in the multivariate logistic regression analysis was the low number of patients (Table 4).

DISCUSSION

In this study, cut-out was observed in the other implant types except HA-coated helical blade, and correlation analysis and multivariate logistic regression analysis showed a significant difference in terms of cut-out between HA-coated helical blade and other cephalic implants.

Murena et al.[3] stated that good reduction quality and suitable implant position can decrease the risk of cut-out complications. Baumgaertner et al.[8] stated that TAD showed a stronger relationship than other variables with cut-out, and the location of the guide-pin should be observed again when the TAD is >25 mm, regardless of the Cleveland zone. Turgut et al.[4] stated that TAD is important in preventing cut-out; however, even if the TAD is >25 mm, the risk of cut-out is low in patients with the helical blade placed in the suitable quadrant without varus alignment. In our study, the TAD was >25 mm in 48 (48.9%) patients, and only 7.1% of patients showed cut-out. However, the TAD was >25 mm in all patients with cut-out, and the CalTAD was >25 mm in six patients with cut-out. Five patients with poor reduction quality and post-operative varus malposition showed cut-out due to increased varus during follow-up. As seen in the literature, this study shows that TAD >25 mm alone is not sufficient to prevent cut-out, also poor reduction quality and post-operative CCD <125° are also important risk factors.

The most suitable position of the cephalic implants according to the Cleveland quadrant for provide strong stability should be center–center or inferior–center.[17,18] Kuzyk et al.[18] reported that the best position of the lag screw against load and torsion is inferior on AP radiography and central on lateral radiography. The present study showed that cephalic implants located in center–center, center–inferior, center–posterior, and inferior–posterior positions did not pose a risk for cut-out and were reliable. This results showed that even if the TAD is <25

Table 3. Comparison of results in patients without and with cut-out complication

Variable	Patients with cut-out (n=7)	Patients with cut-out (n=91)	p-value
Age, years, mean	78.0±8.4	79.6±10.4	0.703
TAD (mm), mean	30.3±3.6	27.4±7.4	0.275
CalTAD (mm), mean	29.2±3.7	27.8±7.4	0.620
TAD >25 mm, n (%)	7 (100)	41 (45.1)	0.005
Suitable Cleveland position#, n (%)	0 (0)	49 (53.8)	0.006
Suitable Cleveland positionϒ, n (%)	0 (0)	70 (76.9)	<0.001
CCD (Normal value: 125°–135°), mean	123.3±5.7	128.1±6.3	0.052
Postoperative varus aligment (CCD <125°), n (%)	5 (71.4)	13 (14.3)	0.001
Postoperative valgus aligment (CCD >135°), n (%)	2 (28.6)	72 (79.1)	
Secondary varus displacement (CCD >10°), n (%)	0 (0)	6 (6.6)	
AP Parker's Ratio (%), mean	54.6±7.0	45.7±9.3	0.015
Lateral Parker's Ratio (%), mean	51.7±16.8	46.4±12.9	0.317
AP Parker's Ratio ≤%45, n (%)	6 (85.7)	51 (56.0)	0.127
Lateral Parker's Ratio ≤%45, n (%)	6 (85.7)	49 (53.8)	0.105
Reduction Quality-poor, n (%)	3 (42.9)	8 (8.8)	0.029
Reduction Quality acceptable-good, n (%)	4 (57.1)	8 (91.2)	
Surgery time, mean	51.0±5.7	45.8±8.9	0.129
Blood loss volüme (ml), mean	107.1±27.5	87.4±30.2	0.097
Floroscopic screening time (sec.), mean	33.7±2.7	26.2±6.4	0.003

#Center-center or center-inferior, ϒcenter-center, center-inferior, posterior-inferior or posterior-center. TAD: Tip–apex distance; HA: Hydroxyapatite; CalTAD: Calcar-referenced tip–apex distance; CCD: Caput–collum diaphyseal.

Table 4. Relationship of variables with cut-out complication

	Univariate analysis		Multivariate analysis		
	r	p-value	OR (Odds ratio)	CI (95%)	p-value
Age	-0.044	0.666			
Unstable fractures type/OTA/AO classification	-0.045	0.658			
Unstable fractures type/Evans classification	0.098	0.336			
Implant type (HA-coated)	-0.199	0.050	0.075	0.007–0.787	0.031
TAD >25 mm	0.261	0.005			
Reduction Quality-poor	0.278	0.006			
CalTAD >25 mm	0.096	0.347			
CCD <125°	0.251	0.013			
Parker's AP Ratio ≥%45	0.155	0.128			
Parker's Lateral Ratio ≥%45	0.165	0.104			
Suitable Cleveland lag position#	-0.439	<0.001			
Suitable Cleveland lag position^	-0.277	0.006			
Surgery time	0.199	0.049			

#Center-center, inferior-center, center-posterior and inferior-posterior, ^center-center or inferior-center. TAD: Tip–apex distance; CalTAD: Calcar-referenced tip–apex distance; CCD: Caput–collum diaphyseal; AO/OTA: AO Foundation/Orthopaedic Trauma Association; CI: Confidence interval.

mm, the cephalic implant placed in the superior or anterior quadrant will increase the cut-out risk with axial loading.

Valentini et al.[1] stated that anatomic fracture reduction, implant placement in the posteroinferior quadrant close to the calcar, and TAD <25 mm are needed to prevent complications. Kuzyk et al.[18] stated that the TAD should be measured by referring to the calcar line on the AP radiograph, which is the CalTAD. Caruso et al.[20] stated that TAD was the most accurate predictive factor and more reliable than CalTAD for the cut-out risk. The present study showed that the risk of cut-out will decrease if the TAD and CalTAD values are between 25 and 30 mm, the CCD is >125°, and the quality of reduction is good.

Parker's ratio has been used in recent years as a marker to define the ideal screw position, all of which have been associated with the determination of cut-out.[3] Murena et al.[3] demonstrated that a higher Parker's AP ratio (more superior lag screw placement) was correlated with cut-out. In our study, Parker's AP and/or Lat. ratio was over 45% in six patients with cut-out. A Parker's AP ratio above 45% indicates superior placement of cephalic implants, and a Parker's Lat. ratio above 45% indicates anterior placement. Hence, we think that the risk of cut-out will increase when Parker's ratio increases.

Inadequate osteointegration between bone and implant in patients with osteoporosis can lead to fixation failure and specific complications such as cut-out.[11,19] Cement augmentation and HA-coated implants have been recommended in addition to osteoporosis treatment to overcome such problems and increase bone–implant osteointegration.[10,11,19] Aksakal et al.[10] reported that an HA-coated screw provided a better and more stable fixation due to increased osteoblastic activity and osteointegration compared to uncoated screws. Moroni et al.[11] used HA-coated and non-coated DHSs to treat osteoporotic proximal femoral fractures in elderly patients. They stated that during follow-up, implant failure and varus alignment were not observed due to increased osteointegration in the group with HA-coated screws, although the TAD was >25 mm. Pesce et al.[21] have compared the results of patients with femoral lateral fractures treated by nail and cephalic HA coated screws. They reported that it was higher mechanical stability of HA coated screws than standard screws. In an experimental animal study, Fini et al.[12] reported that the bone–implant contact of HA-coated pedicle screws was significantly higher than for uncoated screws in osteopenic bones. In our study, although cut-out was observed in other two treatment groups except HA-coated helical blade, there was not a statistically significant difference among all groups. However, it was observed a significant difference between HA-coated and other implants in term of cut-out in correlation analysis and multivariate logistic regression analysis. Implant type was the strongest predictive factor for cut-out complications in the multivariate logistic regression analysis.

Many publications have shown the relationship between implant design and cut-out.[7] Chapman et al.[13] found no difference in TAD between a lag screw and helical blade, but implant extrusion and bone collapse occurred due to the geometry and sharp edge of the helical blade in osteoporotic bones. Although correlations existed between increased cut-out complications and TAD >25 mm, CCD <125,° poor reduction quality, increased surgical time, and unsuitable Cleveland lag positions.[3,4,7,18] There was not a statistically significant differences in this study. This is due to the small number of patients. However, it was seen a negative correlation between increased cut-out and suitable Cleveland lag positions and HA-coated implants.

The main limitations of the present study were its small number of patients, retrospective cohort design, and lack of parameters such as dual-energy X-ray absorptiometry scanning for bone mineral density, computerized tomography for osteointegration, and body mass index.

Conclusion

Regardless of implant design, implant failure will occur in patients with poor reduction quality and unsuitable lag position due to insufficient ossification and osteointegration after axial loading in the very early period. However, HA-coated implants will doubtlessly increase bone–implant involvement due to increased bone ingrowth and osteointegration after the early period. The study results show that HA-coated implants reduced the long-term cut-out risk due to increased osteointegration and bone ingrowth in elderly patients with intertrochanteric femoral fractures with poor bone quality. However, this alone is not enough; a suitable cephalic implant position, optimal TAD values, and excellent reduction quality are other important factors.

Ethics Committee Approval: This study was approved by the Adıyaman University Faculty of Medicine Biomedical Research Ethics Committee (Date: 20.04.2017, Decision No: 2017/3-11).

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ORİJİNAL ÇALIŞMA - *ÖZ*

Yaşlılarda intertrokanterik femur kırıklarının proksimal femur çivisi ile tedavisinde gözlenen cut-out'un önlenmesinde hidroksiapatit kaplı helikal blade tespitinin etkinliği

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AMAÇ: Bu çalışmada, yaşlı hastalarda intertrokanterik femur kırıklarının proksimal femur çivi (PFN) ile tedavisinde gözlenen cut-out'un önlenmesinde hidroksiapatit kaplı implantlar ve diğer baş-boyun implantlarının etkinliği geriye dönük olarak değerlendirildi.
GEREÇ VE YÖNTEM: İntertrokanterik femur kırığı nedeniyle üç farklı PFN ile tedavi edilen toplam 98 ardışık hasta (56 erkek ve 42 kadın; ortalama yaş: 79.42 (61–115) yıl) geriye dönük olarak incelendi. Ortalama takip süresi 7.87 (4–48) aydı. PFN'de kullanılan baş-boyun implant için 40 hastada yivli lag vidası, 28 hastada HA-kaplı helikal blade ve 30 hastada ise kaplamasız helikal blade kullanıldı. Tüm gruplar arasında redüksiyon kalitesi, kırık tipi ve radyolojik sonuçlar değerlendirildi.
BULGULAR: AO/OTA sınıflamasına göre 50 (%52.1) hastada instabil kırık tipi gözlendi. Hastaların 87'sinde (%88.8) iyi bir redüksiyon ve/veya kabul edilebilir redüksiyon kalitesi görüldü. Ortalama tip-apeks mesafesi (TAD) 27.61 mm, kalkar referanslı tip-apeks mesafesi (CalTAD) 28.72 mm, baş-boyun cisim açısı (CCD) 128°, Parker ön-arka oranı %46.36, Parker lateral oranı %46.82 idi. En optimal implant pozisyonu 49 (%50) hastada gözlendi. Yedi (%7.14) hastada cut-out, 12 (%12.24) hastada ise10°'den fazla sekonder varus deplasmanı gözlendi. Korelasyon analizi ve çok değişkenli lojistik regresyon analizinde cut-out açısından HA-kaplı ve diğer implantlar arasında anlamlı bir farklılık gözlendi. Ayrıca, implant tipinin çok değişkenli lojistik regresyon analizinde cut-out komplikasyonu açısından en güçlü prediktif faktör olduğu gözlendi.
TARTIŞMA: HA-kaplı implantlar, kötü kemik kalitesine sahip intertrokanterik femur kırığı olan yaşlı hastalarda artmış osteointegrasyon ve kemik içe büyümesi nedeniyle uzun vadede cut-out riskini azaltabilir. Ancak, bu tek başına yeterli olmayıp, uygun bir vida konumu, optimum TAD değerleri ve mükemmel redüksiyon kalitesi cut-out'un önlenmesinde diğer önemli faktörlerdir.
Anahtar sözcükler: Baş-boyun implantı; cut-out; hidroksiapatit kaplama; intertrokanterik femur kırıkları; proksimal femoral çivi.

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