



# Comparison of long-term results of dynamic hip screw and AO 130 degrees blade plate in adult trochanteric region fractures

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**Objectives:** The aim of this study was to compare the long-term results of two groups of patients with trochanteric fractures of the femur treated with either dynamic hip screw (DHS) or AO angled blade plate (AP) insertions.

**Methods:** A total of 157 patients with trochanteric fractures were included in the study, and 82 patients underwent dynamic hip screw insertion, and 75 underwent AO angled blade plate insertion. The mean follow-up period was 8 years (range 2.3-11.7 years) in the DHS group, and 8.5 years (2.4-12.5 years) in the AP group.

**Results:** According to the Boyd and Griffin classification, there were 37 stable fractures (45%) and 45 unstable fractures (55%) in the DHS group, whereas there were 42 stable fractures (56%) and 33 unstable fractures (44%) in the AP group. According to Clawson's functional classification, 64% of patients in the AP group and 81% in the DHS group had good or excellent function ( $p<0.05$ ). Similarly, according to Foster's classification, 68% of patients in the AP group, and 85% in the DHS group had good to excellent results ( $p<0.05$ ).

**Conclusion:** DHS yields better long-term results in trochanteric fractures than do AO angled blade plates by providing earlier mobilization of the patient, better stability, and earlier union.

**Key words:** AO blade plate; bone screws; hip; trochanteric fractures.

Fractures of the trochanteric region are seen most frequently in the elderly and in people with numerous systemic medical conditions, and are thus, an important problem. Generally, these fractures result from minor trauma. Because the trochanteric region is made up of spongy bones, the problems with trochanteric fractures are related mostly to fixation rather than union. Moreover, confining the patient to bed for a long period of time results in various complications, thus increasing mortality. Patients with trochanteric fractures should be mobilized as soon as possible.<sup>[1-9]</sup>

While it is possible to treat non-displaced trochanteric fractures of the femur by using various internal fixation devices, the method used in com-

minuted trochanteric fractures remains problematic. The sliding dynamic hip screw (DHS) developed by the Richards Company, and the 130° angled blade plates (AP) developed by the AO Group are devices commonly used in fractures of the trochanteric region.

The present study aimed to evaluate the long-term treatment results of patients with trochanteric fractures of the femur treated with either 135° sliding DHS or AO 130° AP.

## Patients and methods

Of the 262 patients who were diagnosed with trochanteric fractures of the femur and underwent

surgical treatment between September 1988 and June 2002 in our clinic, 157 patients who could be reached and followed over a long period of time with a final physical and radiological examinations were included in this study.

Without establishing any criteria to distinguish one patient group from the other, one of the two implants—either the 135° sliding DHS, or AO 130° AP—was randomly implanted in successive patients.

Of the 157 patients evaluated, 82 (52%) underwent 135° DHS fixation, and 75 (48%) underwent AO 130° AP fixation. Each patient was examined clinically, and information was recorded about hip and knee movements, pain status, extremity length, the presence of atrophy, and devices used to assist movement. Radiological evaluation included the condition of the fracture, loss in reduction, and angular deformities.

Preoperatively, skin traction was applied to 78 patients (49.7%), and skeletal traction was applied to six patients (4%). A weight equal to 7-15% of body weight was applied, and traction was continued until surgery. Traction was not required in 73 patients (46.5%).

Preoperatively, trochanteric fractures were classified according to the Boyd and Griffin classification.<sup>[1]</sup> Postoperative evaluation of patients was performed according to the anatomical classification introduced by Foster<sup>[2]</sup> in 1958 and the functional classification introduced by Clawson<sup>[3]</sup> in 1957.

Fisher's exact chi-square test and ANOVA were used to determine whether there were statistically significant differences between study groups.

## Results

Of the 82 patients (mean age, 65.6 years) in whom DHS was applied, there were 49 men (60%) and 33 women (40%). Among the 75 patients (mean age, 67.2 years) in whom AP was applied, there were 44 men (58.8%) and 31 women (41.2%).

The mean elapsed time between the occurrence of the fracture and admission to the hospital was 3.2 days in the DHS group, and 3.8 days in the AP group. The mean duration between admission to the hospital and surgery was 5.2 days (range 2-12 days) in the DHS group, and 5 days (range 2-9 days) in the AP group. The mean length of stay was 13.5 days

(range 7-18 days) in the DHS group and 16 days (9-23 days) in the AP group. The mean follow-up duration was 8 years (range 2.3-11.7 years) in the DHS group and 8.5 years (range 2.4-12.5 years) in the AP group.

In order of frequency from the most to the least common, fractures had been caused by simple fall (minor trauma), fall from height, and traffic accident. This order was the same for both groups.

In neither group did infection necessitate removal of any implant; however, skin infections that responded to medical treatment were observed. Diagnosable deep vein thrombosis developed in four patients in the DHS group and in three patients in the AP group. One patient in the DHS group and one in the AP group developed severe pulmonary embolism, which was treated medically in each case. None of the patients had pathological or open fractures.

Of the 262 patients in our series, 39 (14.8%) died in the first year postoperatively. Of the patients who died, 17 belonged to the DHS group, and 22 to the AP group. Four patients died during the postoperative period. Causes of death included cardiovascular insufficiency, diabetes, pulmonary problems, and neurological diseases. Because they could not be followed up for a long period of time, those patients were excluded from the study. The five-year mortality rate was 36.58% (30 patients) in the DHS group, and 44% (33 patients) in the AP group.

Using screws or cerclage wires, additional fixation was performed in 9 (11%) of the 82 patients in whom DHS was used, and in 12 (16%) of the 75 patients in whom AP was used. Screws were used to prevent rotation in patients in whom stabilization was deemed insufficient, and cerclage wires were used to fixate the fractured and displaced greater trochanter.

Other organ injuries in addition to the trochanteric fracture of the femur were present in 15 patients (9.5%). These injuries are listed in Table 1.

According to the Boyd and Griffin classification, in the DHS group, 37 patients (45%) had stable fractures and 45 patients (55%) had unstable fractures, while in the AP group, 42 patients (56%) had stable fractures and 33 patients (44%) had unstable fractures (Table 2).

Preoperatively, one or more medical problems requiring treatment were present in 24 patients (15%). Of these 24 patients, 11 (7%) were in the DHS group, and 13 (8%) were in the AP group. The most common medical problems included cardiovascular diseases, diabetes, and renal and neurological diseases.

As for the gait analysis, 17 patients (22.6%) in the AP group were able to walk with the aid of a cane, and five patients (6.6%) walked with limping.

As shown in Table 3, late postoperative examination revealed that the screws perforated the antero-superior or posterosuperior parts of the femoral head in eight patients, of whom three belonged to the DHS group. In the AP group, pseudoarthrosis was seen in two patients, acetabular protrusion in one, and avascular necrosis in one patient. In addition, the plate was broken in one patient. Although pseudoarthrosis did not develop in the DHS group, avascular necrosis of the femoral head developed in three patients (Fig. 1).

Among the 92 patients in DHS group, the screws were in the technically desired position in 53 patients (64.6%), in the inferior position in 16 patients (19.5%), and in the anterosuperior position in the remaining 13 patients (15.9%). As for the 75 patients in AP group, the screws were in the technically desired position (Fig. 2) in 45 patients (60%), in the inferior position in 14 patients (18.7%), and in the superior position in the remaining 16 patients (21.3%).

In addition, our late follow-up examinations revealed 0-20° of varus in five patients (6%) and 0-2 cm shortening in six patients (7.3%) in DHS group. As for the AP group, six patients (8%) had 0°-30° of varus (Fig. 3) and seven patients (9.3%)

Additional lesion	DHS group	AP group	Total
Multiple rib fractures	1	-	1
Ischium-pubis fracture	1	2	3
Ipsilateral femoral shaft fracture	1	2	3
Colles fracture	1	1	2
Radius and ulna forearm fracture	2	-	2
Tibial condyle fracture	-	1	1
Vertebral body fracture	1	2	3

had 0-3 cm shortening. While malunion was observed in six patients (8%) in the AP group, mild malunion was recorded in only two patients (2.4%) in the DHS group.

Reoperations were performed for revision with internal fixation in three DHS patients with postero-superior perforation, and in seven AP patients with complications due to technical errors.

Partial prostheses were applied in nine patients (5.7%) with malunion and coxarthrosis around the perforation site. Of these patients, three were in the DHS group, and six in the AP group. Approximately 5 years later, total prosthesis was applied in six of these patients (3.8%) (three from the DHS group, and 3 from the AP group).

Patients in DHS group were allowed to sit after 24 hours postoperatively, to walk with crutches without weight bearing between postoperative days

	DHS group		AP group		Total	
	Stable	Unstable	Stable	Unstable	Stable	Unstable
Type I	12	-	29	-	41	-
Type II	25	2	13	7	38	9
Type III	-	34	-	18	-	52
Type IV	-	9	-	8	-	17

**Table 3**

Distribution of patients with complications according to the internal fixation devices and types of fractures

Complications	DHS group		AP group		Total n (%)
	Stable	Unstable	Stable	Unstable	
Shortening					
1-2 cm	2	3	1	2	8 (5.0%)
2-3 cm	-	1	2	1	4 (2.5%)
≥3 cm	-	1	-	2	3 (2.0%)
Varus deformity					
0-10°	1	2	1	1	5 (3.2%)
10-20°	1	1	1	2	5 (3.2%)
≥30°	-	1	-	2	3 (2.0%)
Femoral head perforation	1	2	2	3	8 (5.0%)
Acetabular protrusion	-	-	-	1	1 (0.6%)
Device breakage	-	-	1	-	1 (0.6%)
Pseudoarthrosis	-	-	-	2	2 (1.3%)
Avascular necrosis	1	2	-	1	4 (2.5%)
Malunion					
Severe	-	-	-	1	1 (0.6%)
Mild	-	2	2	3	7 (4.5%)
Rotational deformity	-	-	-	1	1 (0.6%)
Reoperation	-	3	2	5	10 (6.3%)
Partial prosthesis	1	2	3	3	9 (5.7%)
Total prosthesis	1	2	1	2	6 (3.8%)
Hip movement restriction-					
Flexion	-	-	-	10° (1 patient)	1 (0.6%)
Extension	5° (4 patients)	5° (1 patient)	10° (2 patients)	10° (1 patient)	8 (5.0%)
Internal rotation	7° (2 patients)	10° (2 patients)	8° (3 patients)	7° (3 patients)	10 (6.3%)
External rotation	10° (1 patient)	15° (1 patient)	15° (2 patients)	7-20° (5 patients)	9 (5.7%)

6 and 10, to walk with partial weight bearing between postoperative weeks 4 and 6, and to walk with full weight-bearing and under radiological surveillance between postoperative weeks 8 and 12. Patients in whom AP group were allowed to sit after 48 hours, and to walk with crutches without weight bearing from the 10th day. Under radiological surveillance, they were allowed to walk with partial weight bearing between postoperative weeks 8 and 12, and with full weight bearing between postoperative weeks 12 and 16.

According to Foster's anatomical ranking, the treatment with DHS did not yield any unfavorable results. The results were excellent in 51 patients (62%), good in 14 patients (17%), and moderate in 17 patients (21%). In the AP group of patients, excellent, good, moderate, and bad results were obtained in 39, 17, 13, and 6 patients, respectively ( $p < 0.05$ ). According to the functional classification of Clawson; excellent, good, moderate, and bad results were obtained in 49 (59.8%), 18 (22%), 11 (13.4%), and 4 patients (4.8%) in the DHS group,



**Fig. 1.** Radiograph showing the avascular necrosis of femoral head in DHS group.



**Fig. 2.** Radiograph showing the technically desired position of the screw in AP group.



**Fig. 3.** Radiograph showing the varus malunion position of the femoral neck in AP group.

and 36 (48%), 15 (20%), 14 (18.6%), and 10 patients (7.5%) in the AP group, respectively ( $p < 0.05$ ).

## Discussion

Trochanteric fractures constitute about 8-10% of all fractures, and are most commonly seen in patients over the age of 65.<sup>[4]</sup> These fractures cause the patient to be confined to bed. Due to the complications that develop secondary to long-term immobilization, most of these elderly patients do not survive. Complications including shortening, external rotation, and varus deformity accompanied by other complications may likely contribute to mortality and morbidity, which makes early mobilization mandatory for these patients.

In our series, mean length of hospital stay was 13.5 days in the DHS group, and 15.3 days in the AP group. In previous studies, this duration has been reported to vary between 7.3 and 53 days.<sup>[8,10-19]</sup> The mean length of hospital stay in our study is similar to that reported in recent studies; however, compared with what is reported in older studies, the length of stay is considerably shorter in our study. This result can be explained by developments in medical technology, and improvement in intensive care unit conditions and nursing services.

In both groups, the most common factors in the etiology of fractures were simple fall, fall from height, and traffic accident. In the DHS group, the causes of fractures were simple fall in 52 patients (62.2%), fall from height in 25 patients (30.5%), traffic accident in five patients (6%), and other causes in one patient (1.3%). In the AP group, the same causes were identified in 45 patients (60%), 25 patients (33.3%), four patients (5.3%), and one patient (1.4%), respectively. When both groups were evaluated together, the most common cause was simple fall, with a rate of 61.1%. In contrast, the most common cause of fractures was fall in the study of Görgeç et al.,<sup>[20]</sup> and minor trauma in the study of Korkmaz et al.<sup>[21]</sup> with a rate of 71.3%. Mutlu et al.<sup>[19]</sup> reported a rate of 84% for simple fall, which was also the most common cause according to Ege.<sup>[4]</sup> We believe that the high rate of simple fall as a cause of bone fractures is related to the bone quality of patients in the elderly group, of whom the majority have osteoporosis (grade I-III according to Singh's osteoporosis index).<sup>[4,19,22-24]</sup>

Regardless of the type of fracture, the authors unanimously accept surgical treatment and early mobilization as the preferred treatment method. The reason behind this preference is that the results

obtained by surgical treatment are better than those obtained by conservative treatment.<sup>[3,5-10]</sup> Clawson<sup>[3]</sup> reported a mortality rate of 18% in patients treated with surgical treatment, and 43% in patients treated with conservative methods. In contrast, Evans<sup>[8]</sup> reported a mortality of 16.8% in the surgical treatment group and 30.7% in the conservative treatment group.

In the present study, the five-year mortality rate was 36.58% in the DHS group, and 44% in the AP group. In the literature, the one-year mortality rate has been reported as ranging between 15% and 45%. Factors contributing to mortality include diseases present preoperatively, psychiatric problems, dietary habits, duration of surgery, postoperative care and rehabilitation, age, and sex.<sup>[24-30]</sup> The causes of death in our series are consistent with those reported in the literature; however, studies in the literature focus mostly on one-year survival rates. Our five-year survival rate appears to be higher than that mentioned in the literature. We assume that this results from the fact that the mean age of our patients was lower than that reported in other studies. Hence, we observed a lower mortality rate, which results from the return of the patients to active life after surviving the critical first year.

Of the patients in whom DHS was applied, 1-2 cm of shortening was seen in five patients (6%), and 2-3 cm of shortening in one patient (1.2%); however, 1-2 cm of shortening developed in three patients (4%), 2-3 cm of shortening in three patients (4%), and shortening of >3 cm in one patient (1.3%) of the AP group. Overall, shortening developed in 7.3% of the patients in the DHS group, and 9.3% in the AP group. This complication is closely related to varus deformity, which develops during the postoperative period. There were five DHS-group patients with 0°-20° of varus, and six AP-group patients with 0°-30° of varus deformity. Görgeç et al.<sup>[20]</sup> found that of the 61 patients in whom DHS was used, 16.4% developed shortening. In the study of Temelli et al.,<sup>[11]</sup> shortening was detected in 21%, and coxa vara in 10% of patients. Considering that a shortening up to 1 cm is regarded as anatomically normal, and that a shortening up to 2 cm is not considered as a serious problem since it can be treated conservatively, we only had four patients, all treated with AP, for whom shortening was a problem.

According to Flores et al.,<sup>[31]</sup> a sliding screw-plate allows controlled collapse of the major fragments, but maintains the neck-shaft angle even in unstable fractures. Failure was related to two factors: the type of internal fixation used, and the stability of the fracture. With hip screws, the tendency to collapse into varus was not greater in unstable fractures than in stable ones. In contrast, the authors observed that some fractures had moved into a valgus alignment by the completion of the treatment.

Femoral head or neck perforation was found in eight patients (5%) of our series. DHS was used in three and AP was used in five of these patients. The rate of femoral head perforation was 4% in a study by Korkmaz et al.<sup>[21]</sup> and 10.5% in a study by Cleveland et al.<sup>[13]</sup> In a study by Jacobs et al.<sup>[32]</sup> comparing the Jewett nail-plate and DHS, the rate of joint penetration was reported as 21% and 3%, respectively. In another study comparing DHS and the Jewett nail-plate, MacEachern et al.<sup>[33]</sup> reported that penetration into the joint occurred in 12% of the patients, and all these patients had been treated with Jewett nail-plates. Davis et al.<sup>[34]</sup> could not determine a significant relationship between the penetration of the implant into the femoral head, and the Singh osteoporosis index. Mulholland and Gunn<sup>[12]</sup> recommended the central positioning of the screw while Kyle et al.<sup>[14]</sup> reported that they placed the DHS to the posterior femoral head and eventually observed no femoral head perforations.

The femoral head and neck perforations observed in the DHS group were associated with technical failure. The screw was not placed in the desired central position, but in the anterosuperior position. In comparison, in the AP group, two patients had perforation of the screw into the posterosuperior femoral head due to early weight-bearing, and three patients had fixation of the plate to the superior position instead of the desired central position.

Although we did not observe pseudoarthrosis in any of the DHS-group patients, femoral head avascular necrosis developed in two patients. As for the AP group, avascular necrosis developed in one, and pseudoarthrosis developed in two patients. In the series of Korkmaz et al.,<sup>[21]</sup> which included 63 patients, avascular necrosis was observed in one patient (1.6%) while pseudoarthrosis was not

observed in any of the patients. Temelli et al.<sup>[11]</sup> reported an avascular necrosis rate of 16% in patients treated with DHS. Avascular necrosis does not constitute a major problem for such fractures, which involve extracapsular and spongy bones. In the literature, the rate of avascular necrosis has been reported as 0.8%. A relationship between avascular necrosis and the placement of the screw in the superolateral portion of the femoral head has not been documented.<sup>[5]</sup> The rates of avascular necrosis and pseudoarthrosis in the present study appear to be consistent with the results obtained in the local and international literature.

Overall, according to Clawson's functional classification, the results were good to excellent in 81.2%, and bad in 4.8% of the patients treated with DHS, and good to excellent in 68% and bad in 7.5% of the patients treated with AP. In contrast, according to Foster's anatomical classification, the results were good to excellent in 79% and bad in 1.2% of the patients in DHS, while good to excellent in 74.7%, and bad in 8% of the patients in AP group.

In their evaluation, in consideration of symptomatic penetration, avascular necrosis, malunion, and nonunion; Jacobs et al.<sup>[32]</sup> reported bad results in 6% and 21% of the patients treated with DHS and AP, respectively. The rates of good to excellent results in these groups were 92% and 85%, respectively. In contrast, good to excellent and bad results with DHS were reported as 86.6% and 4.9%, respectively in the study of Görgeç et al.,<sup>[20]</sup> 78.1% and 14.6% in the study of Korkmaz et al.,<sup>[21]</sup> and 89% and 6% in the study of Kyle et al.<sup>[14]</sup>

When we reviewed the literature to compare compression and non-compression screws, we found that complications occur less frequently with compression screws, and that these screws are more stable than are the non-compression screws.<sup>[4]</sup> Jensen et al.<sup>[35]</sup> used DHS along with McLaughlin's, Jewett's, and Ender's nails for the fixation of unstable trochanteric fractures. The authors compared these methods, concluding that DHS should be preferred to the other methods because it results in a lower rate of loss of reduction, has a lower rate of reoperation, and provides secondary impaction without affecting the union of the bone. Other studies comparing the use of DHS, and Jewett's and Ender's nails in

trochanteric fractures have reported that the patients in whom DHS had been implanted were mobilized earlier, and the rate of loss of stabilization was lower in this group of patients.<sup>[24,36]</sup> However, Esser et al.<sup>[37]</sup> compared Jewett nail-plate and DHS, and concluded that patients and doctors were satisfied with the Jewett nail even after many years, and these nails were not sufficiently inefficient to be rejected.

Our review of the literature did not identify a study comparing DHS and AO 130° AP. Because these screws share the same mechanism with Jewett's, MacLaughlin's, and Smith-Peterson's nails, we considered only those studies concerning these nail-plates. A statistically significant difference was present between the anatomical and functional results obtained with the screws used in our study. We noted a greater number of complications with non-compression nails, particularly in unstable fractures. Researchers unanimously concluded that compression nails (Richards, Massie) should be preferred to non-compression nail-plates (Jewett's, Smith-Peterson's, McLaughlin's, AO angled blade plate). Our study, which included 157 patients, suggests that DHS is superior to AP in many ways, although the former is more expensive and more sophisticated, and requires a longer learning curve and a longer duration of surgery. The advantages of DHS include the following:

1. More rigid internal fixation due to its compression feature.
2. Lower risk of femoral head perforation due to its blunt edge and sliding feature.
3. A more anatomical reduction obtained through compression in comminuted and defective fractures.
4. A lower rate of complications.
5. Minimization of complications associated with long confinement to bed through early mobilization of the patient.
6. Financial profit through a decrease in bed occupancy.

In conclusion, we believe that priority should be given to DHS for the internal fixation of trochanteric fractures of the femur, particularly in unstable fractures; however, the use of AP should not be dismissed in patients with poor general medical condition, patients requiring a shorter duration of surgery, and those with anemia.

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