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# VALGUS ANGULATION OSTEOTOMY IN SECONDARY TREATMENT OF FEMORAL NECK FRACTURES

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## ABSTRACT

*Fourteen patients who were operated on by various techniques for collum femoris fracture, between the years 1992 and 1998 were treated by valgus angulation osteotomy for non-union of the fracture. The average age of the patients was 45.2 years (range, 22-58 years). The osteotomy line was healed for all patients and the mean healing period was 3.6 months (range, 2.8 to 6.4 months). The nonunion of the femoral neck and the delay in uniting healed except for in one patient, and the healing period was found to be 5.8 months (range, 4.8 – 11 months). Including the 12 cases that had avascular necrosis at several preoperative degrees, five patients developed postoperative degenerative arthritis. During follow-ups, while the average score in the first year was 89.7, it was 85.7 in the last examination, accounting for 4% failure. For younger patients under the age of 60 who were treated with internal fixation, however nonunion, it is appropriate to perform angulation osteotomy, which is the rescuing operation, without regard to the feeding position of the head. We believe that this process will allow the union of the femoral head and, at most, lengthen the period for transition to prosthesis.*

## Introduction

Femoral neck fracture develops with simple traumas and is frequently observed in older patients. However, in addition to the infrequency of cases involving younger patients, such a condition develops from high-energy traumas and shearing stress. The aim and types of treatment for young patients with femoral neck fracture are different from those for older patients. The aim when treating such patients is to preserve the femoral head. Although various techniques have been developed for internal fixation with open or closed reduction of the femoral neck fracture (12, 19, 20, 25, 26) the nonunion and avascular necrosis of the femoral head are observed as major complications and these require a number of solutions. While the type of fracture, treatment initialization period, and rate of

nonunion in accordance with surgical techniques in such cases varies between 12 and 20 %, the rate of partial or complete avascular necrosis varies between 12 and 55 % in the literature (2, 4, 6, 9, 10, 13).

In cases in which internal fixation is performed, and as a result produced a delay in uniting or nonunion, and where radiological avascular necrosis findings at the femoral head were observed, many surgeons use secondary arthroplasty as the first choice (6). However, the complications of this method are higher in younger patients and do not solve the problems faced by such patients.

The reasons for the nonunion of high energy fractures and fixation losses in relatively younger patients have been identified by Pauwels as mechanical. He argued that biomechanical factors were more influen-

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tial than biological factors within the recovery period of femoral neck fractures (23, 34, 26). The principles of Pauwels have set forth the notion that femoral neck fractures should be treated with high femoral osteotomy in patients of nonunion (1, 3, 11, 18).

In this study, the results of valgization osteotomy in patients under the age of 60 who developed delayed union and nonunion after operations due to femoral neck fracture were examined.

### Materials and Methods

A total of 67 active patients less than 60 years of age with unstable intracapsular fractures who were brought to our clinic between the years 1992 and 1998 were treated by internal fixation. Valgization osteotomy was performed to 14 patients due to the following reasons: 2 patients for technical failure, 3 patients for insufficient union, 9 patients for non-union. The average age of the patients was 45.2 years (range, 22-58 years) (**Table**). For the review of all patients, the Pauwels classification was used. The fracture type in 11 patients was Pauwels type 3, and for the other three type 2.

Preoperative planning: the neck was observed through its anterior-posterior radiographs for the 10 – 20 degree internal rotation of the lower extremity and lateral radiographs of the pelvis.

In order to examine the vascularization of the femoral head, no additional investigations were performed other than radiography. The density of the femoral head, the appearance of its supero-lateral section, and the degree collapse were examined in radiography. In order to perform a radiological examination of avascular necrosis, Inoue and Ono's (14) classification was used. Two patients had normal X-rays (stage 1) prior to osteotomy (14%), and the number of patients that produced slight sclerosis with abnormal or irregular density (stage 2) was eight (58%), and the remain-

ing four patients developed slight collapse with irregular density (stage 3). The average interval from injury to osteotomy was 14.7 months (range, 1-36 months).

Finally, the mechanical analysis of nonunion and the structural position of the femoral head were investigated. The size of the wedge was calculated based on the angle of the fracture line with relation to the femoral shaft.

Surgical technique: The hip of a patient laid on a radiolucent table was heightened to 15-20 degrees. The skin incision was directly lateral and was straight. The tendon of origin of the vastus lateralis was identified and incised 1 cm from the bone to allow repair. The muscle was elevated from the bone and reflected anteriorly. The fixation devices previously fixed were removed without traumatizing the tissues. The osteotomy was planned at the level of the top of the lesser trochanter. The level of the osteotomy was identified with fluoroscopy or X-ray checks and guide Kirschner wire. The osteotomy was carried out transversely. Considering the correction of the rotation, a wedge was taken from the proximal fragment. In addition, in order to correct the substitution, because of valgization of the lateral at the mechanical axis a lateral displacement was performed. Using templates of the implants, the correct length blade plate was traced in position so that ideally the tip of the blade lay in the inferior portion of the head. The angle between the plate and the shaft equaled the desired angle of correction. The plan should consider the position of the blade plate entry point, which should be 2 cm proximal to the osteotomy. For stabilization, 135-degree blade plates were used. The removed wedge was morcellated and used for bone graft around the osteotomy site and nonunion field. The average operation period was 150 min (range, 90 – 200 min). The amount of blood loss was on average 800 ml (range, 400–1500 ml).

Postoperative care: The patient began

TABLE

## Details of patients

Case	Age (years) sex	Initial treatment	Cause of failure	Av nec	Time interval (Months)	Follow-up (Years)	Pre, post-oper. CD angulation	Results	Harris hip score	Harris hip score at last follow-up
	45-F	OR K-pin-3	PNU	2	14	6.8	100-120	Union Deg	89	82
	49-M	OR, CS-3	PNU	2	12	6.5	96-130	Union	94	88
	22-F	OR, K-pin-3	PNU	2	18	6.5	117-136	Union Deg	90	83
	54-M	OR, CS-4	IU	2	11	6.2	100-123	Union Deg.	85	79
	53-M	OR K-pin-3	PNU	3	36	5.4	100-114	Union	90	86
	37-M	OR, CS-3	IU	2	10	5.1	105-135	Union Deg	88	85
	28-M	OR, Hip S	IU	1	10	4.8	110-140	Union	93	88
	58-M	OR, CS-3	PNU	2	13	4.6	105-135	Union	94	92
	53-F	OR K-pin3	PNU	2	21	4.5	115-130	Union Deg	83	90
	41-M	OR, CS-4	PNU	3	20	3.7	110-130	Union	91	79
	57-M	Recon nail	Technical problem	1	1	1.4	-	Non-unionTHR	-	-
	49-M	CP 135 <sup>0</sup>	PNU	3	16	3.3	115-135	Union	86	86
	57-M	OR, Hip S	Technical Problem	2	9	3	100-130	Union	94	88
	31-M	OR, CS-3	PNU	3	16	2.8	113-135	Union	90	89

OR: Open reduction; CP: 135<sup>0</sup> condylar blade-plate; K-pin: Number of Knowles' pinning for fixation; Recon: Reconstruction; CS: Number of Cannulated Screw for fixation; Hip S: Hip Screw; PNU: Persistent non union; IU: insufficient Union; Deg: Degenerative arthritis; Pre, post-oper. CD angulation: pre, post operatif collo-diafizer angulation.

active exercises of the hip and knee immediately thereafter and began using crutches within the first 24 hours of surgery. Weight bearing was delayed until healing was seen at the osteotomy site on radiographs, usually about 6 weeks, and thereafter progressed gradually to full weight bearing, as tolerated. To review the results, the Harris numerical review system was used.

### Results and Discussion

The cases were followed up for an average of 4.75 years (range, 2.8 – 7.1 years). All of the osteotomy sites healed in an average of 3.6 months (range, 2.8 – 6.4 months). All of the femoral neck nonunion cases healed except for one patient (case 11), in an average of 5.8 months (range 4.8 – 11 months).

The average preoperative leg length discrepancy was 2.3 cm short on the side of

injury (range, 0.5-3.5 cm short), and the average postoperative discrepancy was 1.1 cm short (range, 0-2.5 cm). The preoperative and postoperative radiographs were evaluated to measure the change in inclination of the fracture line effected by osteotomy. The average change in inclination after osteotomy was 23.6 degrees (range, 14-34 degrees) (Table).

The number of cases in whom avascular necrosis was seen after osteotomy together with minimal collapse was five. Due to the technical failure, blade passed through superior femur neck in two of these five cases. Degenerative changes were observed to increase in such patients from the 4th year. According to Harris hip score, the early results of the postoperative 1st year were compared to the score results obtained from later checks. According to this comparison, excluding the disunited patient

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on whom we performed total hip prosthesis (case:11 ). While the average score in the first year was 89.7, it was 85.7 in the last examination, since 4% failure was observed as a result of osteoarthritic changes on the hips (Table).

There were early and later postoperative failure of fixation in two patients (case:1,11). Unstabilization was seen in the case in which we used Recon-nail as a result of technical failure because of mispassing of the screw, and in addition to this, the patient also gave early weight bearing out of our control. In the others, hip screw was cut out from the femur neck.

It was observed in our study that treatment intervals and age did not play a major role in the union of the fracture. There were no infections, thromboembolic complications, or hardware failures in this series.

The most effective outcome after a femoral neck fracture is the recovery of the femoral neck and head of the patient. Therefore, primary treatment should be reduction and internal fixation. However, after this treatment, fixation failure or nonunion can be seen (1, 25). In several studies, this rate was as much as one in three. This rate is higher in displaced and vertical femoral neck fractures (12, 21).

Where nonunion in the femoral neck that is extremely disabling in nature occurs a variety of treatment alternatives such as refixation, arthrodesis, arthroplasty and osteotomy alone or together with grafts are available. However, it is not clear when and which of these methods should be chosen (1, 2, 3, 10, 12, 19, 21).

Total hip arthroplasty is one of the best-known treatment methods. The early and late complication rate for the treatment of femoral neck nonunion with this method is quite high and extremely expensive compared to other treatments (7, 21, 22). It is considered that the nonunion of collum femoris fractures do not constitute a great problem due to prosthesis implementation

in hip surgery and its popularity. However, practice has shown that problems are not completely solved by such as prosthesis, and they even become more pronounced in some cases (7). The reason why most orthopedic surgeons use this method is that the early outcomes are generally better (21, 22). In later follow-ups, mechanical failure is frequently observed particularly in younger patients (5, 27). While hip prosthesis should be the first choice in older patients with neurological problems and systemic pathologies, this type of treatment should be avoided in patients under the age 60 with no problems (5, 7, 21, 22).

The second treatment alternative is hip arthrodesis. In patients with hip arthrodesis, even though hip movements are lost, if union is achieved later, outcomes will prove better. However, union in hip arthrodesis cannot always be achieved, and it is harder to make patients accept this method (12, 22, 25).

It is difficult to apply refixation alone in such patients due to the reduction in bone stock that the previous implants form, and of which the head bone quality deterioration. Refixation may be combined with cortical or vascularized grafts. Dickson and Baksi (2) have emphasized that the use of cortical and cancellous grafts may create disimpaction and angulations in the femoral head and that these grafts cannot contribute in the union due to their rapid resorption. The use of a vascularized graft was popularized by Meyer (19) and recommended especially in relatively fresh fractures. In addition to the authors who support the idea that this method is unreliable, Baksi (2) reported that he achieved union in 42 cases out of 56 femoral neck union failures he treated with vascularized graft.

By osteotomy, which was frequently used previously, the mechanical and physiological causes for nonunion may be removed. With this aim, two types of osteotomy were once used. One of them was a displacement



1a



1b

**Fig. 1.** Case3. a. 22 – year –old woman sustained a right femoral neck fracture and was treated with multiple Knowles' pinings. b. After 18 months all pins were removed and showing persistent nonunion.

McMurray osteotomy performed exactly on the trochanter minor of the osteotomy, and the other was the Schanz type osteotomy performed underneath the trochanter (3, 8). The abduction angulation osteotomy initially applied by Schanz was improved by Pauwels. The principal conceptual base of the Pauwels osteotomy was that biomechanical factors affected the healing period

of femoral neck fractures more than biological factors. Pauwels argued that the compression stress at the line between the head and neck accelerate uniting, and, in contrast, the shearing and tension stress affect the union negatively (3, 23). Thus, Pauwels suggested subtrochanteric valgus osteotomy in type 3 fractures and nonunion cases. Pauwels' suggestion was only used



1c



1d

**Fig. 1.** Case3. c. The nonunion was treated with valgus osteotomy and anterior-posterior radiograph three months postoperatively. d. Control 6.5 years later.

to a limited extent in valgization osteotomy in Europe, and its outcomes were published. Medialization was also added to the valgus osteotomy for common use (3, 18). In many small series where only Pauwels angulation osteotomy was performed,

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union was reported in 96 % of 58 cases (8, 15, 17, 27). When using the Marti (18) intertrochanteric Pauwels osteotomy 86% consolidation was obtained. In some small series where medialization was performed in addition to valgus osteotomy, 100% union was reported (8, 18, 27). We achieved union in 13 cases (92%) out of 14. In contrast to medialization, slight lateral displacement was administered in order to correct any deviation in the mechanical axis due to valgization. Nonetheless, the union rate was quite effective and in accordance with the literature.

Catto (6) has stated that the rate of avascular necrosis was 66% in unstable fractures; they were 30-33% in Pauwels type 2 and type 3 fractures. Avascular necrosis was observed in one in three of the most unstable fractures and thus pseudoarthrosis was found in 26% (6, 18). Avascular necrosis without head collapse generally has not been considered a contraindication for the procedure (8, 18, 27). In preoperative period, only two of our patients were radiologically normal. There were stage 2 or stage 3 changes for the other 12 patients in accordance with Inoue and Ono's (14) classification. However, these patients achieved union with valgus angulation osteotomy. The presence of a vascular necrosis in cases under the age of 60 and the nonunion of the fracture did not produce prosthesis indication. Even though uniting is slow and limited in such cases, revascularization is shown (4, 6, 22). While there are avascular necrosis symptoms in many of the radiographic evidence pertaining to the patients, few of them cause problems. Ballmer et al. (3) were compromised by avascular necrosis, and the authors recommended evaluating the viability of the head by noninvasive means. However, provided there was no head collapse, they believed that osteotomy still was indicated, even with necrosis present, because the neck fracture can heal and a necrotic head can be re-vascularized, although this process re-

quires prolonged, adequate fixation (1).

While outcome is good within early postoperative years, degenerative changes are frequently encountered in later years (3, 11, 16). However, although we found union satisfactory in our cases with distorted femoral head vascularization, we could not impose full load due to the risk of late segmentary collapse and degenerative arthritis. We observed degenerative arthritis during our follow up of 4.75 years on average in 5 patients (38.4%).

Even though delays in patients with subcapital femoral neck fracture were observed, alternatives like valgus osteotomy that provide the co-existence of the patient and his bone and enable sufficient union by solving mechanical problems in such cases, when the animateness of the femoral head at a percentage of 75% is taken into consideration. In addition to the achievement of a large amount of union with the valgus osteotomy (by medialization or lateralization), it may be possible to lengthen the period for transition to prosthesis. We are of the opinion that valgus angulation osteotomy, which is the rescuing operation, should be implemented without regard to the feeding position of the head for nonunion of collum femoris fractures in cases under the age of 60.

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