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Dr. Asif Ali Dar
PG Scholar, Department of Orthopedics, Govt. Medical College, Srinagar, Jammu and Kashmir, India

Dr. Imtiyaz Hussain Dar
Professor, Department of Orthopedics, Govt. Medical College Srinagar, Jammu and Kashmir, India

Dr. Ansar Ul Haq Lone
Lecturer, Department of Orthopedics, Govt. Medical College Srinagar, Jammu and Kashmir, India

Dr. Sayar Ahmad Manto
Senior Resident, Department of Orthopedics, Govt. Medical College Srinagar, Jammu and Kashmir, India

Corresponding Author:
Dr. Sayar Ahmad Manto
Senior Resident, Department of Orthopedics, Govt. Medical College Srinagar, Jammu and Kashmir, India

Evaluation of the neck shaft angle after DHS fixation in intertrochanteric hip fractures

Dr. Asif Ali Dar, Dr. Imtiyaz Hussain Dar, Dr. Ansar Ul Haq Lone and Dr. Sayar Ahmad Manto

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Abstract
Introduction: The characteristic morphology of the proximal extremity of the femur and the muscle balance of the hip are factors that make weight bearing possible among patients. Restoration of neck shaft angle is as important as union because if neck shaft angle is not restored, it can lead to disability. Recent studies have been conducted with the intention of showing the relationship between fracture of the proximal extremity of the femur and the anatomical configuration of the hip. This study was a prospective one to evaluate neck shaft angle after DHS fixation in intertrochanteric fractures.
Patients and Method: Prospective study done on 25 (13males and 12 females) patients who were operated by a single surgeon. Evaluation of neck shaft angle in non-fractured side and the restoration/change in neck shaft angle on the operated side after surgical fixation with DHS, radiographs taken with both hips in 15 degrees of internal rotation.
Result: All fractures got united, average age of patients was 58 years, varus malunion in 2 cases and valgus in 4 cases. Average NSA on normal side was 136±4 and on operated side it was 126±4 degrees.
Conclusion: The neck-shaft angle is the most important parameter after fixation of intertrochanteric fracture by DHS, we must preserve the near normal angel after fixation to avoid valgus and varus malunion.

Keywords: Hip fractures, intertrochanteric fractures, dynamic hip screw (DHS), neck-shaft angle (NSA)

Introduction
An increase in the elderly population has resulted in raising the incidence of hip fractures in many parts of the world. Increased longevity, together with osteoporosis and senile muscular insufficiency, may explain the increasing number of patients with hip fractures [1]. More recent evidence suggests that variations in Proximal Femoral Geometry also play an important role in the hip fracture etiology [2]. The characteristic morphology of the proximal extremity of the femur and the muscle balance of the hip are factors that make weight bearing possible among patients. Recent studies have been conducted with the intention of showing the relationship between fracture of the proximal extremity of the femur and the anatomical configuration of the hip [3, 4].
Surgical stabilization of the intertrochanteric fractures and early mobilization of the patients are the optimal treatment to prevent the complications of prolonged immobilization. For geriatric intertrochanteric hip fractures, internal fixation enables early mobilization and prevents complications related to long-term confinement to bed.
Evaluation of the NSA of femur helps in understanding biomechanics of the hip joint and its clinical relevance, and it also helps in planning of treatment of various affections of hip region and in designing implants and prosthesis for this region. Recently, a number of researchers presented the geometry of trochanteric region and proximal femur to improve the design of new implants, with respect to their anatomical landmarks, structure and distribution of their bony tissue [5, 6].
The Dynamic hip screw (DHS) had been the standard and the best documented implant in treating intertrochanteric fractures with lower complications and less expensive. In this study, we tried to evaluate the effect of restoration of proximal femoral geometry on outcome of patients with intertrochanteric fractures treated with dynamic hip screw.

Patients and Methods

This prospective study was done on 25 (13males and 12 females) patients with intertrochanteric fractures treated by Dynamic Hip Screw (DHS) and were operated by a single surgeon in the postgraduate department of orthopedics, Govt. Bone and Joint Hospital, Barzillai, Srinagar from January 2020 to December 2020. The operated patients were followed up for a minimum 2 years.

The inclusion criteria were all adult patients with intertrochanteric fractures undergoing surgery. Only recently, isolated and stable intertrochanteric fractures were included in the study. Unstable and comminuted fractures, Pathological and neglected fractures, bilateral hip fractures, associated pelvic fractures and skeletally immature patients were excluded from this study. A written informed consent was obtained from all patients. Fractures were classified radiologically according to AO classification and all fractures were (31- A1) Per trochanteric simple [7].

Radiological Assessment

Serial x-rays were taken pre and post-operatively and in every check (4 weeks) to determine union (delayed union, non-union or malunion), implant position in the femoral head (tip-apex distance [TAD]) [8] to predict implant failure and fixation failure (lag screw cut-out, penetration or loosening) and position of lag screw in the femoral neck (superior, central or inferior) according to Goffin et al. [9] Study.

Evaluation of Changes of proximal Femur geometry

The pelvic radiographs were taken in the anteroposterior (AP). The patient was positioned in horizontal supine position with the patella facing straight ahead and the lower limbs internally rotated 20°. The morphometric evaluation was done by radiograph of the normal hips and the fractured hips (AP both hips), the proximal part of the contra lateral femur was used as a control for the measurements. The measurements were taken, and changes were recorded.

The analyzed measurements were: Femoral neck length (FNL) and Neck-shaft angle (NSA). The choice of these measurement indexes based on Pires *et al*. [4] Study and Ravichandran et al. [10] study of morphometric analysis of the proximal region of the femur, changes of both sides were compared by students' t-test [11] to (non-significant, mild or significant).

Clinical Assessment

The final assessment was done by Harris hip score (HHS) [12] used to assess hip function more specifically.

Statistical Analysis

Statistics were performed by SPSS Statistics

Results

25 intertrochanteric fractures were included in this study. They were evaluated both radiologically and clinically. Radiological evaluation included assessment of union, delayed union, nonunion or mal-union, failure of fixation, position of lag screw in femoral head by (Tip-apex distance [TAD]) and in the femoral neck (central, superior or inferior) and evaluation of changes of proximal femur morphology (non-significant, mild or significant). The clinical results were assessed according to the Harris hip score (HHS). There were 13 male and 12 female with an average age of 58 years (range 36-70). The mechanism of injury was a simple fall in 14 (56%) cases; fall on stairs in 4 (16%) cases and RTA in 7 (28%) cases. The fracture was in the right side in 14 cases and on the left side in 11 cases. The follow up period ranged from 25 to 33 months, with an average of 26 months.

Union was detected by the absence of the fracture line and presence of bone bridging on the AP as well as in lateral view (Table 1).

Table 1: Statistical distribution of union condition

Condition	No. of patients	Percentage
Union	25	100
Delayed union	1	4
Mal-union	6	24
Non-union	0	0
Total	25	100

Table 2: Change of degree in angle.

No. 0f patients	Proximal hip geometry		P Value
25	DHS side NSA Average angle	Normal side NSA	
	136.4 degree	126. 4dgree	0.05
NSA-Neck Shaft Angle			

Table 3: Distribution of changes of proximal femur according to gender

Sex	No. of patients	Proximal Hip Geometry	P-value
		NSA	
Male	13	135.5	
Female	12	132.4	
Both	25		0.05
NSA-Neck Shaft Angle			

Table 4: Change in length.

No. of patients	Proximal hip geometry		P Value
25	DHS side Average FNL	Normal side FNL Contralateral hip	
	13.4 cm	13.7 cm	0.05
FNL-Femur Neck Length			

Discussion

The predicted increase in the aging population and the associated increase in the fractures of the proximal femur have induced a search for improved treatment methods. Many treatment modalities have been used, including non-operative methods, intramedullary nails, fixed angle plates, and the dynamic fixation devices.

The dynamic device is the implant of choice for stable intertrochanteric fractures [8]. Several aspects of the geometry of the femoral neck have been found to influence the risk of hip fractures. Studies have correlated greater length of the femoral neck and lower values for the neck-shaft angle with greater incidence of hip fractures [13-15]. The purpose of the research is to analyze the consequences of bad reduction on bony union and function and compare the DHS device measurements with Egyptian femora.

The position of the lag screw was more important determining factor. Cases fixed with acceptable alignment, but without bone contact, have shown no cut out or migration and united when an anterior or posterior position was avoided. Birdle et al. reported a lower incidence of screw cut out and/ or migration compared to previous series, reflecting the good lag screw position which they obtained. They found that the incidence of central positioning of the lag screw in the femoral neck was higher for the DHS [16].

The incidence of varus deformity was significantly less in patients treated with the DHS. In a study of George et al. [17] treatment of unstable intertrochanteric fractures with a sliding hip screw led to a 56% failure rate (9 of 16 cases). Alvarez et al had six out of their total of 43 patients (13.9%) ending with varus malunion. In our work, the neck shaft angle ranged from 107° to 140° with an average of 136.4°. We had only 2 cases of the mild varus collapses of the proximal fragment (mild varus 4°) and 4 cases of valgus malunion (13° of valgus. The neck of the femur in humans is a very important structural and functional specialization for man's erect posture. Most of the textbooks of Anatomy quote the average neck-shaft angle in adults as 125 degrees (range 110 degrees to 144 degrees.) and in fetuses as 140 degrees [18-24]. The mean neck length of our study is 13.5 mm. Kate found the Formosans to have lowest average neck shaft-angle (125.6 degree) and Asians the highest angle (134 degree). We considered population in our study had average angles (126.4 deg.) almost same as previous studies. It is clear that the proximal femoral geometry varies among different ethnic groups. Therefore, the usage of implants designed exclusively for Western bones will not be suitable for other ethnic groups.

In this study we measured the neck-shaft angle based on the axis of the proximal femur. This will replicate the actual neck-shaft angle when performing hip arthroplasty as the stem of the femoral component was designed to restore the anatomy of only the proximal femoral region. Trying to place the implant based on the long axis of the femoral shaft may jeopardize bone stock by unnecessarily removing the medial cortex of the femoral diaphysis. There was a change toward varus angulation of the neck-shaft angle (an inward deviation of the distal femoral segment) if the measurement was performed using the long axis of the femoral shaft instead of using the axis of the proximal femur. In our study, we found no significant changes of the greater trochanter-pubic symphysis distance. Statistically significant difference was detected in the median of the femoral neck length (FNL) in keeping with the fracture.

Conclusion

The neck-shaft angle is the most important parameter after fixation of intertrochanteric fracture by DHS, we must preserve the near normal angel after fixation to avoid valgus and varus malunion.

Conflict of Interest

Not available

Financial Support

Not available

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