

Analysis of Fracture Healing and Choice of Operative Method in Subtrochanteric Femur Fracture Depending on Time from Trauma to Surgery

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Abstract: *This study conducted as a retrospective radiological analysis on a population of subtrochanteric femur fracture patients presents findings correlating the time interval between trauma and surgery with fracture healing outcome and the surgeon's choice of surgical method.*

Keywords: subtrochanteric, femur, fracture, trauma, surgery, interval, direct, indirect

1. Introduction

Hip fractures are one of the most common fractures encountered in the adult population. They often result in pain lasting for variable duration, loss of function, and reduction in the quality of life. Among all the patients, a half would almost never regain their level of functioning and independent lifestyle, as they did, earlier to the fracture. Hip fractures, in addition to the burden of increased morbidity and loss of working days, contribute significantly to a rise in the overall mortality, especially in the elderly population, sometimes reaching even upto 20%-25% [1]. A bigger role exists for the optimisation of the treatment, surgical and other, in the management of the entire spectrum of hip fractures.

Although, amongst all the hip fractures, subtrochanteric fractures form a minor group, however, owing to the sheer number of hip fractures that occur in the adult and the elderly population, the subtrochanteric fractures add up to a significant number of fractures encountered in the clinical practice. Subtrochanteric fractures are diaphyseal fractures of the femur occurring in the proximal femur between the inferior aspect of the lesser trochanter and a distance of about 5 cm distally [2].

This study intends to measure the difference in outcome, if any, depending on the time interval from trauma to surgery. This study incorporates subtrochanteric femur fracture cases operated within a time interval ranging from 1 to 13 days. The cases included have been operated either by direct or indirect methods. This study also intends to measure whether the time interval from trauma to surgery dictates surgeon's choice of operative method.

Operative Methods

In the DIRECT TECHNIQUE, the fracture is exposed, the reduction instruments remain visible when inserted into or near the fracture zone, and the result of the reduction can

be examined visually.

In the INDIRECT TECHNIQUE, the fracture is not exposed, and reduction is usually achieved by longitudinal traction, sometimes using reduction instruments inserted through the skin.

2. Methods

2.1 Aims and Objectives

This study was intended to measure the radiological outcomes, in terms of fracture union, using the follow-up radiographs of post-operative patients of subtrochanteric femur fracture, and compare the outcomes among different groups according to interval between trauma and surgery.

We measured the specific radiological parameters on the follow-up radiographs of patients aged >18 yrs. and <50yrs., who had already undergone reduction and fixation for subtrochanteric femur fracture and having achieved acceptable intra-operative reduction and fixation.

- 1) Following radiological parameters were studied in the follow-up radiographs
 - a) Hammer scale
 - b) The number of cortices (out of four on AP and lateral views) with bridging callus
 - c) The post-operative duration in weeks when Grade 2 Hammer scale (union) achieved
 - d) The post-operative duration in weeks when 3 out of 4 cortices were bridged by callus
 - e) Occurrence of Non-Union
- 2) Analyses of changes in these parameters were done according to the groups into which the patients are classified with respect to the trauma to surgery interval.

The radiological follow-up data of 53 patients of subtrochanteric femur fracture, who had been operated with 95 Dynamic Condylar Screw (DCS) plating or Intramedullary Nailing (Proximal Femur Nailing PFN) at King Edward Memorial VII Hospital (KEMH), Mumbai, from July 2012 to November 2013 were studied. The patients were classified as those operated by direct and those by indirect methods of reduction and fixation. The post-operative follow-up radiographs till fracture union were studied. Only those between 18 and 50 years of age were included to eliminate the effect of osteoporosis or other degenerative changes on the rate of fracture union [3].

2.2 Study Design

Retrospective, analytical, observational study: This is a retrospective study in which the patients were already operated at least 9 months ago and their post-operative follow-up radiographs were studied. As part of routine fracture fixation follow-up each such patient had a 6 weekly radiograph done till fracture appeared to have healed. Thus this study only included patients after 9 months of their surgery, and they were labeled as united or non-united cases of subtrochanteric fractures.

Definition of Fracture Nonunion (Definition by FDA-1986 Endorsed by the OTA IN 2011 Annual Meeting):

A fracture that is a minimum of 9 months post occurrence and is not healed and has not shown radiographic progression for 3 months is a non-union.

Definition of Fracture Union: Conventionally radiological union has been defined as the presence of bridging callus on at least two views. Elaborate methods, such as that of Hammer, Hammerby and Lindholm [4], grade the healing of the fractures on the presence of callus, the bridging of callus, and the presence or absence of lucent fracture lines.

For this study, fracture was considered to have united or healed when 3 of the 4 cortices were bridged on two separate Radiograph views and when Hammer scale 2 was achieved.

The analysis and conclusion of the study was based on:

- 1) Fracture healing time (in weeks) noted between various groups classified according to trauma to surgery interval (in days).
- 2) Surgeon's choice of operative method (direct or indirect) depending on trauma to surgery interval (in days).

2.3 Inclusion Criteria

All Patients operated at KEMH with following characteristics

- 1) Unilateral Subtrochanteric femur fracture
- 2) Age >18 years and <50 years

- 3) Fixation done with 95 Dynamic Condylar Screw plating or Intramedullary Nailing (Proximal Femur Nailing PFN)
- 4) Acceptable (good) reduction criteria [5], [6] seen on immediate post-operative Radiograph as:
 - a) Femoral neck shaft angle is < 100 of varus compared with uninjured contralateral hip.
 - b) Femoral neck shaft angle is <150 of valgus compared with uninjured contralateral hip.
 - c) <200 of angulation on lateral radiograph
- 5) Acceptable fixation criteria for 95 DCS [7], [8]
 - a) Tip-Apex Distance (TAD) < 25 mm
 - b) DCS tip to lie in the antero-inferior part of femoral head
 - c) Minimum eight cortical purchases distal to the fracture site.
- 6) Acceptable fixation criteria for PFN [7], [9]
 - a) The distal most of the 2 proximal screws to lie within 5 mm of inferior femoral neck and within 5 mm of subchondral bone.
 - b) The proximal most of the 2 proximal screws to have a central position in the femoral head.
 - c) The distal end of the nail to be secured by one or two bicortical screws.

2.4 Exclusion Criteria

- 1) Open fractures
- 2) Pathological fractures
- 3) Fixation combined with Osteotomy, bone grafting or other augmentation.
- 4) Associated fractures of femoral head / shaft / acetabulum.
- 5) Co-morbid conditions associated with rapid callus formation (closed head injury, burns)
- 6) Patients treated after more than 4 weeks from injury.
- 7) Patients with incomplete or inappropriate records.
- 8) Patients unlikely to comply with non-weight bearing post-operatively E.g. psychiatric illness

2.5 Statistical Analysis

As the study involved numerical data and comparisons between groups following statistical tools were employed:

- 1) Involving more than two independent categorical variables and dependent continuous variables, the statistical test used was one-way ANOVA test. (test of significance between trauma to surgery interval and fracture healing time)
- 2) Involving more than two independent categorical variables and dependent categorical variables, the statistical test used was chi-square test. (test of significance between trauma to surgery interval and surgeon's choice of operative method-direct or indirect)

3. Results

A total of 53 cases operated for subtrochanteric fractures were included in the study. These post-operative cases were operated either by using 95° Dynamic Condylar

Screw and plate (95 DCS) or Proximal Femur Nailing (PFN). All cases of 95 DCS were operated by the direct method (n=30), and all cases of PFN were operated by the indirect method (n=23) of reduction and fixation.

The mean age of the patients in our study was 38.87 years with the minimum age being 28 years and the maximum age being 49 years. Maximum patients belonged to the 35-44 year age group (n=28). The study population had 28 males and 25 females. The average duration from the time of trauma to surgery was 3.11 days with a range of 1-13 days. Maximum cases were operated in the period of 2-4 days (n=39).

None of the cases operated underwent bone-grafting procedure. No complications were noted in the post-operative radiological data collected. Clinical complications could not be accessed since the purview of this study was limited to radiological data collection and compilation. No case demonstrated any complication related to fracture healing in terms of nonunion or deep bone infection such as osteomyelitis. The definition of nonunion was applied to cases only after a radiological follow-up of at least 9 months. None of the cases showed nonunion at a minimum follow-up of 9 months. The time of fracture union was noted when at a minimum post-operative duration, the post-operative Radiograph showed a minimum of 3 of the 4 cortices bridged which also coincided in all cases with Hammer Scale 2. The average time of fracture union in weeks, irrespective of the method employed, was 13.04 weeks ranging from a minimum of 9 weeks to a maximum of 24 weeks. The average final follow-up duration in weeks was 46.96, ranging from a minimum of 39 weeks to a maximum of 61 weeks. At their respective maximum radiological follow-ups, 47 (25 direct and 22 indirect) cases showed all four cortices with bridging callus in post-operative radiographs, whereas the remaining 6 (5 direct and 1 indirect) showed three bridging cortices. Among the 53 total post-operative cases, at their respective maximum radiological follow-ups, 50 showed healing upto Hammer Scale 2 and the other 3 showed Hammer Scale 1. Thus all cases achieved union.

With respect to time interval from trauma to surgery, the patients were grouped as operated in < 2 days (n=6), 2-4 days (n=39), 5-7 days (n=4), >7 days (n=4).

Table 1: Selection of method according to time from trauma to surgery

Time from trauma to surgery	All cases operated, n=53		Method selected by surgeon			
	n	As a % of all cases	Direct		Indirect	
			n	As a % of overall n	n	As a % of overall n
< 2 days	6	11.32	3	50	3	50
2-4 days	39	73.58	19	48.72	20	51.28
5-7 days	4	7.54	2	100	2	0
> 7 days	4	7.54	2	100	2	0

p value by (two-tailed) chi square test: 0.81
 p=0.81 (p>0.05) denotes that there was **no statistically significant relation between time from trauma to surgery and the choice of method (direct or indirect) selected by the surgeon**

These groups were further studied in terms of fracture healing time in weeks.

Table 2: Healing time in independent groups of time from trauma to surgery

Time from trauma to surgery in days	Fracture healing time in weeks		
	Average	Minimum	Maximum
< 2 days	13.5	9	18
2-4 days	12.56	9	24
5-7 days	16.5	14	20
> 7 days	13.5	12	16

p value by (one-way) ANOVA test: 0.121
 p=0.121 (p>0.05) denotes that there was **no statistically significant relation between time from trauma to surgery and the fracture healing time in weeks**

4. Discussion & Conclusion

The discussion on the management of subtrochanteric fractures has shifted from one based purely on the selection of implants, to the involvement of the method of reduction and fixation and the perceived need for early surgery. Our study highlights the relation, if any, between the time interval from trauma to surgery and its influence over surgeon's choice of operative method and its effect on fracture healing. (Table 1, Table 2)

- 1) The time interval from trauma to surgery (from 1 to 13 days) did not influence the surgeon's choice of operative method (direct or indirect).
- 2) The time interval from trauma to surgery (from 1 to 13 days) did not significantly affect the fracture healing time.

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