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Retrospective Analysis of Radiological Outcome in Subtrochanteric Femur Fracture Operated By Direct and Indirect Methods of Reduction and Fixation

orthopaedics

KEYWORDS : subtrochanteric fracture; direct; indirect; radiological; union.

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ABSTRACT

Total 53 cases operated for subtrochanteric fractures were classified according to Seinsheimer's classification. Type IIIA constituted the maximum (n=11) with 7 operated by direct and 4 by indirect method of reduction and fixation; followed by Type V (n=10) with 6 direct and 4 indirect. Rest of 32 patients belonged to Type I (n=4), IIA (n=4), Type IIB (n=5), Type IIC (n=7), Type IIIB (n=7) and Type IV (n=5). Statistical significance was found for unstable and comminuted fractures (Seinsheimer types: III A, III B, IV, V) for the method chosen (direct or indirect) by the surgeon, in terms of fracture healing time. The operative method influences the healing time for unstable, comminuted subtrochanteric fractures, and dictates the importance of the indirect method for fracture reduction and fixation. In cases of stable subtrochanteric fractures there appears to be no significant relation between the fracture healing time and the method chosen.

Introduction

Hip fractures are one of the most common fractures encountered in the adult population. 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.

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]. There are various systems of classification for subtrochanteric fractures [3]. In our study we used the classification given by Seinsheimer, which enjoys a high popularity among traumatologists.

Subtrochanteric fractures pose certain anatomical, biological and biomechanical challenges and typically give high complication rates [4]. This vital aspect of fracture fixation has been highlighted in multiple studies that have evaluated the outcome of various modes of fracture fixation in subtrochanteric fractures.

Methods Of Reduction And Fixation: Direct and Indirect:

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.

In the operating room, the selection of these methods eventually determines the preservation or loss of the fracture hematoma during the surgical exercise. This study demonstrates the different rates of fracture union achieved in subtrochanteric fractures, operated by direct versus indirect methods.

MATERIAL AND METHODS

Aims And Objectives: This study measures the radiological outcomes, in terms of fracture union, using the follow-up radiographs of post-operative patients of subtrochanteric femur fracture, operated by direct or indirect methods. The patients were classified according to Seinsheimer's Classification (I-V)

1. They were also classified according to direct or indirect methods used for reduction and fixation
2. We measured specific radiological parameters on follow-up radiographs of patients between 18 and 50yrs., who had already undergone reduction and fixation for subtrochanteric femur fracture and having achieved acceptable intra-operative reduction and fixation.
3. Following radiological parameters were studied in the follow-up radiographs

Hammer scale

- The number of cortices (out of four on AP and lateral views) with bridging callus
- The post-operative duration in weeks when Grade 2 Hammer scale (union) achieved
- The post-operative duration in weeks when 3 out of 4 cortices were bridged by callus
- Occurrence of Non-Union Analysis of these parameters among various groups was done with respect to the post-operative duration.

The radiological follow-up data of 53 patients of subtrochanteric femur fracture, 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 indirect methods of reduction and fixation. The pre-operative and follow-up radiographs till fracture union of 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 [5].

Study Design: Retrospective cohort, analytical, observa-

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tional study: As part of routine follow-up each such patient had a 6 weekly radiograph done till fracture healing. 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 [6], 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 (healed) when 3 of the 4 cortices were bridged on two separate radiograph views and when Hammer scale 2 was achieved.

Inclusion criteria: All Patients operated at KEMH with:

1. Unilateral Subtrochanteric femur fracture
2. Age >18 years and <50 years
3. Fixation done with 95 DCS or PFN
4. **Acceptable reduction criteria [7], [8] 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 [9], [10].

a) Tip-Apex Distance (TAD) < 25 mm
b) DCS tip to lie in the antero-inferior part of femoral head
b) Minimum eight cortical purchases distal to the fracture site

6. Acceptable fixation criteria for PFN [9], [11]

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 positionin the femoral head.
c) The distal end of the nail to be secured by one or two bicortical screws.

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

Statistical Analysis: The statistical tests used were Independent 't' test and Chi-Square test.

1. The cases were mainly divided according to the following criteria:
2. The method of reduction and fixation (direct or indirect)
3. Seinsheimer classification into types: I, II A, II B, II C, III A, III B, IV, V
4. Jensen-Michaelsen classification into stable and unstable types
5. Groups based on the number of bridging cortices
6. Groups based on the Hammer Scale
7. Groups according to fracture union and nonunion

RESULTS

A total of 53 cases operated were classified according to Seinsheimer's classification. Type IIIA had the maximum cases (n=11) with 7 operated by direct and 4 by indirect method; followed by Type V (n=10) with 6 direct and 4 indirect. Rest of 32 patients belonged to Type I (n=4), IIA (n=4), Type IIB (n=5), Type IIC (n=7), Type IIIB (n=7) and Type IV (n=5). By Jensen-Michaelsen classification of subtrochanteric fractures into stable and unstable varieties, the study population could be divided into 20 stable (11 direct and 9 indirect) and 33 unstable (19 direct and 14 indirect) fractures. These post-operative cases were operated 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. The study population had 28 males and 25 females. No case demonstrated any complication related to fracture healing or deep bone infection. 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 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 **(Table 1)**, ranging from a minimum of 9 weeks to a maximum of 24 weeks.

Table 1: Average time to union (fracture healing time) according to Seinsheimer grade, irrespective of method

Seinsheimer grade	Cases	Average time to union in weeks	min	max
I	4	11.5	10	14
IIA	4	10.25	9	12
IIB	5	11	9	14
IIC	7	11	9	12
IIIA	11	12.36	10	16
IIIB	7	14	12	18
IV	5	16.8	14	20
V	10	15.6	12	24
Overall		13.04	9	24

Table 2: Average time to union (fracture healing time) according to Seinsheimer grade in cases operated by direct method

Seinsheimer grade	Cases	Average time to union in weeks	min	max
I	2	12	10	14
IIA	2	11	10	12
IIB	2	12	10	14
IIC	5	11.2	10	12
IIIA	7	13.14	12	16

IIIB	3	16	14	18
IV	3	18.67	18	20
V	6	17.67	14	24
Overall		14.27	10	24

For cases operated by the direct method, the average time of fracture union in weeks was 14.27 weeks **(Table 2)**, ranging from a minimum of 10 weeks to a maximum of 24 weeks.

For cases operated by the indirect method, the average time of fracture union in weeks was 11.44 weeks **(Table 3)**, ranging from a minimum of 9 weeks to a maximum of 14 weeks.

Table 3: Average time to union (fracture healing time) according to Seinsheimer grade in cases operated by indirect method

Seinsheimer grade	Cases	Average time to union in weeks	min	max
I	2	11	10	12
IIA	2	9.5	9	10
IIB	3	10.67	9	12
IIC	2	10.5	9	12
IIIA	4	11	10	12
IIIB	4	12.5	12	14
IV	2	14	14	14
V	4	12.5	12	14
Overall		11.44	9	14

At maximum radiological follow-ups, 47 (25 direct and 22 indirect) cases showed all four cortices with bridging callus, whereas the remaining 6 (5 direct and 1 indirect) showed three bridging cortices. At their respective maximum radiological follow-ups, 50 showed healing upto Hammer Scale 2 and the other 3 showed Hammer Scale 1. All those operated by direct method (n=30), showed Hammer Scale 1. Among those operated by indirect method, 20 showed Hammer Scale 2 and 3 showed Hammer Scale 1. At a minimum radiological follow-up of 9 months, all 53 operated cases showed fracture union. No statistically significant relation was found between Seinsheimer grade and the choice of method (direct or indirect) selected by the surgeon ('p' value (two-tailed) by chi square test: 0.997)

DISCUSSION

Our study highlights the significance when it comes to the choice between direct and indirect methods, in the unstable variety of subtrochanteric femur fractures (Seinsheimer types: III A, III B, IV and V). **(Table 4, Table 5).** Thus our study, which when compares all cases done by 95 DCS (direct) versus PFN (indirect), the choice of implant along with the choice of method, appears significant for unstable and comminuted subtrochanteric fractures. indirect method being significantly superior in these cases.

Table 4: 't' and 'p' values in independent Seinsheimer types denoting significance for the method chosen (direct or indirect) by the surgeon, in terms of fracture healing time

Seinsheimer grade	Cases	t value	p value (two-tailed)	Result (for p<0.05)
I	4	0.447	0.699	Not significant
IIA	4	1.342	0.312	Not significant
IIB	5	0.889	0.440	Not significant
IIC	7	0.614	0.566	Not significant
IIIA	11	2.362	0.043	**Significant**
IIIB	7	3.090	0.027	**Significant**
IV	5	5.422	0.012	**Significant**
V	10	2.558	0.034	**Significant**

Table 5: 't' and 'p' values among stable and unstable fracture types denoting significance for the method chosen (direct or indirect) by the surgeon, in terms of fracture healing time

Fracture type	Cases	t value	p value	Result (for p<0.05)
Stable	20	1.701	0.106	Not significant
Un-stable	33	3.858	0.001	Significant

CONCLUSION

The method of reduction and fixation (direct or indirect) significantly influenced the fracture healing time in unstable and comminuted (Seinsheimer types: III A, III B, IV, V) subtrochanteric femur fractures: The indirect method being significantly superior in these cases.

Both the parameters chosen, namely, the number of bridging cortices and the Hammer Scale, corroborated with each other for all the cases studied.

There was no incidence of nonunion in any case in the study.

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