Original Article

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Orthopaedics Section

Fixation of Subtrochanteric Fracture of the Femur: Our Experience

CHAKRABORTY M.K., THAPA P.

ABSTRACT

Introduction: Subtrochanteric fracture of the femur is a variant of the peritrochanteric fracture of the femur. It extends upto 5 cm below the lesser trochanter. The incidence is relatively much lower (3.9% of all the proximal femoral fractures). It is common in the older population with low energy trauma along with osteoporosis and in younger patients with high energy trauma. This is also the commonest site for a pathological fracture. Pathophysiological and biomechanical studies have shown that the subtrochanteric region is the most stressed area which concentrates stress on the implant and this is difficult to treat due to complications. With the improved knowledge and understanding of the fracture pattern, specific treatment options with successful results of improved quality may be obtained.

Material and Methods: A total of 12 cases of subtrochanteric fracture of the femur which were admitted in the Orthopaedic Dept, Manipal Teaching Hospital, Pokhara, Nepal, from Jan, 2010 to July, 2011, were selected in our study. The classification of the fracture was done by using the Russell and Taylor's classification for simplicity and it is the one which is currently mostly used for clinical use. Various implants like locking plate, proximal femoral nail (PFN), dynamic hip screw (DHS) and K-nail were used for fracture fixation. Clinical and radiographic analyses were done at a follow up of 3 weeks, 6 weeks, 3 months, 6 months and 1 year.

Results: Out of 12 cases, 9 were males and 3 were female.s K-nail fixation was done in one case of pathological fracture. Three locking plates, 4 DHS and 4 PFN were done. All the fractures united with good to excellent results, with few complications like mild restriction of the hip range of motion, mild varus deformity and a shortening of 2 cm.

Conclusion: With the various choices of implants for the fixation of subtrochanteric fracture of the femur, PFN, in our opinion, gave the best fixation with excellent results. We recommend PFN as a reliable cephalomedullary implant for the fixation of subtrochanteric fracture of the femur.

Key Words: Sub-trochanteric fracture, Femur, Proximal Femoral Nail, Fixation

INTRODUCTION

Subtrochanteric fracture of the femur is a variant of peritrochanteric fracture of the femur [1]. It lies in the area which is 5cm below the lesser trochanter. It may extend proximally into the intertrochanteric area and distally upto the isthmus of the shaft of the femur [2, 3]. Its incidence is much lower than that of the intra and extra capsular fracture of the neck of the femur. The incidence usually is six per 1 lack population per year, with a female preponderance [4]. Parker et al. reviewed the epidemiology of Subtrochanteric fracture of the femur and showed that it accounted for 3.9% of all the proximal femoral fractures and that the average age was 74 yrs [5]. It is common in older patients after low energy trauma along with osteoporosis and in younger patients with high energy trauma [6]. This area is also the commonest site for pathological femoral fractures (17%) due to metastatic deposits from the lung, breast, prostate, myeloma and Paget's disease [4]. The mechanism of the injury is fall and direct lateral hip trauma, road traffics accidents, axial loading, fall form height and gunshot injury [7]. Subtrochanteric fracture is one of the most difficult fractures to treat and treatment failure is common for it, due to the complications of mal-union, non-union, shortening, angular deformity and rotational mal-union (Waddel 1979, Mullaji and Thomas 1993) [8,9]. It is associated with a mortality or morbidity of 20% because of the maximum stress which is exerted at the fracture site during the activities of daily living, as compared to the rest of the femoral fractures [4]. An appropriate implant for internal fixation and implant failure remains debatable.

Pathophysiology

The muscle of the proximal femur displaces the fracture and the bone is cortical. Healing in this region is achieved through a primary cortical healing and it is slow to consolidate [10]. The axial loading forces through the hip joint create a large moment arm with large lateral tensile and medial compressive loads. The muscle forces of the hip also play torsional and rotational shear forces. This area is highly vascular and so the bleeding in the thigh is common, leading to shock and the compartmental syndrome. During normal activities, 6 times of the body weight is transferred across this region [11].

Biomechanical Studies

During weight bearing, mechanical stress acts on the femur. The compression stress is >1200 lb/sq inch in the medial Subtrochanteric area and 3cm distal to the lesser trochanter. The lateral tensile stress is 20% less at 1000 lb/sq inch [4]. There is continuous stress on the implant system, even during bed rest .So, the attention of the medial cortical buttress is required to minimise the implant failure. Higher forces are generated with eccentrically placed devices such as plates and screws, as compared to the centromedullary devices. Rotational shear forces may lead to implant failure due to cyclical loading. Plate and screw devices restored approximately 40% of the normal femoral torsional stiffness. Interlocking nails are better in bending stiffness than the hip compression screws. There was a marked improvement in the bending stiffness, torsional stiffness and the axial load to failure with the closed section interlocking devices [12].

Bending forces cause the medial cortex to be loaded in compression and the lateral cortex to be loaded in tension. The compression forces are much higher than the tensile forces and they are therefore mandatory in restoring the medial cortex stability. 2mm separation of the medial cortex will lead to medial collapse and lateral plate bending. The more communition, the less the bio-mechanical stability and the more the bio-mechanical loading, the more the communition. When the medial cortical support is inadequate, the internal fixation devices act as tension band in the lateral femoral cortex and the loads are concentrated in one area of the implant, thus resulting in implant failure or loss of fixation [13].

Relevant Anatomy

The Subtrochanteric region is a cortical bone. Femoral head antiverted 13°, piriformis fossa at the base of the neck. The lesser trochanter is posterior medial and the iliopsoas muscles are inserted on it, which flexes the proximal fracture fragment. The gluteus medius and the minimus abduct and externally rotate the proximal fragment. The adductors pull the distal fragment medially and upward. The muscles are highly vascularised and can lead to haemorrhage during injury or surgical procedures. The vastus lateralis is splinted close to the perforating branches of the profunda femoris artery, which may get injured, leading to bleeding with difficult exposure [14].

Classification

Because of the fracture configuration and the patient heterogeneity no universally accepted classification exists [14]. Many classification systems have been proposed, but Seinsheimer's (1978) and Russell and Taylor's (1992) classifications have been used most commonly. The treatment of the Subtrochanteric fracture has been revolutionised by the development of the long reconstruction nail which was previously difficult to treat. The Russell and Taylor classification has Type I and Type II fractures with sub groups A and B in both. The Type I fracture does not extend into the piriformis fossa. The Type II fracture extends to the greater trochanter and it involves the piriformis fossa. The Type IA fracture line is below the lesser trochanter and the Type IB extension involves the lesser trochanter. The Type IIA fracture extends to the piriformis fossa and the Type IIB fracture involves the piriformis fossa and it extends to the medial femoral cortex and the loss of continuity of the lesser trochanter [1]. The classification is biomechanically sound, it fulfils the criteria best and it was designed to allow the selection of the technique of the internal fixation that produces the most biomechanically sound reconstruction [4]. The extent of involvement of the lesser trochanter, the greater trochanter and the piriformis fossa were taken into consideration.

Seinsheimer's classification is based on the number of fragments and the location and configuration of the fracture line. It classifies the fractures as Type I to type V [15].

Treatment Protocol

Surgical stabilization is the treatment of choice, but it is technically challenging. The treatment goals are – anatomical alignment, restoration of the length, rotation with good fixation, prevention of the varus deformity, maintainence of the lever arm of the abduction muscle and encouraging early mobilization and rehabilitation.

Role of the bone graft: Bone graft should be advised as a routine procedure in comminuted fracture with lack of medial and posterior cortical continuity. It helps in protecting the fixation device from the varus deformity which is caused due to lack of medial cortical continuity [2].

Implants which are used conventionally:

1. Intramedullary – Centromedullary nail (conventional interlocking nails) and Cephalomedullary (PFN/IMHS).
2. Plate osteosynthesis – 135° screw plate (DHS), 95° dynamic condylar screw (DCS) and 95° angle condylar blade plate.

Advantages of the IM devices over the Nail blade plate [13]:

1. Shorter lever arm – so it is biomechanically stronger and the stress on the implant is less
2. Load sharing device instead of load bearing –less stress on the implant
3. Can be introduced without exposing the fracture site –fracture haematoma not disturbed, hence chances of the union are more and faster.
4. Transmits weight close to the calcar and has greater mechanical strength.
5. Distal locking screw provides length and rotational control and early weight bearing.

The variables which have to be considered while making the choice of the implant are:

1. Fracture extension to the piriformis fossa-common nail entry portal.
2. Continuity of the lesser trochanter.

The predisposing risk factors are: Degree of comminution, involvement of the lesser and greater trochanter and the severity of osteoporosis.

Advantages of the Medullary Technique: Retained blood supply to the fragment, less operative blood loss and less disruption of the fracture environment and cephalomedullary nailing allows length and rotational control.

Treatment Algorithm: An appropriate implant for internal fixation is still debatable [3].

Type IA: Conventional intramedullary inter-locking nail or long cephalomedullary reconstruction nail.

Type IB: Long cephalomedullary reconstruction nail.

Type II: Plate osteosynthesis by using one of these implants- long DHS, 95° DCS, 95° angle blade plate and locking plate. Long DHS+bone grafting is the treatment of choice [4].

Treatment of the fracture at the level of the lesser trochanter – DHS is satisfactory.

MATERIAL AND METHOD

A total of 12 cases of Subtrochanteric fracture of the femur were admitted in the Manipal Teaching Hospital, Pokhara, in the Department of Orthopaedics from Jan 2010 to July 2011. Out of these 12 patients, 9 were males and 3 were females. Their ages ranged from 10 to 78 years (average age 47.25 years). We used the Russell Taylor classification for simplicity and it is the one which is currently used mostly. There were 4 types of fractures- Type I A, 4- Type IB, 2- Type IIA and 2- Type IIB fractures. Of these, 4 were left sided and 8 were right sided.

The mechanism of the injury included one pathological fracture following fall, 8 were due to motor vehicular injury and 3 were due to low energy trauma.

One patient with a pathological fracture had a unicameral bone cyst fixed with a K-nail. Three locking plates are used in one Type IA and two Type IIB cases and the cerclage wire was used in two cases with bone graft. Four DHSs were used, 2 in each Type IA and I B fractures. Four PFNs were used in two Type IB and two Type IIA fractures and a cerclage wire was used to hold the fracture fragment in position. As per our protocol, we removed the suture after 14 days. We allowed the operated cases to stand and walk with non weight bearing and with bi-lateral axillary crutches after 2 weeks to 3 weeks. After 3 weeks, we allowed partial weight bearing, followed by full weight bearing after 6 weeks for PFN fixation. For plate fixation, the weight bearing was delayed; non weight bearing was advised for a period of 6 weeks. Partial weight bearing was advised when the patient could tolerate it without pain, with bi-lateral axillary crutches. Full weight bearing was delayed for 3 months. Radiographs were taken at 3 weeks, 6 weeks, 3 months, 6months and 1 year. Strengthening exercises for the quadriceps, hamstrings and the gluteal muscles were done in bed and out of bed under the supervision of a physiotherapist. The range of motion of the hip and knee was examined during the follow-ups. The post operative patients were followed up for one and a half years.

RESULTS

The distribution of the age, sex and the sides are shown in the [Table/Fig-1]. The average age of the female patients was 60 years and it was 43 years for the males. One patient with pathological fracture was of 10 years of age . Bone graft was done in 3 locking plate fixation and one PFN cases. Cerclage wiring was done in 2 locking plate and two PFN cases.

[Table/Fig-2] shows the type of fixation, the type of fracture, the no. of cases, the union time in months, the ROM of the hip and the functional outcome and thecomplications.

LP-locking plate, DHS-Dynamic hip screw, PFN- proximal femoral nail, ROM-range of motion.

Radiologically, the average time of the union for the Locking plate was 4- 5.5 months, for DHS,it was 3-4 months, for PFN, it was 3- 3.5 months and for K-nail, it was 3 months. ROM of the hip in the case of pathological fracture was mild to moderate pain with restriction up to 7 months and in the case of locking plate, there was mild restriction of up to 6 months. There is a mild varus deformity in one case of locking plate and a shortening of 2 cm in K-nail for pathological fracture. The functional outcome varied from good to excellent in all our cases.

	Sex		Affected sides		Total
AGE (in yrs)	male	Female	Left	right	
0-20	2	0	1	1	2
21-40	2	0	0	2	2
41-60	3	1	1	3	4
61-70	1	1	1	1	2
71 and above	1	1	1	1	2
TOTAL	9	3	4	8	12

[Table/Fig-1]: The distribution of the age, sex and the sides affected

DISCUSSION

In modern trauma care, there is no role of conservative treatment, as was advocated by Delee et al [16]. The treatment of Subtrochanteric fractures was mainly focussed on ORIF by using various implants with or without bone graft and cerclage wiring [7]. Plating was blamed for extensive surgical exposure, severe soft tissue damage, severe blood loss, non-union and implant failure. Eccentrically, plating usually resulted in fatigue breakage due to a mechanical load shearing effect. Intramedullary nailing had a more biological and mechanical advantage and it was accepted as an implant of choice without the complications of cut out, breakage of the implant or peri-implant fracture. Osteosynthesis, like MIPPO, LISS and LCP, is gaining popularity nowadays [3]. Most important for success is the correct entry point; the laterally shifted entry point should be on the top of the greater trochanter in the AP view and in line in the centre of the femoral canal in the lateral view. Long/Spiral fracture needs open reduction with cerclage wiring.

In our series, we used cephalomedullary IL nailing PFN for more stability, locking plates for more communited fracture and extra-medullary devices like DHS for Type I A and B in the cases, with quite satisfactory results. The overall result of the locking plate was not satisfactory because of the longer duration which it took for healing and mild varus deformity.

Long PFNs, as implants of choice, healed the fractures uneventfully and the walking and squatting abilities were completely restored with the bone union. The lag screw of the PFN should be placed in the lower part of the femoral neck, close to the femoral calcar, with the screw tip reaching the subchondral bone, 5-10 mm below the articular cartilage in the AP view. In the lateral view, it should be placed in the centre of the femoral neck. The timing of the weight bearing will be partial up to 6 weeks, to allow callus formation. Full weight bearing can be advised after 12 weeks if the lesser trochanter is attached to the proximal fragment. The interlocking nail is preferred because there is a better control of the rotation and the length can be confirmed by biomechanical and clinical studies. Load sharing devices allow compression at the fracture site, with good results.

Intramedullary fixation of Subtrochanteric fractures with the Proximal Femoral Nail (PFN) – is a reliable implant, leading to good union and less soft tissue damage. It has a biomechanical advantage, but it is

Fixation	Type of fracture	No. of cases	Union in months	ROM of hip	Functional outcome	Complication
LP	RT type-IA	1	4	Mild restriction	Good	Mild varus deformity
	RT type-IIB	2	5.5			
DHS	RT type-IA	2	3	Full	Excellent	NIL
	RT type-IB	2	4			
PFN	RT type-IB	2	3.5	Full	Excellent	NIL
	RT type-IIA	2	3			
K-Nail	RT type-IA	1	3	Pain and stiffness	Good	Shortening 2cm

[Table/Fig-2]: The type of fixation, the type of fracture, the no. of cases, the union time in months, the ROM of the hip and the functional outcome and the complications


[Table/Fig-3]: Pathological Fracture RT I


[Table/Fig-4]: FX fixed with K-Nail and Thomas Splint


[Table/Fig-5]: 2 months post op


[Table/Fig-6]: 3.5 months after K-Nail removal after 1yr

[Table/Fig-7]: Pre op RT I A


[Table/Fig-8]: Fixed with locking plate and cerclage wiring


[Table/Fig-9]: Pre-op RT II B


[Table/Fig-10]: Fixed with locking plate with bone graft


[Table/Fig-11]: Pre-op RT I B


[Table/Fig-12]: Fixed with DHS


[Table/Fig-13]: Pre-op RT I B (reverse oblique)


[Table/Fig-14]: Fixed with PFN, cerclage wiring with bone graft


[Table/Fig-15]: Pre-op RT IIA


[Table/Fig-16]: Fixed with PFN

[Table/Fig-17]: Post-op Union after 3 months

a technically demanding operation. Long PFN fixation, irrespective of the degree of proximal comminution, is preferable and the cephalomedullary nail with a greater lateral offset, allows the entry portal more laterally, irrespective of the involvement of the piriformis fossa. It is also clear that the overall results of IM nailing are better than those of plate fixation, according to Parker et al (1997) [3].

Intramedullary Hip screw (IMHS) is a better design; it buttresses the head and neck, temporarily substituting for the unstable, large posterior medial fragment. Because of the femoral re-fracture rates in zickel nail and the femoral shaft fractures in gamma nail, they are discontinued. The cut-out failure of the RT nail is a well recognized complication. A long reconstruction nail with a single side arm still remains one of the optimum methods of fixation of Subtrochanteric fractures [4].

Complications like non-union, failure of the implant, infection, and heterotrophic ossification were not encountered in our series, expect for the mild to moderate painful restriction of the ROM of the hip in one case, mild varus deformity in one case and the shortening of 2 cm in cases with pathological fractures.

CONCLUSION

In our study, there was only a small group of patients and there were drop out cases in the follow up. Our experience of fixation with various devices showed that PFN gave a better control of the rotation, length and proximal purchase. The load shearing nature of this implant which allowed compression at the fracture site and even in the osteoporotic bone and its cephalomedullary location had decreased moments as compared to the plate. So, we recommend the cephalomedullary PFN as one of the better methods of fixation than plate osteosynthesis. DHS with a long barrel plate and the Centromedullary locking nail are quite satisfactory. Bone grafts should be routine procedures with comminuted fracture, with lack of posterior-medial cortical continuity.

Despite the introduction of newer designs, better quality of the implant and improvement in the technique, fixation is still a challenge for the orthopaedic surgeons. Search for an ideal implant and an ideal method of fixation in this complex situation is still going on.

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AUTHOR(S):
1. Dr. Chakraborty M.K.
2. Dr. Thapa P.

PARTICULARS OF CONTRIBUTORS:
1. Prof & HOD, Orthopaedics Department, Manipal College of Medical Sciences, Pokhara, Nepal.
2. Resident, Orthopaedics Department, Manipal College of Medical Sciences, Pokhara, Nepal.

NAME, ADDRESS, TELEPHONE, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Chakraborty M.K.
Prof & HOD, Orthopaedics Department,
Manipal College of Medical Sciences, Pokhara, Nepal.
Phone: 00977-9726155900
E-mail: drmkc2010@yahoo.com

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