ORIGINAL ARTICLE

Treatment of long-segment fracture at middle-up part of femur with long proximal femoral nail antirotation

Lin Yanbin, Li Renbin, Zhuang Yan, Xiong Guosheng, Xiong Shenren, Huang Xiangui

Abstract

Objective: To investigate the results of non-invasive operation method and evaluate clinical and radiological outcome of long proximal femoral nail antirotation in treating long-segment fracture at middle-up part of femur.

Methods The retrospective study was conducted at the Second Hospital of Fuzhou, China, and comprised cases of long-segment fracture in middle-up part of femur power treated with long proximal femoral nail antirotation between June 2006 and December 2013. The patients were followed up for a minimum of 9 months. Clinical outcomes were evaluated according to Harris Hip Score and radiological examinations were done at 1, 2, 3, 6, 9 and 12 months and once a year thereafter.

Results: Of the 139 patients, 104(75%) were males and 35(25%) females, within the age range of 18-86 years. The time period from injury to the index ranged from 3h to 15 days. The operative time of all cases ranged from 35 to 90 minutes, while the blood loss during surgery ranged from 30ml to 200ml. All patients walked with walking aid appliance 4-10 days post-operation with partial and gradually increasing to full weight-bearing. None of the patients developed infection, thrombus, cut-out or breakage of the implants. Follow-ups ranged from 9 to 37 months. According to Harris Hip Functional Score, 108(77.7%) cases behaved excellent, 22(15.9%) good, 8(5.7%) fair, and 1(0.7%) case poor. The good rate, as such, was 130(93.5%).

Conclusion: Long proximal femoral nail antirotation is an effective treatment method for long-segment fracture at middle upper part of femur, with high healing rate, quick function recovery as well as less complication incidence.

Keywords: Femoral fracture; Fracture fixation intramedullary internal fixator, PFNA. (JPMA 64: S-64 (Suppl. 2); 2014)

Introduction

With the development of high speed transportation and the high-rise construction industry, the incidence of high-energy trauma has increased markedly. As such, the incidence of comminuted long-segment fracture at middle-up part of femur, involving the proximal end, has tremendously increased.

The treatment of long segmental proximal middle part of femoral fracture with without comminution fractures identified as 31-A2 by Orthopaedic Trauma Association/Association for Osteosynthesis (OTA/AO) are rather tricky for their proximity to joint and high fracture position, wide range of motion and the limitation of alternative internal fixation devices. In the past, conservative treatment with traction followed open reduction and internal fixation (ORIF) with fixed angle plate, Dynamic Hip Surgery (DHS and Dynamic Condylar Screw (DCS). These surgeries in fact took a longer period of time with massive blood loss and soft tissue stripping, as well as late recovery, leading to bone non-union, breakage of implant, hip pain and high rate of infection.[1]

Following development of proximal femoral nail antirotation (PFNA) for proximal femoral and intertrochanteric fracture with osteoporosis, with added advantages of the minimally invasive technique, the complication rate significantly reduced as well as time of healing with PFNA implant bone assembling provide high fixation-strength and have excellent accordance with biomechanic characteristics. With this hypothesis of having achieved satisfied clinical results and minimum complication with PFNA-long (320mm-340mm-360mm-380mm) as defined by AO/Association for the Study of Internal Fixation (AO/ASIF), we retrospectively reviewed our cases to know the radiological outcome in long-segment fractures at middle-up part of femur with PFNA and to summarise current treatment strategies.

Materials and Method

The retrospective study was conducted at the Second Hospital of Fuzhou, China, and comprised cases of long-segment fracture in middle-up part of femur power treated by closed reduction, and in a few cases limited ORIF, with PFNA-long between June 2006 and December 2013.

Data included related to patient of either gender over 18 years, and with one-sided closed femur fracture. Children

Department of Orthopaedics, the Second Hospital of Fuzhou, Fuzhou, China.
Correspondence: Lin Yabin. Email: b860603823@139.com

and patients unfit for surgery with pathological and mandible fractures were excluded.

Type 31-A2 intertrochanteric fracture is classified by AO/OTA as the comminuted fracture of proximal extra-articular trochanteric femur area across the trochanter, which extend to 1cm below the lesser trochanter. Similar fractures has been classified in literature as femoral subtrochanteric fractures as: type I -- the fracture of lesser trochanteric plane; type II -- fracture at 2.5-5cm below lesser trochanter plane; type III -- fracture at 5-7.5cm below lesser trochanter plane.[2] Both classifications cover the comminuted long-segment fracture of intertrochanter, subtrochanter and long-segment fractures at femoral shaft, but fail to encapsulate the entire cases of this study. We, therefore, reclassified the fractures as four types.

Type I included IA and IB. IA: Fracture at the intertrochanteric, subtrochanteric area or the upper middle part of femur shaft. No obvious large dislocated or shifted fracture pieces (Figure-1A). IB: Fracture at the basilar neck area, intertrochanteric, subtrochanteric area or the upper middle part of femur shaft. No obvious large dislocated or shifted fracture pieces (Figure-1B). Type II: Fracture at the subtrochanteric area and the middle part of femur shaft. The intertrochanteric area may be intact. No obvious large dislocated or shifted fracture pieces (Figure-1-II). Type III: Fracture at the intertrochanteric, subtrochanteric area and multiple fractures at the upper middle part of femur shaft (Figure-1-III). Type IV: The intertrochanteric part may suffer from fracture or not. Multiple fractures at the subtrochanteric part or long and comminuted fracture with shift of large fracture pieces that involved the middle part of femur shaft (Figure-1-IV).

With all preoperative preparation, fitness and preoperative traction till surgery, the patients were operated under general anaesthesia/spinal anaesthesia combined with epidural anaesthesia as decided by the anaesthetist. Orthopaedic traction table was used in only when needed. Otherwise, ordinary radiolucent top table were used by title elevations of the effected hip with a soft pillow in horizontal supine position. All fractures were treated by closed reduction under C-arm fluoroscopy control except patients with subtrochanteric unstable comminuted fractures with significant displacement who needed limited open reduction with 2-3cm incision over lateral or anterolateral position of the fracture. Through the lateral longitudinal incision made 5cm above the peak of the greater trochanter, (enlarge in obese patients) a guide wire was inserted through the tip slightly lateral to the tip on the greater trochanter. The proximal part was reamed up to 18mm for placement of PFNA. The PFNA was inserted on the guide wire and pushed with gentle strokes by hammer, with care not to displace or distract the fracture fragments and produce iatrogenic fragmentation. The nail was adjusted to place spiral blade into the head of femur in the lower half part or more of the centre of the femoral neck. After the satisfactory position of the nail, a guide wire was inserted into the neck of femur 5cm under the facies articularis with the help of lateral aiming tester and protecting jacket. The position was confirmed under C-arm image intensifier. With +5mm drill bit, the lateral cortex and neck was drilled for placement of spiral blade. The spiral blade was assembled with the locking bolt. After meaning the depth and confirmed on C-arm the spiral blade was humarised to 10mm below articular surface, and spiral blade was locked by screwing the tail cap. Position of blade was verified with fluoroscope from normotopia and frog-leg position again to guarantee a good placement. After finishing the fixation, wound was flushed and incisions were closed in layers over a suction drain.

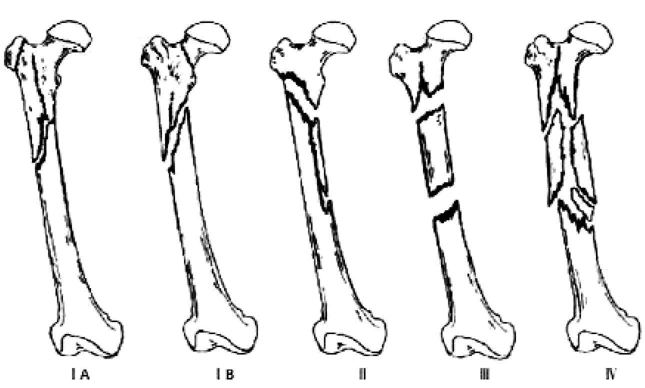

Figure-1:

Type I fracture was easier in reduction with closed pining fixation; type II fractures needed percutaneous reduction by leverage in the proximal needle-inserting point. In type III, closed reduction was difficult to achieve during the surgery, therefore, minimal incision, without achievement of periosteum of fracture segments and reduction was carried out by finger touch with the assistance of fluoroscope. Type IV long-segment comminuted fractures were checked with contra-lateral leg exposure to prevent shortening and rotational deformity.

Postoperative antibiotic was given for 03 days. In all cases, the quadriceps isometric contraction exercise and hip and knee joint flexion and extension exercises were given on the second postoperative day. Crutch walking was allowed for closed fractures on the 4th day. Patients with type IA and type III fractures were allowed to walk weight-bearing gradually, while type II and type IV fractures were allowed delayed walk. Patients were instructed to walk in proper gait to correct bad walking habits. Quadriceps-strengthening exercises were advised on the first return to hospital. The front and lateral radiographies of middle-up part of femur were taken on the second return. The final evolution for study was made minimum at 09 month.

The functional evaluation, included the activity of hip joint, degree of pain, gait and the function of sitting down and getting upstairs. The assessment was made with Harris Hip Joint functional assessment[2] and through radiography examinations.

Follow-ups were performed at 1, 2, 3, 6, 9 and 12 months postoperatively, and at least once a year thereafter. All patients got complete follow-up. Front and lateral radiographies of the middle-up part of femur were taken on follow-up visits, while contact was maintained in between the visits through phone, email and clinical examinations.

Result

Of the 139 patients whose records were part of the study, 104(75%) were males and 35(25%) females, within the age range of 18-86 years and a mean of 48.8. Traffic accidents accounted for 63(45%) cases; fall from height 51(37%); and simple fall 25(18%). Besides, 34(24.5%) patients were of poly trauma Of them, 16(47%) had abdominal and throacic injuries, including 4(25%) with rib fracture, mild pulmonary contusion and minimal hemopneumothorax, 7(44%) with spleen contusion and hematoma of splenic capsule, 4(25%) with renal contusion and 1(6%) with acute haemorrhagic shock for splenic rupture. The remaining, 18(53%) poly trauma cases also had multiple bone fractures, including 6(33.4%) with ipsilateral calcaneal fracture, 4(22.2%) with lumber vertebrae fracture, 3(16.7%) with acetabular fracture, 1(5.5%) with ipsilateral fracture of the head of radius, 3(16.7%) with fracture of the distal end of radius and 1(5.5%) with contralateral fracture of radius and ulna.

According to the study's classification, 61(44%) cases were type IA, 8(5.8%) were type IB, 46(33.1%) were type II, 8(5.8%) type III, and 13(9.3%) were type IV.

Traction table was used for 32(23%) patients, while the other 107(77%) were operated on ordinary radiolucent top table. Of the 139 cases, 4(2.9%) cases were fixed with PFNA of 320mm length, 45(32.4%) with 340mm length, 37(26.6%) with 360mm length. Patients with associated fractures were fixed simultaneously under same anaesthesia, and 4(2.9%) patients with kidney contusion and 6(4.3%) with ipsilateral calcaneus fracture underwent simultaneous operation, using closed reduction of leverage and kirschner wire fixation. Besides, 4(2.9%)

Figure-2: male, 35 years old.

a. Preoperative x-ray of long-segment fracture in middle-up part of left femur (Type IA): left comminuted inter-trochanteric and subtrochanteric fracture; the fracture line approximately extends to the middle part of femur.

b. Closed reduction, postoperative anteroposterior x-ray film using the intramedullary fixation with the 340mm PFNA: good reduction of fracture end and the fracture line, no obvious shortening occurs.

c. Postoperative lateral X-ray film: good reduction of fracture end and the fracture line, no significant shortening or rotation.

d. Anteroposterior x-ray film 3 months after operation: good callus growth, the fracture line turned ambiguous.

e. Lateral X-ray film 3 months after operation: good callus growth, the fracture line turned ambiguous.

f. Good postoperative activity like hip & knee joint flexion.

patients with lumbar fractures were treated conservatively. Three (2.2%) patients had acetabulum fractures, and 2(66.7%) of them received open reduction and posterior approach plating fixation synchronously, while 1(0.7%) patient with ipsilateral radial head fracture received simultaneous operation with open reduction and screw fixation. Three (2.2%) patients with distal radius fractures underwent manipulative reduction plaster fixation; 1(0.7%) patient with contralateral ulna and radius fractures received open reduction and dual plating fixation synchronously.

The time from injury to the index was 03h to 15 days, with a mean of 4.8 days. The duration of surgery ranged 35-90min, with a mean of 45min; and the blood loss was 30-

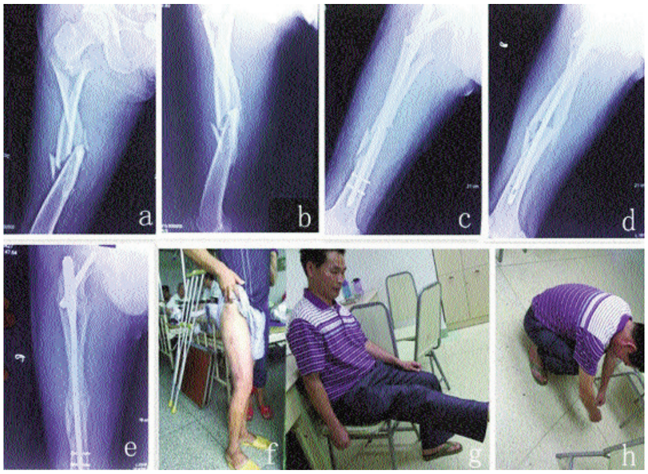

Figure-2: Male, 37 years old, damage caused by fall from high place.
a,b: Preoperative x-ray of long-segment fracture in middle-up part of left femoral (Type IV): long-segment comminuted fracture in middle-up part with dislocation of long fragment, and without big damage of the greater trochanter.
c,d: Closed reduction, postoperative anteroposterior and lateral x-ray film using the intramedullary fixation with the 360mm PFNA: good reduction of fracture end and the fracture line, no significant shortening or rotation.
e: Anteroposterior x-ray film after 6 months after surgery: good callus growth, the fracture line turned ambiguous.
f: Postoperative photo of the incision.
g: Normal postoperative flexion of hip & knee joint after 6 months.

200ml, with a mean of 78.6ml.

Earliest large amount of callus was found on the X-ray film on the 70th day in types II, III and IV fractures. The healing time of segmental or subtrochanteric with big fragment fractures (types II, III, IV) were relatively lagging. The fracture healing time ranged from 2.8 to 6.8 months, with a mean of 3.9 months. Spiral blades were correctly inserted and placed without cutting femoral head in this group. Four (3%) cases of screw breakage with phase I non-union, shortening and angular deformity also got healed after the second operation, However, the patients had amyotrophy and limited motion of hip and knee joints. None of our patients experienced cut-out, implant breakage, local infection or thigh pain. However, two (1.4%) patients developed coxa vara, crispation, and significant displacement of trochanter, pain in medial hip, increasing limb crispation, and partially limited range of motion (ROM).

All patients began crutch-walking on the 4-10d postoperatively, except 13(9.3%) complicated long-segment comminuted fractures of type IV.

According to Harris Hip Functional Score, 108(78%) cases were excellent (Figure-2), 22(15.9%) good, 8(6%) fair, and 1(0.7%) poor. Overall, excellent-good grading was noted in 130(93.53%) cases.

Discussion

Most of the date reviewed related to high-energy trauma cases, accompanied with associated injuries, some of which were liable to be missed, which included thoracic and abdominal injuries patients. The multidisciplinary approach to cope with cornorbidities was the common practice.

The recommended delay of 72h after trauma was relatively safer and we could effectively decrease the risk of anaesthesia and operation.[3,4] This delay was required for haemodynamic stability and to allow time for efficient preoperative planning and pre-anaesthesia fitness. With this delayed surgery approach, we had no mortality compared to the reported mortality.[3,4] Except for 1 case of emergency operation for splenic rupture, all patients received selective operations. Four patients, with complicated rib fracture, slight pulmonary contusion with slight hemopneumothorax had their operation after 3-5 days of conservative treatment for stabilising the condition.[7] With this strategy, we did not have fixation problems.

The significantly high-bending movements in long segment fracture with defective medial buttress lead to high stress on any implant fixed for this fracture. Inappropriate treatment often results in complications such as hip deformity, fracture non-union, and persistent hip pain etc. DHS fixation following a few days of skeletal traction through proximal incision was the treatment of preference. However; significant soft tissue dissection, periosteun, stripping during DHS fixation show stress concentration. Therefore, non-union and plate break clinically happens in a large numbers.[6] It generally takes patients three months (callus growth in the X-ray) to leave a sickbed and gradually take loaded walking. With regard to a patient whose proximal parts were relatively intact and stable and permitted the intramedullary (IM) nail locking with one screw in proximal part, we actively adopted interlocking IM nail fixation technique. Many scholars believe IM fixation accords with biomechanical stability. Gamma nail and proximal femoral nail (PFN) are recommended in peritrochanteric femoral fractures. But their high intraoperative and postoperative complications limit further application. A study reported complication rate of 8%-15%;[7] and there exists potential readability and sheer force in the fracture ends, which are liable to cut femoral head and neck, whereas PFN for subtract oblime fractures longer than 08cm is considered unsuitable.[8] For these fractures, PFNA, with features of pressurisation and anti-rotation, has been a better option.[9] The spiral blade of PFNA accomplishes the task of antirotation and support simultaneously during "drive-into". "Drive-into", rather than "spin-into" of the spiral blade assures maximum pressure in the eancellous bone in the femur head and preferable anchor force to impact the blade specially benefit patients with osteoporosis.[9] Moreover, taking into consideration the limited space and fixed shaft angle of femur neck, PFNA is easier to use with single spiral blade than double screws for fixation.[10] Minimally invasive fixation with PFNA avoids extensive peeling of soft tissue and periosteum in the fracture ends. During intraoperative traction, it can take full advantage of hinge effect to achieve reduction of fracture ends. Meanwhile, anatomical reduction is not strictly required, which would fully protect blood supply of the fracture ends, and is in accordance with concepts of biological idea of internal fixation, increasing fracture healing rate and reducing postoperative complications.[10]

Determination of the entry point of the nail is the paramount step for smooth operation. It is generally considered that the entry point is located at the anterolateral greater trochanter top point, where procedure should be conducted under the guidance of C-arm X-ray. Little variation to this may lead to problem in reduction and change in neck shaft angle and persistent pain, which happened in a case in our series, where the nail broke, and the entry point was found placed slightly to the rear. Lateral cortex defects were caused after reaming, along with exposure of nail and unsatisfactory reduction of fracture. So after less than two months of ambulation, the nail broke, leading to varus and shortening deformity. Treatment then performed was to replace the nail, implanting autologous iliac bone, restricting walking with stick and with load. The recovery was considered fair according to Harris Hip Score.

Good reduction is the key to operation. Unsatisfactory reduction would never bring satisfactory fixation regardless of internal fixation material used. For stable fractures, anatomical reduction can be achieved by axial traction, mild abduction and internal rotation. As a result of stable mechanical support by intact medial arch in the back of the fracture end padlock, any internal implants can be fixed firmly. For unstable fractures, complete anatomical reduction is difficult to achieve. Conducting anatomical reduction of greater and lesser trochanters by force may add extra operative trauma and make it hard to maintain after operation. alone study[11] reported 162 cases of unstable intertrochanteric fractures treated by anatomic reduction and patients using compression hip screw fixation technique were followed up. Overall, 98% patients suffered secondary displacement. At present many scholars advocate restoring the anatomic relation between femoral neck and shaft instead of anatomic reduction for unstable fractures.[11]

There were 4 nail breakage cases in out series, and 3 of them were due to unsatisfactory reduction and nail selection on the shorter side in the first operation. Preoperative heavy weight tibial tubercle traction and intraoperative traction on the traction bed are essential. They can make good use of hinge effect of soft tissues to achieve full reduction of fracture ends. Operation time and intraoperative bleeding amount are reduced simultaneously.[12] Preoperatively, unaffected side limb length measurement and intraoperative length measurement and orientation of bilateral femur under the guidance of C-arm intensifier could effectively avoid limb shortening.

Some types II and III cases (52 cases) difficult for closed reduction need to undergo poking reduction with the aid of auxiliary small incision at the lateral or anterolateral thigh in the fracture area. For the time being, attention should be paid to minimising soft tissue peeling. Anatomic reduction is not required, but good counterpoint and line jitter should be pursued. Small incision can directly touch the fractured part, which is beneficial in distinguishing displacement direction of the fractured ends and avoid fluoroscopy location with C-arm X-ray, thus enormously reducing radioactive rays' irradiation and protecting both the doctor and the patient. We also took full advantage of reaming cancellous bone, then through the poking reduction small incision we implanted the fractured end to fill the capitulum bone graft. Patients with additional incision in this group (52 cases) received this kind of bone graft, and were observed for callus growth in the fractured ends in the short-term follow-up. We think this method is easy to obtain and graft bones, of which quality is excellent, amount is ample, contributing to bone growth in the bone ends and is deserving of clinical promotion.

In view of the non-availability of aiming guides with external standard for distal locking screw, we recommend that a distal aiming device be used to determine length and to make distal hole, which has a high accuracy; punch the two distal locking holes under the guidance of C-arm; reduce X-ray irradiation as much as possible.

AO principles of fracture treatment are reduction, fixation and functional exercises. Among them, firm internal fixation sets the stage for early functional exercises, and postoperatively early functional exercise serves as the base and key of the functional rehabilitation of lower extremity joints and helps regression of limb swelling and fracture healing. Functional exercise should be carefully planned under medical guidance. Recovery plan of cases in this group includes passive flexion and extension exercise of hip, knee and ankle joints 3 to 4 sets daily, 10 to 20 a set, from the first day after operation, and active isometric contraction of quadriceps femur is recommended 3 to 4 days after operation when the swelling and pain have reduced. Patients should be encouraged to do more active flexion and extension exercise of hip, knee and ankle joints and straight-leg raising exercise. In the meantime, symptomatic treatment like analgesia should be actively performed to ensure lessening of pain during functional exercises. After 4 to 7 days of the operation, patients should be advised to walk with stick and with load gradually except patients with type IB, II and IV fractures. One 35-year-old type IB patient who started walking early after the operation had good functional exercise, but, shortening healing appeared at the femoral neck and the fracture end, presenting with about 2.5cm shorter and slight claudication. Patients of this group all receive good postoperative functional exercise guide and regular follow-up. Bony growth union is observed significantly 3 to 5 months after the operation.

An effective bone fracture classification can not only describe the severity, promote the communications between surgeons, help documentation and research of clinical cases, but also provides basis for the evaluation and treatment. In this group, we classified the fracture generally based on the clinical type: long-segment fracture at middle-up part of femoral, including intertrochanteric and lower trochanteric fractures as well as compound fractures of the middle-up section (oblique split, multistage or comminuted fractures). Presently, there is no standard for the classification of this kind of fracture. The study generated its own classification from type I to IV, with corresponding plans for traction, reduction, fixation and postoperative recovery. It is hoped that summarising more clinical cases in this way of classification will be accepted and widely applied, and will provide guidance for treatment of related fractures.

Conclusion

Simple classification of fracture helps clinical comparison and treatment. With regard to treatment of this composite fracture, IM fixation is more in line with biomechanical stability. Minimally invasive fixation designed by PFNA avoids extensive peeling of soft tissue and periosteum in the fracture ends and protects blood supply of the fracture ends. Firm internal stent fixation helps patients to do early load exercises.

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