Original Article

Fixation of subtrochanteric fractures : Comparative study of Dynamic condylar screw *versus* Proximal femoral nail

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This prospective study was performed to compare the functional & anatomical results with two different implant fixation devices, in the management of Subtrochanteric femoral fractures in adults. Thirty patients were included in this study from June 2007 to June 2010. The proximal femoral nailed patient showed identical functional & anatomical results compared to patients fixed with dynamic condylar plating, but time to fracture union & full weight bearing was earlier in the PFN patient group.

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Subtrochanteric fractures of femur extend from lesser trochanter to isthmus of diaphysis. This segment of femur is subjected to axial loads of weight bearing and tremendous bending forces because of eccentric loading of femoral head. Compressive stresses in medical cortex are significantly higher than tensile stresses in lateral cortex. This asymmetrical loading pattern is important in determining the choice of internal fixation devices and understanding the causes and prevention of failure of these devices[1]. Despite marked improvements in implant design, surgical technique and patient care, subtrochanteric fractures continue to consume a substantial proportion of health care resources.

Subtrochanteric fractures comprises about 10 to 34% of hip fractures[2]. They have bimodal age distribution and different mechanisms of injury, in older patients they occur following low velocity trauma and in younger result from high energy motor vehicle accidents or fall from height.

Subtrochanteric fractures are complicated by malunion and delayed or nonunion. The factors responsible for these complications are high stress concentration, predominance of cortical bone and difficulties in getting biomechanically sound reduction because of comminution and intense concentration of deforming forces[3].

Many internal fixation devices have been recommended for use. Lack of single satisfactory implant has lead to series of evolution in design of a perfect implant. However these fractures were associated with high rates of nonunion and implant failure, regardless of the method of fixation. Only recently with better understanding of biology, reduction techniques and biomechanically improved implants these fractures can treated with consistent success.

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Materials and Methods

Our study consisted of 30 adult patients with subtrochanteric facture of femur, who were randomly treated with Proximal Femoral nail and Dynamic Condylar Screw in Goa Medical College and Hospital, Bambolim, Goa between June 2007 to June 2010. This study was carried out to testify the anatomical and functional outcomes of treatment with proximal femoral nail and dynamic condylar screw. All these 30 patients included in the study were followed up at regular intervals. Initially patients underwent necessary clinical and radiological evaluation and were admitted to the ward after splintage using appropriate size Thomas splint. Skeletal traction was then applied by passing stienmen pin through proximal tibia of the affected limb and kept till the surgery. All the patients were evaluated for associated medical problems and were referred to respective departments and necessary treatment was started. Associated injuries were evaluated and treated simultaneously. All patients were operated on elective basis. Fractures were classified according to Seinsheimer's and Russel & Taylor classification. Subtrochanteric fractures with intertrochanteric extension were included while pathological fractures were excluded from study.

All the cases included in our study were fresh fractures who underwent surgery at the earliest possible in our setup. The delay was due to associated injuries and medical conditions. Patients were operated at an average interval of 7 days from day of injury.

Technique :

Proximal femoral nailing :

Patient was placed in supine position on fracture table.

Affected limb was adducted by 10 to 15 degree and closed reduction of fracture was done by traction and gentle manipulation. Greater trochanter was exposed by a longitudinal incision 5 to 8 cm proximal to its tip. Entry point made slightly lateral to tip of trochanter and confirmed on C- arm image intensifier. Guidewire inserted and position confirmed on AP & lateral images. Canal was reamed with flexible reamers over the guide wire. Appropriate size nail with length determined preoperatively and with diameter 1 mm less than last reamer used was assembled to insertion handle and inserted manually into femoral opening. This step was done carefully without hammering by slight twisting movement of hands. Wherever satisfactory reduction was not possible open reduction was done.

Two self tapping 6.5 mm cannulated neck screws were inserted with help of aiming device tightly secured to the insertion handle and colour coded drill sleeve system after confirming correct positioning of guide wires on AP and lateral C-arm images. Inferior screw was placed first, superior screw was placed approximately 4 to 5 mm from superior cortical margin of femoral neck. Proximal screws were tightened after releasing traction to maximum compression at fracture site. Distal locking done with two 4.9 mm locking bolts by free hand technique using image intensifier.

Dynamic condylar screw :

With patient placed in supine position on fracture table, fracture was exposed by a 15 to 20 cm incision made along an straight imaginary line drawn from tip of trochanter to lateral femoral condyle. Guide wire inserted at an angle of 95 to anatomical axis of femur using angle guide roughly just below tip of greater trochanter and proximal aspect of osseous insertion of gluteus medius. After confirming the position on C-arm images an appropriate size Richards screw was inserted after reaming and tapping.

Fracture reduced by adjusting traction and manually using bone holders. Butterfly fragments were reduced and fixed with interfragments screws. After satisfactory reduction barrel of the plate was mounted on the Richards Screw and shaft of the plate fixed to distal fragment using 4.5mm cortical screws with minimum eight cortical purchase distal to fracture and atleast four cortical purchases in proximal fragment.

Posteromedial comminution was assessed, if necessary primary bone grafting done. Ipsilateral iliac crest was used for the purpose.

Postoperatively, patient's pulse, blood group, respiration and temperature were monitored. Injectable antibiotics were continued in the post operative period for 2 days. Analgesics were given as per patients compliance. Drain removal done by 48 hours & sutures removed on 12th postoperative day. Patients were encouraged to sit in the bed 24 hours after surgery. Quadriceps setting exercises were started in immediate post operative period. Patients were encouraged to walk with axillary crutches or walker with toe touch down depending on the pain tolerability and were discharged from the hospital when independent walking was possible. Patients were followed up every month till the fracture union and thereafter once in 3 months for 1 year. At every visit patients were assessed clinically regarding hip and knee function, walking ability, deformity and shortening. AP and lateral X ray of the involved hip with femur was done to assess fracture union.

Result of the Surgery :

Anatomical Result :

Anatomical result	Good	Poor
Shortening	<1cm	>1cm
Varus deformity	Absent	Present
Hip movement	Full range	Restricted
Knee movement	Full range	Restricted

Functional Results:

Functional assessment was done using Owestry hip scoring system (patient assessed score) which consisted of presence of hip pain, mobility and range of motion. Range of motion was measured in terms of ability to squat and sitting crossed legged. Following point system was used:

Hip pain :	
No pain	2 points
Occasional pain	1 point
Constant pain	0 point
Ambulatory status:	
Walking without aid	2 points
Walking with aid	1 point
Not able to walk	0 point
Range of motion :	
Able to squal	1 point
Unable to squal	0 point
Able to sit crossed leg	1 point
Unable to sit crossed leg	0 point
Interpretation :	
Excellent	6 points
Good	4 to 5
Fair	2 to 3
Poor	1

Observation and Results

The mean follow- up time was 18 months. All patients tolerated the operation well and adapted to rehabilitation program without any problem.

In our series maximum age was 70 years. Most of the patients were in the age group of 20 to 60 years, with mean age of 49.1 years. Males were affected more than females and fractures were right sided in 22 patients. Out of 30 cases, 21 cases gave history of motor vehicular accidents, 03 cases gave history of fall height and remaining 6 cases gave history slip and fall.

Sinsheimer type 3B (36.66%) fractures were more common followed by type 3 A (20%) and according to Russel & Taylor type 2A (33.33%) were more common followed by 1A (30%) fractures.

Mean duration of surgery was 120 minutes for PFN and 90 minutes for DCS, with mean blood loss of 100ml for the former and 300ml for latter. Radiographic screening in DCS was used to pass a guide wire and was minimal as compared to PFN.

In PFN group, closed reduction was not possible in 2 cases and open reduction was attempted. One patient had iatrogenic fracture of the lateral cortex of the proximal segment which did not require any fixation but mobilization was delayed for 3 weeks. In all cases proximal and locking was possible. There were no incidences of jamming of nail and drill bit breakage.

In DCS group, one patient required primary bone grafting due to posteromedial comminution. Three had extensive blood loss more than 500 ml. On an average blood loss was approximately 300ml in most patients. No technical difficulties were encountered. The mean duration of hospital stay was 12.46 days while mean time for full weight bearing was 7.2 weeks in proximal femoral nailing and 14 weeks in Dynamic condylar plating. Average time required for radiologic fracture union was 14 weeks in PFN and 17.13 weeks in DCS.

Postoperative complications :

In DCS group, one patient had superficial skin infection at operative sight who required lavage and wound healed with regular dressing and appropriate antibiotics. One patient in PFN group, who required open reduction developed deep infection, lavage was given twice and antibiotic beads were put. However fracture healed without complications.

One patient had delayed union in DCS group who underwent secondary bone grafting. All cases operated with PFN united without bone grafting with no incidence of non union. Over all 90% of our cases had excellent to good results. No mortality was reported in our study. One patient in DCS group had nonunion with shortening who underwent revision ORIF with DCS and bone grafting. Another patient in DCS group had implant breakage following trauma, PFN was put along with bone grafting. Most of the patients enjoyed good range of motion at hip and knee except one in PFN group had knee stiffness and one had hip stiffness following iatrogenic breakage of lateral cortex while inserting nail. Only one patient in DCS group had hip stiffness.

Complications :

Complication	Number of cases	
	PFN	**DCS**
Hip Joint stiffness	01	01
Knee Joint stiffness	01	00
Delayed union	00	01
Non union	00	01
Shortening of >1cm	00	01
Malunion	00	00
Implant failure	00	01
Superficial infection	00	01
Deep infection	01	00

Functional Results :

	PFN	**DCS**
Excellent	12	9
Good	1	3
Fair	1	1
Poor	1	2

Anatomical Results :

	PFN	**DCS**
Good	13	11
Poor	2	4

Discussion

Management of subtrochantric fractures of femur poses a great challenge to orthopaedic surgeon. In adults these fractures are usually the result of high energy trauma and often comminuted at the medical cortex. In older patients the need for early mobilization and osteoporosis makes the selection of implant an important issue. Many clinical and biomechanical studies have analyzed the result of different implants. Treatment of subtrochanteric fractures of the proximal femur is still associated with some failure, the reason being: disregards for biomechanics, overestimation of the potential of new surgical techniques or new implants and poor adherence to established procedures[4]. High stress concentration that is subject to multiple deforming forces, slow healing time because of predominance of cortical bone, decreased vacularity[5], high incidence of complications reported after surgical treatment compels the surgeon to give a second thought regarding selection of the proper implant. The most common current modes of fixation are Blade plate systems, sliding screw systems and intramedullary devices. From the mechanical point of view, a combined intramedullary device inserted by mean of a minimally invasive procedure seems to be better, especially in elderly patients[6]. Closed reduction of the fracture preserves the fracture hematoma, an essential element in the consolidation process[7]. Intramedullary fixation allows the surgeon to minimize soft tissue dissection thereby reducing surgical trauma, blood loss, infection, and wound complications[8].

In 1996, AO/ASIF developed the proximal femoral nail as an intramedullary device for treatment of unstable per, intra- and subtrochanteric femoral fractures[9]. Careful surgical technique and modification of PFN can reduce high complication rates. Proximal femoral nail has all the advantages of an intramedullary device, such as decreasing the moment arm, can be inserted by closed technique, which retains the fracture hematoma an important consideration in fracture healing, decreases blood loss, infection, minimizes the soft tissue dissection and wound complications.

In an experimental study, Gotze *et al* (1998) compared the load ability of osteosynthesis of unstable per and subtrochanteric fractures and found that the PFN could bear the highest loads of all devices. Andrew J Pakut (2003) conducted a clinical study of treatment of subtrochanteric fractures of femur in 15 patients operated with DCS before 1999 and 11 operated with PFN after 1999. The mean age of patient was 70 years (31-90). Patients with intertrochanteric fractures and pathological fractures were excluded in study. The mean age of follow up was 16 months. All fractures united. There was no infection or implant cut out. In DCS group there was one malunion in varus and one late breakage of implant. In PFN group there was one malunion in internal rotation and three intraoperative fractures. Functional evaluation showed no significant difference in pain, range of movement or walking ability, but recovery was earlier in PFN group. In our study, mean age was 49.1 years and study included only subtrochantric fractures. There were two cases with postoperative infection one with PFN and other with DCS. In DCS group there was one case with nonunion and one case with late fracture with implant breakage. No case of malunion was reported. In PFN group we encountered one case with intraoperative fracture of lateral cortex. No cases of malunion was reported. Functional evalution showed significant difference in walking ability in form of early weight bearing in PFN group. Differences in pain and range of motion was similar in both the groups, but recovery was earlier in PFN.

Consecutive prospective randomized clinical study was conducted by Department of Orthopaedics surgery, Uppasal University Hospital, Uppasal, Suede of 203 patients admitted with subtrochanteric fractures of femur. Surgery was performed with Proximal femoral nailing and Dynamic condylar screw. Follow up visits occurred at 6 weeks, 4 weeks and 12 months. Functional outcome was measured by walking ability, rising up from chair, living conditions and complications. The ability to walk 15 meters at 6 weeks was significantly better in PFN group as compared with DCS group with P value of 0.04. The major complication rate (8% in PFN and 4% in DCS) did not differ statistically with P value of 0.50. Reoperations were more frequent in PFN group (9%) compared to DCS group (3%). Study concluded that there was no major difference in functional outcome or major complication between the treatment group. In our study of 30 patients functional outcome was measured by postoperative mobility, hip pain and patient assessed range of motion in terms of ability to squat and sit crossed leg. Anatomical outcome was assessed by presence of shortening, deformity, and hip and knee movements. No statistical significance was found in functional and anatomical outcomes with DCS and PFN with P values of 0.623 and 0.549 respectively. However union of fracture and ability of full weight bearing was statistically significant with P values of 0.042 and 0.0001. Complication rate was higher in DCS group and was the reoperations rate.

Major advantage of 95 DCS is its proximal extension, that makes it possible to insert two or more cortical screws through the plate into the calcar, which greatly strengthens its hold in proximal fragment and prevents varus and rotational deformities. However use of DCS is associated with blood loss due to extensive dissection, while chances of implant failure and delayed union or nonunion are more. Secondary procedure may be required in form of secondary bone grafting or revision ORIF with bone grafting. Although operative technique is easy the complications associated with DCS are many.

The modification of the PFN and careful surgical technique should reduce the complications associated with PFN. Locking the proximal fragment to nail has decreased the tendency to drift into varus and locking the distal fragment has prevented shortening and rotation. The locking of fragments provides exceptional rotational and axial stability which has permitted one to deal with all fracture patterns. Although technically challenging, PFN is an excellent minimally invasive device for stable and unstable subtrochanteric fractures of femur with excellent anatomical and functional outcomes and minimal complications in comparison with use of DCS.

Some of the disadvantages of P.F.N are:

(i) Steeper learning curve for the surgeon.

(ii) More technically demanding surgery.

(iii) Specialized instrumentation and larger inventory of implants.

(iv) Longer operative time.

(v) More exposure to radiation of image intensifier.

Conclusion

Subtrochanteric fractures are common in high velocity trauma. High stress concentration, slow healing time because of predominance of cortical bone and difficulties in getting biomechanically sound reduction because of usual medical communication, has led to evolution of various internal fixation devices. Inspite of it, the incidence of complications are high after surgical treatment. The potential advantages of the Proximal femoral nail over the 95 degrees Dynamic condylar screw with regards to mini-

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mal invasiveness because of closed technique and minimal soft tissue dissection, better biomechanical design to prevent implant failure and ability to bear more stress shows that this implant technique holds considerable promise in complex fractures. The earlier rehabilitation, less blood loss, less surgical trauma makes it the implant of choice in complex unstable subtrochanteric fractures.

With our sample study, we consider that PFN is an excellent implant for the treatment of subtrochanteric fractures of the proximal femur. The terms of successful outcome include a good understanding of fracture biomechanics, correct indication and exactly performed osteosynthesis.

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