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CLINICAL AND RADIOLOGICAL ASSESSMENT OF PATIENTS WITH INTERTROCHANTERIC FRACTURES MANAGED WITH PROXIMAL FEMORAL NAIL WITH HELICAL BLADE

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ABSTRACT Various treatment methods have been described for the treatment of intertrochanteric fractures. We present our experience with proximal femoral nail with helical blade in the management of intertrochanteric fractures at SGT Medical College Hospital and Research Institute, Gurugram. Methods: This study was conducted from October 2018 to April 2020 and included 30 patients above 18 years presenting with intertrochanteric fractures of femur managed by proximal femoral nail with helical blade. Clinical and Radiological evaluation of the patients was done at 6,12,18 and 24 weeks. Functional outcome was assessed according to Modified Harris Hip Score and was graded excellent, good, fair or pair as per the score. Results: The average age of patients in the present study was 58.16 years with slight male preponderance. The average operating time in the present study was 71.8 minutes. The average time of union was 18 weeks, with one case of implant failure and two cases of delayed union. average value of Neck-Shaft Angle in our study was 128.26 and the average Tip-Apex Distance (TAD) was 21.63mm. There was a case each of superficial infection and varus collapse. The average Modified Harris Hip score in present study was 90.5 with a range of 78-99, excellent in 63.33% patients, good in 26.66% of the patients and fair in 10% of the patients as per the Modified Harris Hip scoring system.

KEYWORDS : Proximal Femoral Nail with Helical Blade (PFNA), intertrochanteric fractures

Introduction

Intertrochanteric fracture is one of the most common fractures in Orthopaedics, particularly in the geriatric age group. Majority of the elderly population is osteoporotic, so they are generally more prone and can sustain the fracture even with a minor fall, accounting for nearly ninety percent of fractures. In younger patients the fracture usually results from high energy trauma like road traffic accident, fall from height and account for only ten percent.[1]

Trochanteric fractures unite readily, but if there is failure in maintaining the alignment these can malunite. Surgical treatment has been accepted as the standard protocol of management of intertrochanteric fracture throughout the world. Operative management has kept changing with time with the evolution of newer concepts and implants. The implants fall in two main categories, extramedullary and intramedullary.

DHS (Dynamic Hip Screw) is the most commonly used extramedullary implant. It has taken the test of time and continued to be the gold standard in the management of intertrochanteric fractures, especially stable fractures.[2]

With the introduction of intra-medullary concept and devices, Gamma nail in 1988 & later proximal femoral nail (PFN) in 1996 by AO/ASIF group, the intramedullary devices have gained attention and popularity globally.[3]

PFN (Proximal Femoral Nail) is an intramedullary device, it was designed to overcome the implant related complications of DHS and to facilitate the surgical management of unstable intertrochanteric fractures. The various advantages it offers are – better biomechanical strength, shorter duration of surgery, preservation of fracture biology, lesser extensive surgery, earlier weight bearing, smaller incision and less wound related complications.[4]

The implant underwent more changes and finally Proximal Femoral Nail with Helical Blade (PFNA) was introduced in 2003. The helical blade of PFN achieves better cancellous bone compaction in femoral neck (particularly in osteoporotics), thereby decreasing the risk of secondary displacement, and it has superior resistance to rotation and varus collapse as compared to conventional PFN. The new PFNA device ensures reliable fixation with low mechanical complication.[5]

Material and methods

This study was conducted on 30 adult patients with age 18 and above after informed consent, presenting with intertrochanteric fractures in the Department of Orthopaedics in SGT Hospital, Budhera (Gurugram) from October 2018 to April 2020. Patients who were ambulatory before surgery and trauma duration was upto 2 weeks were included. In every patient a detailed history regarding the mode, duration and nature of injury was taken.Radiological investigation included X-ray pelvis with bilateral hip joint antero-posterior and lateral view were done for fracture classification and comparison with uninvolved side and all the fractures were classified according to AO-OTA classification. Till the patient was fit for surgery the limb was kept in skeletal/skin traction. Pre-operative planning was done to decide the size and length of implant to be used.

Post-operative patients received broad spectrum intravenous antibiotics for a minimum of 3 days, and then were shifted to oral antibiotics till suture removal. Hip, Knee and Ankle mobilization exercises were started on the next day of surgery. Weight bearing on the affected limb was allowed gradually starting from partial to full weight bearing according to findings on x-rays (fracture pattern & stability, osteoporosis, quality of fracture reduction and implant position). In stable fracture weight bearing was allowed as early as possible, as per tolerability & co-operation of the patient. In case of communited fracture / unstable fracture weight bearing was delayed & was started in graded manner as per fracture anatomy and patients profile.

Clinical and Radiological evaluation of the patients was done at 6,12,18 and 24 weeks. Functional outcome was assessed according to Modified Harris Hip Score and was graded excellent, good, fair or pair as per the score.

Results

The average age of patients in the present study was 58.16 years with slight male preponderance. There was equal occurrence of right sided fractures and left sided fractures. Trivial fall was the mode of injury in 70% cases and high velocity trauma in 30% cases. 13.32% patients were having associated injuries and 60% patients were having associated medical illnesses. Most common mode of injury was trivial

fall. 60% patients had unstable fracture, while 40% patients had stable fracture. The average operating time was 71.8 minutes. The average post-operative hospital stay was 15.46 days with a range 13-18 days. All the patients were allowed partial weight bearing ambulation from 2nd post-operative day. Weight bearing was gradually increased from 25% to 100% in graded manner. Full weight bearing was allowed 4 weeks onwards. The average time of union was 18 weeks in present study. 18 patients were managed using short-PFN sized 220mm, the most common of them being 11mm x 220 mm. In 12 cases , long-PFN was used sized 380mm and 400mm. In one case, there was implant failure (blade migration) and helical blade was hammered back (resurgery) after 24 days of surgery. In two cases, there was delayed union, associated with factors like smoking, and co-morbidities like diabetes mellitus. Blood loss was quantified using mops, the average blood loss in our study was 180 mL. Limb length discrepancy (>2cm) was seen in six patients. All these patients were given shoe raise and gait training. One patient had varus collapse due to early weight bearing before fracture had healed completely, leading to the collapse of the fracture site. The average value of Neck-Shaft Angle in our study was 128.26°, with values ranging between 123-137 degrees. In all the patients, the neck shaft angle was maintained above 120 degrees. The average Tip-Apex Distance (TAD) was 21.63mm. All patients were observed for general complications like chest infection, urinary tract infection and deep venous thrombosis, however they were observed in none. None of the patients had any deep infection. All the cases were assessed for ability to squat and sit cross legged .Three patients were not able to squat out of which two patients were not able to sit cross legged. All these cases were having osteoarthritis of knee out of which one patient had flexion contracture of 15º in bilateral knees. All these three cases were not able to do these functional movements even before injury. The average Modified Harris Hip score in present study was 90.5 with a range of 78-99 . The overall functional outcome was assessed to be excellent in 63.33% patients, good in 26.66% of the patients and fair in 10% of the patients as per the Modified Harris Hip scoring system.

Fig 1- PFN with helical blade and static locking screw

Fig 2- Helical Blade

Fig 3- Jig being used to insert helical blade

Fig 4 - Jig used along with Open Reduction in one of the cases

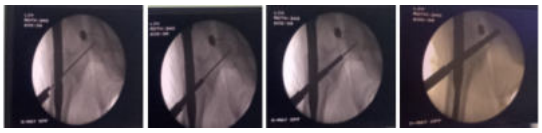

Fig 5 - Steps of Helical Blade insertion - Guide wire inserted in femoral head, Reamer passed over guide wire, Reamer advanced in femoral head and Helical Blade inserted in Femoral Head

Fig 6 - Pre Op X-Ray and Post Op X-Rays (AP and Lateral)

Fig 7 - Patient showing Sitting and Squatting at 6 month follow up

Discussion

Internal fixation of intertrochanteric fractures is now a days considered to be the treatment of choice in order to prevent morbidity and mortality associated with the conservative means of treatment. There are many factors influencing the outcome of surgical treatment like age of patient, comorbidities, degree of osteoporosis, fracture anatomy, degree of comminution of fracture, type of fixation used and stability of fixation.

The average age of patient in the present study was 58.16 years. According to literature, these fractures are more common in old age due to increased osteoporosis. The average age of patients in the study of Naja et al[6] in 2018 was 80 years, in the study of Radaideh et al[7] was 72.18 years and that of study conducted by Sharma et al[4] in 2018 was 61 years. Average age of patients as reported in literature is more than 60.67 years and only a low energy trivial fall is sufficient to cause the fracture in the elderly age group as they are towards the osteoporotic side. In 30% of the cases in the present study, high velocity trauma (road traffic accidents and hit by vehicle) was the cause of injury, all those were males who had to go outside for work, thus they were prone for high velocity trauma.

The patients in elderly age group have high number of associated medical illness. In the present study nearly 60% of patients were having associated medical illness, most of which were diagnosed at the time of admission to the hospital.

Almost all the patients in the study, were ambulatory prior to the injury, two patients were ambulatory with the help of a stick and one patient was ambulatory with the help of the walker. The difficulty in walking was attributed to factors like age induced arthritic changes in the knee and the other joints.

Fractures were classified in the present study as per AO Classification of intertrochanteric fractures. 60% fractures were unstable in nature. In the study by Naja et al[6] in 2018, out of 69 patients 41 had unstable variety of fracture whereas 28 had stable fractures. Unstable fractures are more common in elderly age group because of increased osteoporosis leading to increase in comminution.

All cases were operated on fracture table and closed reduction was tried, though cases in which closed reduction failed were opened at fracture site (2 cases) to achieve good reduction. In the study by Sharma et al[4], closed reduction was attempted and successful in all except one case out of 31 cases in which reduction was achieved by indirect reduction techniques. Antonio Barquet[8] did a study on

minimally invasive reduction aids in trochenteric fractures in 2016, he emphasized that we have to consider contralateral hip anatomy for pre-operative reduction maintaining the adequate neck-shaft angle; reduction should proceed step by step, reducing one by one the various displacements; reaming should not be initiated until fracture is reduced in all planes and secured; and we should not hesitate to proceed to open reduction if minimally invasive procedures have failed- reduction is of utmost importance to prevent fixation failures. As bone fragility, i.e., osteoporosis, and fracture instability facilitate fixation failure, unstable trochanteric fractures should undergo anatomical reduction & proximal femoral nailing with a femoral neck-head sliding component to produce a bone-implant construct stable enough to provide for early painless full weight-bearing.

The average duration of surgery in the present study was 71.8 minutes and with a range of 45-100 minutes, which is comparable to other similar studies as shown in Table 1. The operative time is directly related to the experience of the surgeon and the familiarity with the operative procedure. The short PFN takes less time, time taken during insertion of long PFN is longer as it involves reaming and distal locking by a free hand perfect circle technique.

Table 1: Comparison of Duration of Surgery with other studies

Name of Author	Duration of Surgery
Radaideh et al[7] (2018)	62.1 minutes
Landevoisin et al[10] (2012)	47 minutes
Arrigio et al[11] (2012)	45 minutes
Sharma et al[4] (2018)	56 minutes
Pradeep et al[9] (2016)	77 minutes
Present Study	71.8 minutes

The short PFN is indicated for more proximal fractures, and the long PFN for more distal fractures. The sub trochanteric fractures are generally associated with slightly higher failure rates with normal length PFN. The reasons for this include the greater intrinsic instability of the sub trochanteric fractures, demanding more stabilization; more difficult fracture reduction because the proximal fragment has got a tendency to ante flex relative to distal fragment, owing to psoas muscle activity; and shorter distance from locking screw hole to fracture.

Blood loss was quantified using mops. The average blood loss was 180 ml. The average blood loss in the study by Pradeep et al[9] was 190 ml, which is comparable to our study. Reduced surgical handling of the soft tissues in intramedullary nailing directly reduces the blood loss.

In the present study, physiotherapy was started from 2nd post-operative day, in the form of hip, knee and ankle range of movement exercises. All the patients were allowed partial weight bearing ambulation from 2nd post-operative day. Weight bearing was gradually increased from 25% to 100% in graded manner. Full weight bearing was allowed 4 weeks onwards. In the study by Sharma et al[4] in 2018, post-operatively all the patients underwent similar rehabilitation protocol with dynamic quadriceps and ankle pump exercises being started from 1st day, early mobilization with walker as soon as possible with non weight bearing and later partial weight bearing was started depending upon patient's compliance. In the study by Acker et al[12], patients began weight bearing on 2nd post-operative day and were discharged to a rehabilitation centre 4 days after the surgery, to continue recovery. The first follow up visit in their study was 1 month after surgery, when the patient came walking with his cane. So, the post-operative rehabilitation regimen employed in our study was more or less similar to other studies.

The average time of union was 18 weeks in present study (n=30), with a range of 12 to 24 weeks. In two cases, there was delayed union, associated with factors like smoking, and co-morbidities like diabetes mellitus. Average consolidation time in the study of Pradeep et al[9] was 18.7 weeks, in the study of Landevoisin et al[10] it was 10.3 weeks. In our study, we had kept the follow up at 6,12,18 and 24 weeks. So, majority of the fractures in our study were in the process of union at 12 weeks and must have united between 12-18 weeks, and hence on the 18 week follow up they had appeared to be united.

In our study, 6 patients had developed complications like superficial infection, varus collapse, delayed union, blade migration and bed sore. Every patient had some limb shortening, 6 patients had a shortening of more than 2cms. In the study by Sharma et al[4] on 31 patients, no case of iatrogenic fracture, DVT, deep infections, nonunion or malunion was noted, the mean shortening in their study was 5.3mm. Limb length discrepancy (>2cm) was seen in six patients in our study. But in five of those patients it was less than 2.5 cm. All these patients were given gait training, and the one above 2.5 cm was given shoe raise.

Absence of clinically evident deep venous thrombosis in the present study does indicate that early mobilization of the patient with walker and active physiotherapy significantly reduces the chance of development of deep venous thrombosis and may obviate the need for its prophylaxis.

In one case , there was backwards (outwards) blade migration. The helical blade was hammered back (resurgery) after 24 days of the initial surgery. The patient was followed up after the resurgery, and the follow up period was uneventful. There was no subsequent re-migration, no change in patient's reduction anatomy and the TAD remained the same subsequently. According to Landevoisin et al[10], blade backout was rarely associated with complications, because the cause was femoral head impaction, allowed by the device. They recorded three surgical complications. All three were associated with faulty technique during implantation of the device: blade malposition in the neck in all three patients and inadequate fracture reduction in one patient. All cases of cut-out in their study occurred in patients with incomplete reduction or unstable fractures or improper implant position. In the study by Sharma et al[4], incidence of technical errors was higher in PFN group (9.67% as compared to 3.48% in DHS group) which included varus angulation at fracture site, distal translation of the head and neck fragment due to it being pushed distally by nail entry point, opening up of the fracture site in one case after insertion of nail when the fracture was located at the entry point itself and protrusion of the nail at the entry point due to mismatch between direction of neck screws and neck shaft angle.

One patient in our study had varus collapse due to early weight bearing before fracture had healed completely, due to non-compliance of the patient, leading to the collapse of the fracture site.

In the retrospective study by Landevoisin et al[10] on 102 patients, the main complications were hardware- related fractures (2% to 3%), screw cut-out in femoral head due to varus deviation (3% to 10%), and penetration of screw into the joint (3 to 15%). Cephalic screw cut-out is defined as an atleast 5-mm displacement of the screw. This multifactorial complication was related to the loads applied to the bone, type of fracture, quality of reduction and implant design. Arrigio et al[11] emphasized in his study that, cut-out appears to result from poor position of screw in femoral head rather than being implant related. While the cut-out rates were found to be 2% in a study by Takigami et al.[13] , 4.7% in a study by Sahin et al.[14] and 7.9% in a study by Zhang et al.[15] The rates of femoral head perforation were found to be 1.4% in a study by Karapinar et al.[16] and 1.2% in a study by Simmermacher et al[17]. In consistence with previous reports, in this study, the rate of blade cut-out and femoral head perforation was 0%.

All the cases in the present study were assessed for ability to squat and sit cross legged because in our country these two functions are must for carrying out daily activities. Three patients were not able to squat out of which two patients were not able to sit cross legged. All these cases were having osteoarthritis of knee out of which one patient had flexion contracture of 15° in bilateral knees. All these three cases were not able to do these functional movements even before injury.

In our study, the average neck-shaft angle was 128.26°. A neck shaft angle of more than 120 degrees was achieved in all patients immediately intra-operatively. In the study by Radaideh et al[7] on 50 patients, neck shaft angle was above 120° in 44 patients (88%) and only six patients (12%) developed secondary varus collapse (neck-shaft angle <120°). In the study by Naja et al[6], the mean neck-shaft angle for A2 fracture was 127.59°, while that for A3 fracture was 126.08°, with no significant difference between two fracture patterns. The varus collapse rate was found to be 5.8% in a study by Zhang et al.[15] When interpreting failure rates of internal fixation , several factors were identified. Firstly, the failure can be due to inadequate reduction and/or poorly placed helical blade of the PFNA (in superior-center position on radiographs). Additionally, early functional exercise, high activity levels, increasing age and presence of osteoporosis might increase the risk of implant failure.

The average Tip-Apex Distance (TAD) in our was 21.63mm. In the study by Naja et al[6], the average tip-apex distance was 23.44mm. The

TAD in the study by Stern et al was 23mm and no patient with a TAD<25mm experienced cut out. Hence, the quality of reduction whether it is optimal or suboptimal (i.e. TAD of 25mm, neck shaft angle of 130°, non-displaced lesser trochanter and femoral shaft) did correlate with postoperative outcomes of the intertrochanteric reduction. Naja et al[6], noted in their study that TAD<25mm, avoidance of anterior screw placement and fracture reduction with a valgus neck-shaft angle of 5-10° relative to the contralateral side was associated with a trend towards a lower rate of screw cut-out.

We had zero case of cut-in complication in our case series. Weil et al[18] postulated that the main reason for the "cut-in" or medial migration was the result of an unstable fracture pattern. Brunner et al[19], was one of the first surgeons to report the cut-in complications and he was the first to recommend using shorter blades and not to pre-drill the femoral neck and head before the introduction of the blade in osteoporotic patients. Frei et al[20], emphasized the quality of reduction and caudal placement of blade as major prevention steps.

According to Modified Harris Hip Scoring system, 63.33% of total patients in the present study were in excellent grade, 26.66% in good grade, 10% in fair grade and 0% in poor grade. The average Modified Harris Hip score in present study was 90.5 which has been compared to other studies in Table 2, The mean Harris Hip Score was in the excellent range in our study probably due to extensive physiotherapy regimen, proper briefing of all the instructions to the patients and relatives and taking care of all the parameters that come in the Harris Hip Scoring. There was initial abductor lurch, but the scores improved due to regaining of abductor strength with progressive physiotherapy.

Table No. 2 : Comparison of Harris Hip Score with other studies

Name of the Author	Harris Hip Score
Naja et al[6] (2018)	84.3 points
J. Li et al (2015)	86.19 points
Arrigio et al[11] (2012)	78 points
Radaideh et al[7] (2018)	79.3 points
Sharma et al[4] (2018)	94 points
Present study	90.5 points

In our study, the helical blade was positioned in center-center or inferior-center position. The first biomechanical study of the PFNA device suggested that the inferior position of the helical blade in the frontal plane and the center position in the sagittal plane is superior to the center-center position in both the planes and provides better biomechanical stability. Biomechanical studies have shown that the blade has a higher resistance to head collapse than the commonly used screw design.

Limitations

Our study has certain limitations, both patient and surgeon related fallacies may have existed. The follow up period was relatively short (6 months), however, most of cut-outs usually occur within 3 months. The sample population was from one medical college with a limited number of patients which may have not be represented the entire population. We did not compare our results with another implant to analyze the advantages of PFN with helical blade over the same sample population to limit as many confounders as possible. We did not analyze the different entry points of the implant which is one of the potential predictors of mechanical failure. Some observations like incidence of technical errors, implant failure, second surgery etc. which were not found to be statistically significant in our study, but are noted in many other studies is probably due to the smaller size of this study.

Conclusion

In the last few decades treatment of intertrochanteric fractures has evolved significantly. Various method of fixation devices have come and gone. The treatment still merits the type of fracture and quality of bone. DHS has been considered the gold standard of intertrochanteric fracture fixation for a long time, especially for the stable fracture types. The PFN was designed to overcome implant-related complications of DHS and facilitate the surgical treatment of unstable intertrochanteric fractures as it, being an intramedullary implant, imparts a lower bending moment, compensates for the function of medial column and acts as a buttress in preventing the medialization of the shaft. However, in stable IT fractures, whether all these characteristics aid in improving the outcome as compared to the DHS, is still a matter of debate. The proximal femoral nail with helical blade is a good implant for the operative management for intertrochanteric fractures, especially in the elderly osteoporotic individuals and fractures of the unstable variety. It offers good functional recovery in a relatively shorter period of time, if we follow the operative procedure with all the technical considerations.

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