Original Article

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Outcomes of Cephalomedullary Nailing in The Treatment of Extracapsular Proximal Femur Fractures and Factors Affecting it

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Abstract

Indroduction: Cephalomedullary nailing (CMN) has become popular in treatment of extracapsular proximal femur fractures due to its mechanical advantages. This study aims to analyse the functional outcomes of the same and factors affecting it.

Material and Methods: 140 prospective cases of extracapsular proximal femur fractures were treated with CMN between October 2016 and October 2017 with a minimum follow-up period of 12 months. Patients were clinically assessed with range of motion, weight bearing status, Harris hip score (HHS) and Short form (SF)-36 score. Radiologically, change in neck shaft angle (NSA) and neck length ratio were assessed in comparison to unaffected hip.

Results: 140 patients, 52 had excellent while 88 had good HHS. Patient in age group 20-40 had an average HHS of 87.79, 40-60 age group had an average HHS of 87.41, while patients in age group > 60 years had an average HHS of 87.63. Patients achieved average full weight bearing at 9.94 ± 2.76 weeks (p-value 0.578). Change in the neck shaft angle (NSA) was statistically significant in the immediate post-operative and at 1-year radiographs (p-value <0.001). Comparison of neck length ratio between affected and unaffected hip showed no statistical difference. There was no significant difference in function, range of motion and HHS in males (88.51 ± 2.72) compared with females (87.61 ± 2.98) (p-value 0.082). There was no significant association between occurrence of limp with change in NSA and neck length ratio (all p values >0.05). 6 complications occurred (1 peri-implant fracture, 2 surgical site infections and 3 cases of helical blade migration).

Conclusion: CMN gives excellent functional outcomes in all AO types A1, A2, A3 irrespective of age and sex with early mobilisation, full weight bearing and better functional range of movement. Limp occurred independant of change in NSA and neck length ratio.

Keywords: Extracapsular proximal femur fractures; Cephalomedullary nailing; Unstable intertrochanteric fractures; Reverse oblique fractures.

Introduction

Hip fractures are increasingly common resulting in significant morbidity and mortality [1]. Risk of proximal femur increases as the population age increases. It is reported that 1.26 million hip fractures occurred in adults in 1990 and this number is estimated to rise to 7.3–21.3 million by 2050 [2]. The goal of fracture treatment is restoration of patient condition to pre-injury status as early as possible. This has led to recommendation for internal fixation of these fractures to increase patient comfort, facilitate nursing care, decrease hospitalisation and reduce complications of prolonged bed rest [3]. Operative management is the treatment of choice in elderly as it helps in early mobilisation which is shown to be effective in reducing mortality [4,5,6]. Various authors have reported effectiveness of CMN in extracapsular proximal femur fractures with better clinical and functional outcomes. Few other authors reported excellent results with no cut out of screw even in unstable fractures with appropriate placement of screw in head and neck [7,8,9,10,11,12,13].

Patients especially with low bone quality, limited compliance and inability for partial weight bearing benefit from CMN stabilisation in extracapsular proximal femur fractures. More over CMNs inserted in minimally invasive manner is better tolerated due to minimal soft tissue dissection and thereby reducing surgical trauma, blood loss, and infection and wound complications which results in better functional outcome [14,15].

Currently available CMN is the popular treatment modality for intertrochanteric femur fracture in the recent years and has advantage of small incision, shorter operative time, lesser blood loss and transfusion requirement, less reaming, shorter hospital stay with no difference in outcome between short or long nail making them preferred fixation method [16,17].

As the current literature requires larger studies for more acceptance of evidence on the usefulness of CMN in these fractures, the present study

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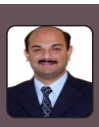
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attempts to validate the current knowledge relating to the subject and factors affecting it. The study was performed after obtaining approval from the Institutional Ethical Review Board and informed consent was taken from all patients.

Materials and methods

140 prospective patients above 18 years of age who underwent treatment with CMNs for extracapsular proximal femoral fractures between October 2016 and October 2017 were assessed for eligibility. The mean age at the time of surgery was 67.86 ± 17.09 years (range 19 - 100). Out Of the 140 patients, 79 (56.4%) were males and 61 (43.6%) were females. 122 (87.1%) patients had history of slip and fall while 18 (12.9%) patients had history of road traffic accident (RTA). Inclusion criteria consisted of all patients with age >18 years and patients with extracapsular proximal femur fracture. Patients with pathological fractures and age <18 years were excluded from the study. All patients underwent standard radiographic evaluation in the form of radiographs of pelvis with both hips in anteroposterior view and lateral view of the affected hip along with radiograph of ipsilateral full length femur with knee to rule out any associated femur shaft fracture. Neck-shaft angle (NSA) was measured and noted for both affected and unaffected side. Fractures were classified using the revised AO classification of proximal femur fractures as 31A1– Trochanteric region, simple pertrochanteric fracture; 31A2– Trochanteric region, multifragmentary pertrochanteric, lateral wall incompetent (<20.5 mm) and 31A3– Trochanteric region, intertrochanteric (reverse obliquity) fracture [18].

For all patients, spinal block was the anaesthesia of choice unless contraindicated. All cases were done in lateral position with the opposite lower limb flexed at hip and knee and affected limb resting in neutral position on the normal lower limb to facilitate easier fracture reduction and direct fluoroscopic visualisation. Fracture was reduced with manual traction and internal rotation. In cases with large posteromedial fragment with beak, a bone hook was used to reduce the beak onto the shaft and held throughout the procedure to maintain accurate posteromedial reduction. Lateral approach to the hip was taken.

Post operatively, in bed exercises for glutei, hamstrings and quadriceps were started as per pain tolerance. Active hip range of motion exercises were initiated till the discharge. Walker assisted weight bearing or non-weight bearing walking started on operated side on day one post-op.

Clinically, patients were assessed with range of motion and Harris hip score (HHS) at each follow-up. Radiologically, patients were assessed with fracture reduction, union status, change in NSA and neck-length ratio. Any helical blade back out, migration or implant failure during the course of treatment was noted. The effect of age, sex and type of fracture were primary variables used in this study to statistically measure the functional outcome. Short form (SF) 36 questionnaire was done at 1-year follow-up.

Results

All patients were followed up for a period of 12 months. Patients were classified according to AO classification as AO type A1: 16 patients (11.4%), A2: 103 patients (73.6%), A3: 21 patients (15%). We could achieve closed reduction internal fixation (CRIF) in 131 patients (93.6%), while 9 patients (6.4%) required open reduction internal fixation (ORIF). At 1-year follow-up, mean flexion was 116.57 ± 4.79 (range, 110-130^0), mean abduction was 38.78 ± 3.43 (range, 35-45^0), mean adduction was 28.66 ± 3 (range, 25-35^0), mean internal rotation was 33.34 ± 4.86 (range, 25-40^0) and mean external rotation was 38.58 ± 2.59 (range, 30-40^0). Range of motion of affected hip compared with normal hip by the end of 1-year by using unpaired t-test we found external and internal rotation are statistically significant but clinically insignificant (Table 1).

In our study, we compared HHS by 6-weeks, 3-months, 6-months and 1-year by using paired t-test. We noticed significant improvement in HHS assessed from 6-weeks to 1-year. HHS at 6 weeks was 58.42 ± 5 (range 52-79) which improved to 88.11 ± 2.86 (range 84-96) at 1-year (p-value <0.001). 52 patients (37.1%) had excellent HHS while 88 patients (62.9%) had good HHS. On comparing HHS between the fractures types using analysis of variance (ANOVA) test, we found it statistically significant but clinically insignificant (AO A1: mean HHS was 89.13 ± 3.07; A2: mean HHS was 87.70 ± 2.77; A3: mean HHS was 89.15 ± 2.76) (p-value = 0.038). Patient in age group 20-40 had an average HHS of 87.79, 40-60 age group had an average HHS of 87.41, while patients in age group > 60 years had an average HHS of 87.63. There was no significant difference between HHS and functional range of motion in males (88.51 ± 2.72) compared with females (87.61 ± 2.98) (p-value 0.082) using unpaired t-test.

We found significant difference in SF-36 scores between age group <60-years and >60-years as shown in Table 2. There was no significant difference in weight bearing status of patient between the AO subtypes. Mean full weight bearing was achieved in 9.60 weeks for A1 type, 10.08 weeks for A2 type and 9.41 weeks for A3 type with an average of 9.94 ± 2.76 weeks (p-value 0.578). Case examples of AO 31A2 & A3 are shown in Figures 1 & 2 respectively.

Radiologically, Change in the neck shaft angle (NSA) was statistically significant in the immediate post-operative and at 1-year radiographs (p-value <0.001). We tested the association between occurrence of limp with change in NSA and neck length ratio and found no significant association (p-value- 0.105 and 0.754, respectively)

Table 1: Range of motion between affected and unaffected hip

Range of Motion (1-year)	Range of Motion				P value
	Affected Side		Opposite side		
	Mean	SD	Mean	SD	
Flexion	116.57	4.79	116.93	5.74	0.584
Abduction	38.78	3.43	38.29	3.97	0.277
Adduction	28.66	3.11	28.71	3.02	0.888
ER	33.94	4.86	35.5	2.02	**< 0.001***
IR	38.58	2.59	41.01	3.71	**0.001***

P value is for unpaired t-test

Table 2: SF-36 in age group <60 and >60 years

SF-36 score	Age ≤60 year		Age > 60 year		P value
	Mean	SD	Mean	SD	
Physical functioning	82.1	8.1	71.2	8.4	**< 0.001***
Role limitation due to physical health	85	12.5	71.7	16.9	**< 0.001***
Role limitation due to emotional problem	92.1	11.4	84.8	14.4	**0.005***
Energy / fatigue	82.7	3.8	76.8	6.8	**< 0.001***
Emotional well being	87.3	3.9	82.5	6.2	**< 0.001***
Social functioning	87.5	11.1	72.2	13.2	**< 0.001***
Pain	79.8	5.3	76	5.3	**0.005***
General health	75.4	4.5	69.3	6	**< 0.001***

P value is for unpaired t-test

In our study, we came across 6 complications (4.29%). 1 patient developed peri-implant fracture which was treated successfully with long CMN, 2 cases developed surgical site infection which was treated with antibiotics, local debridement but ultimately required implant removal after successful fracture union and 3 cases of helical blade migration. In one case, helical blade backed out but fracture united with collapse, while in other 2 cases helical blade migrated towards acetabulum which mandated helical blade removal (Figure 3).

Discussion

Ideal implant for surgical fixation of extracapsular proximal femoral fractures remains debatable. Mechanically, intramedullary device inserted through a minimally invasive approach appears to be ideal in view of minimal blood loss, minimal soft tissue handling, reduced infection, etc. [19,20,21]. Puram et al reported satisfactory outcomes in 102 cases of AO type A2 unstable intertrochanteric fractures with dynamic hip screw (DHS) augmented with trochanteric wiring for posteromedial and greater trochanter comminution. They also found significant association between occurrence of limp with varus change in NSA, decrease in neck length ratio and greater trochanteric non-union [22]. However, we found no association between occurrence of limp with change in NSA and neck length ratio in our study. Kuzyk et al performed a systematic review of literature on types of fixation for subtrochanteric fractures and concluded that intramedullary fixation can be done in short operative time with more reliable fixation as compared to surface fixation [23]. Zeng et al reported improvement in the post-operative HHS in both DHS and PFNA groups with significantly higher rates of complications in the DHS group [24]. In our study, we noticed significant improvement in HHS with subsequent follow-ups giving excellent results in 52 patients and good results in 88 patients.

Few studies have studied the weight bearing status in unstable intertrochanteric fractures treated with CMN and suggest that CMN provides better stability and early weight bearing than surface fixation [25]. Carulli et al reported significantly earlier full weight bearing and earlier independent walking in patients with PFNA group as compared to DHS group [26]. In our study, we observed average full weight bearing at 9.9 weeks. Weight bearing status depends on fracture pattern, fracture reduction and union status of fracture. We found similar results as compared to other studies.

Krigbaum et al compared the use of short and long CMNs in similar fracture patterns and reported similar outcomes between the two types of nails with significantly higher costs and length of stay with long CMNs [16]. Galanopoulos et al reported significantly shorter operative time with short CMNs which can be of significant benefit in elderly patients with comorbidities. They also reported similar

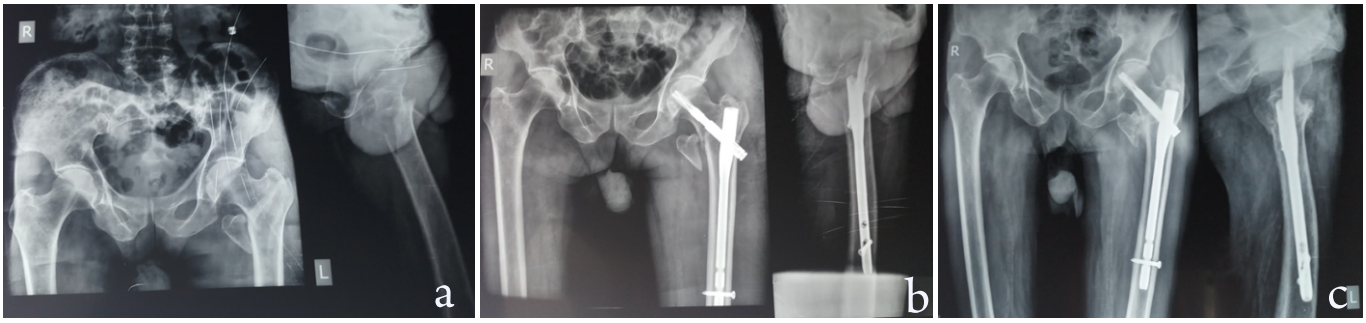

Figure 1: 1a: Radiograph of 80-years male with AO 31A2 fracture of left hip, 1b: He was treated with CRIF with Short CMN, 1c: Follow-up radiograph at 1 year showing complete union

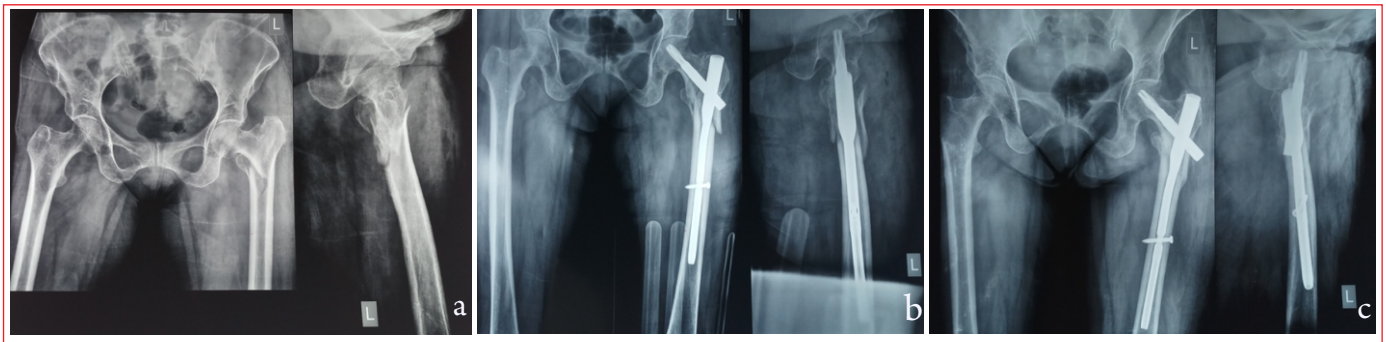

Figure 2: 2a: 75-years female with AO 31A3 fracture of left hip, 2b: She was treated with CRIF with Long CMN, 2c: Follow-up radiograph at 1 year showing complete union

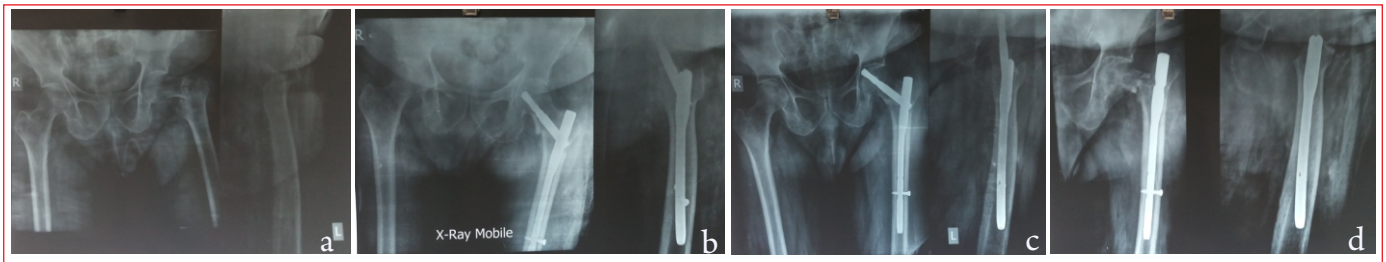

Figure 3: 3a: 77-years male with AO 31A2 of left hip, 3b: He was treated with CRIF with Short CMN, 3c: Follow-up radiograph at 2 months showing proximal migration of helical blade, 3d: Helical blade removal was done at this stage

outcomes and complications between short (1 peri-implant fracture) and long (1 Z-effect phenomenon) CMNs [27]. Kleweno et al found similar failure results between long and short CMNs with no superiority with the length of the nail [28]. Robinson et al in their study concluded that trochateric-entry long CMNs are useful in subtrochanteric fractures with favorable outcomes [29]. In our study, we preferred long CMN in AO 31A3 (reverse oblique) fractures. We had one case of peri-implant fracture distal to short nail which was treated with long CMN.

There are several studies in literature reporting complications that possibly develop postoperatively, such as non-union, delayed union, implant failure, proximal screw cut-out and Z-effect in intertrochanteric fractures treated with CMN [30,31]. The most common complications reported are cut-outs, followed by non-union, peri-impant fractures, avascular necrosis, heterotrophic ossification and sleeve pull out. Other complications reported are infections and complications related to helical blade migration [32,33,34]. Complications like screw cut-out, Z-effect, helical blade migration, peri-implant fractures are directly related to length and type of implant which can be avoided by using long nails with single helidal blade placed in center of the head and neck. In our study, we came across 6 complications. 1 patient developed peri-implant fracture distal to the short nail which was treated successfully with long CMN, 2 cases developed surgical site infection which was treated with antibiotics, local debridement but ultimately required implant removal after successful fracture union and 3 cases of helical blade migration. In one case, helical blade backed out but fracture united with collapse, while in other 2 cases helical blade migrated towards acetabulum which mandated helical blade removal.

Our study has few limitations. Although we were able to prospectively evaluate the functional outcomes in these patients but it is a non-randomised study. Secondly, the number of cases included in this study was small with a short follow-up of one year.

Conclusion

Cephalomedullary nailing gives excellent functional outcomes in all AO type A1, A2, A3 irrespective of age, sex with early mobilisation, full weight bearing and better functional range of movement. We preferred long nails in extracapsular proximal femur fractures with subtrochanteric extension and reverse oblique fractures (AO 31A3). Limp occurred independant of the change in NSA and neck length ratio.

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