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THE STUDY OF TREATMENT OF TROCHANTERIC FRACTURES WITH THE GAMMA3 NAIL AND WITH ITS PREDECESSOR

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ABSTRACT Gamma nail is a cephalomedullary implant that was developed for the treatment of pertrochanteric hip fractures and has been successfully used for over 20 years. During this period, modifications of design and instrumentation have occurred to combat the intra- and postoperative complications that were associated with the use of early designs. The purpose of this study was to compare the complications observed with the use of the Gamma3 nail (G3N) with those seen following use of the previous trochanteric gamma nail (TGN). This study prospectively recorded the intra- and postoperative complications of 22 patients treated with the Gamma3 nail and compared them with those of a historical cohort of 24 patients treated with the trochanteric gamma nail. We encountered less intra- and postoperative complications with the use of Gamma3 nail. Femoral fractures and lag screw cutout were significantly lower. The reoperation rate was significantly higher in the TGN group. Gamma3 nail has proved to be a safe and efficient implant for the treatment of pertrochanteric fractures. The improvement of the biomechanical characteristics has led to a significant decrease in complication rates, demonstrating superiority over its predecessor.

KEYWORDS : Trochantrics fractures gamma3 Nial,Trochantric gamma nail

1. Introduction

Fractures in the trochanteric region of the femur are very common in the elderly. The elderly population is increasing steadily making treatment of these fractures increasingly important in terms of medical, social, and economical issues.

Cephalomedullary nailing is theoretically the most stable and least invasive method of fixation. Biomechanical examinations had shown that intramedullary devices might be superior to plating systems, especially in unstable extracapsular fractures of the proximal femur [1]. The standard gamma nail (SGN) was the first intramedullary device introduced to provide a sliding cervical lag screw that would allow controlled fracture impaction and intramedullary fixation in the femoral shaft. It has also proven to be effective in the minimization of surgical trauma, blood loss, bone devascularisation, and wound complications [2]. But, clinically, the SGN was associated with a high rate of intra- and postoperative complications—in particular femoral fracture- and reoperation [2–4]. For that reason, modifications of design and instrumentation have occurred, resulting in the most recent version, the Gamma3 nail (G3N) .

The purpose of this study was to compare the complications of the treatment of trochanteric fractures with the G3N and the second version of gamma nail, the trochanteric gamma nail (TGN).

2. Method

The prospective study group consisted of patients that had been treated for trochanteric fractures with the G3N in the period between 2009 and 2012. The historical cohort consisted of patients that had been treated with the TGN between 2004 and 2009.

All operations were performed with the use of Gama nails. The method of treatment was similar to both groups. Patients were positioned supine in traction table and closed reduction of fracture obtained under fluoroscopic control. All intramedullary canals were reamed up to 12 mm distally for both nails and proximally up to 13.5 mm and to 15 mm for G3N and TGN, respectively. Lag screw was inserted in a 130° angle, optimally in apposition inferiorly to the neck in the AP plane and centrally in the lateral plane. All short nails were locked distally with one locking screw using the targeting device and all long nails were locked with two distal screws with a free hand technique. All patients mobilized fully weight bearing as tolerated.

The following variables were collected: patients' age and gender, mechanism of injury, fracture type, waiting time to surgery, operation time, fluoroscopy time, duration of hospital stay, intra- and postoperative complications, and mortality rate. Patients were followed up at 6 weeks, 3 months, and 1 year with clinical and radiological assessment. Statistical analyses .

3. Results

Between 2009 and 2012, 22 patients were admitted with an intertrochanteric and subtrochanteric fracture, treated surgically with a G3N (group A). We used 18 short (SG3N) and 4 long (LG3N) G3N. The historical cohort group (group B) consisted of 24 TGN—19 short (STGN) and 5 long (LTGN).

Preoperative patient data :- The average age was 75 years (range 30–90 years) for group A and 80 years (range 50–90 years) for group B. The sex ratio between females and males was 2.5 : 1 and 3:1 for the two groups, respectively. Fractures were classified according to AO classification and the results for the two groups are shown in Table 1. Mechanism of injury was a simple fall in majority of cases (85% and 88%, resp.). Road traffic accident was responsible for 5% and 7% of fractures and a fall from height for 10% and 5% of fractures for the two groups, respectively.

Table 1: Preoperative patient data.

Data	Group A	Group B
Number of patients	22	24
Age	75(30-90)	80(50-90)
Gender		
(F/M ratio_	2.5:1	3:1
Classification		
31 A1	6	6
31 A2	7	8
31 A3	3	3
31 B2	3	3
32 A	2	2
32 B	1	2
Mechanism of injury	85%	88%
Simple fall	5%	7%
RTA	10%	5%
Fall from height		

Average waiting time to surgery was 2 to 3 days depending on the comorbidities for group A and 3 to 4 days for group B. Average surgical time (skin to skin) was 45 mins to 60 mins and 60 mins to 90mins respectively. Fluoroscopy time was 60 sec for group A and 90 sec for group B.

The differences between the two groups in the waiting time to surgery and the surgical time were not statistically significant. Fluoroscopy time in group A was statistically significantly reduced compared with group B.

Intraoperative complications:- 2 complications in group A and 4 in group B were reported. The difference between the total number of intraoperative complications in the two groups was considered to be statistically significant .

Table2: Intraoperative complications

Complications	Group A	Group B
Femoral fracture	-	3
Reduction difficulties	-	
Open reduction	1	2
Perforation of acetabulum	1	-

The major complications encountered with the use of TGN were 3 intraoperative fractures of femur. In 1 case, the fracture was an undisplaced crack of the lateral cortex of the femoral shaft just distally to the tip of nail; this was treated conservatively with nonweight bearing mobilization until callus formation was seen radiographically. One case of shaft fracture was treated with internal fixation with plate and 1 case of greater trochanter fracture were treated with partial weight bearing mobilization for 6 weeks. There was significant difference between the two groups no femoral fractures were encountered in the G3N group.

Open reduction was performed in 3 cases (1 in group A and 2 in group B). In 2 cases (1 in group A and 1 in group B) the fracture reduction was lost intraoperatively but no further action was taken due to critical medical problems of the patients. Perforation of acetabulum by the lag screw occurred in one case of G3N; the lag screw was revised with a shorter one.

Postoperative complications :- We encountered in total 2 postoperative complications in group A (9.09%) and 4 in group B (16.66 %). There was significant difference between the two groups . The differences between the two groups for postoperative femoral fractures nail breakage , distal screw breakage , loss of reduction , and nonunion were not significant. The difference in lag screw cutout complication was statistically significant .

Table3: Postoperative complications :-

Complications	Group A	Group B
Femoral fracture	-	3
Nail breakage	-	1
Lag screw cutout	2	4
Distal screw breakage	2	2
Loss of reduction	1	2
Nouunion	1	3
Total	6	15

Femoral fracture occurred postoperatively in 3 patients of group B, following a fall. Two of those sustained a fracture just distal to the tip of the nail (one patient was treated conservatively and one patient was treated with an open reduction and internal fixation) and one patient sustained a neck of femur fracture which treated with a hemiarthrop lasty after removal of nail.

In two cases, a TGN failed at the junction of nail with the lag screw, 4 and 6 months postoperatively, due to delayed union. The nails were revised to DCS and the fractures healed uneventfully 4 months after revision operation (Figure 1).

Figure 1: AP radiograph of a complex intersubtrochanteric fracture of femur, showing a broken long TGN at the junction of the nail with the lag screw (a). The nail was revised to DCS plate and the fracture healed at 4 months postoperatively (b).

The most frequent complication in both groups was the cutout of the lag screw (2 and 4 cases, resp.) which resulted in reoperation in 2 cases of group A (1 total hip replacements and 1 hemiarthroplasties) and in 4 cases of group B (1 total hip replacements, 2 hemiarthroplasties, and1 DCS).

Figure 2: AP radiograph of an 81 yr patient with a 3-part intertrochanteric femoral fracture (a) treated with a short G3N (b). Cutout of the lag screw at 2 months postoperatively (c) treated with a THR (d).

In group A, loss of reduction occurred in 1 case (treated with DCS) and nonunion in 1 case of subtrochanteric fracture which were treated by revision to a long gamma nail with bone grafting. In group B, nonunion rate was higher (3 cases) and all were treated with revision nailing and bone grafting. Loss of reduction occurred in 2 cases; one case was revised with a DHS and 1 case with a long gamma nail.

The overall reoperation rate was 5.71% (10 cases) for group A and 11.45% (22 cases) for group B, The difference of reoperation rates between the two groups was significant .

4. Discussion

The Gamma nail was introduced in the year 1988 for the treatment of intertrochantric fractures and later in the year 1992 the long Gamma nail was introduced .The Gamma nail shown advantages over extramedullary procedures (6) .Despite these advantages Gamma nail has certain complications like implant failure and femoral fractures .

Trochantric Gamma nail was introduced in 1997.Modificataions including reduced length from 200mm to 180 mm this standard proximal diameter of 17 mm and the distal diameter of of 11 mm and reduced medio lateral curvature from 10 Degrees to 4 degrees(10) were the reasons to decrease the rates of complications (11,12). Last modification of gamma nail is G3 nail which was introduced in the year 2003 its narrow year proximally of 15.5 mms and the mediolateral curvature of 4 degrees but whith its apex positioned more distally .The distal locking screws are 5mm .The shape of long screws has been improved . Long G3 nail has got same character stics has the sahrt G3 nail and has an antecurvature of radius of 2.0mm of the femoral shaft which is more anatomical .

The design of Gamma 3 nail seems superior to previous generations , giving promising out come and reduced mechanical complication rates .The shape of the Gamma nail is thought to cause 3- point loading across the trochanter and diaphyseal cortices.Therefore stress is concentrated mainly along the medical cortex in contact with nail curvature and on the nail tip incontact with the lateral cortex ,Thus exposing the femur to intra operative and post operative fractures , even underhysialogical load(13).

Results from other studies show high numbers of femoral shaft fractures, up to 17% for SGN [4, 9, 14] and up to 4.5% for TGN [5, 11, 12,15–17].

No fracture of femur occurred in the G3N group of patients, which is similar to the results of other studies on G3N which is less than 1% [18, 19]. We attribute the low rate of the femoral shaft fractures to improvement of mechanical characteristics of the new design, namely, the decreased proximal diameter which requires less reaming and the distally positioned apex of the mediolateral curvature of the nail which reduces the three-point loading at the femoral shaft [10].

Breakage of gamma nail occurred at the junction of the nail with the lag screw and was reported in the literature in an incidence of up to 5.7% [7, 8, 13, 20]. In our study, none of the G3N failed, in contrast with 2 TGN broken nails (1.1%). It is known that the weak point of this implant was around the insertion hole for the lag screw where the cross-sectional area was reduced by approximately 73%. This is a critical zone where forces coming from the femoral neck are transmitted to the diaphyseal nail [7]. We believed that the decreased incidence of failure of the nail was attributed to the reduction of the lag screw diameter from 12 mm to 10.5 mm. Therefore, the aperture is smaller and thus the nail would be thicker in this area and less prone to

failure. Delayed union/nonunion at the fracture site was the trigger factor for both the implant failures. The cause of breakage was metal fatigue due to dynamic stress [8, 21].

The most frequently occurring complication was the cutout of the lag screw through the femoral head (2.28% versus 6.77%). Our results were similar to the results of other studies showing an incidence rate of up to 9.72% [5, 10, 12, 17, 22] for the TGN and up to 4% for G3N [18]. Lag screw cutout has been shown to be dependent on the position of the screw within the femoral head. Optimizing tip-apex distance is critical in preventing fixation failure when using an extramedullary sliding hip screw to fix pertrochanteric fractures [23]. A recent study suggests that placement of the lag screw of the gamma nail inferiorly in the AP plane and centrally in the lateral plane maximizes biomechanical stiffness and load-to-failure of the fixation [24]. The position of the lag screw was considered optimal (inferiorly in AP/centrally in lateral plane) in 1 out of the 2 failed cases in group A and in 3 out of the 7 failed cases in group B. In the remainder of the failed cases, the position was considered suboptimal (centrally in AP/centrally or anteriorly in lateral plane). Therefore, we attributed the lower rate of cutout complication to the improvement of lag screw design, especially in the area of the thread and the cutting flutes at the tip of the screw. This design offers superior cutting behavior during lag screw insertion, providing very low insertion torque. The thread design also offers excellent grip in the cancellous bone of the femoral head and strong resistance against cutout.

The rate of reoperation after complications with the G3N was 5.11%, which was similar to the 5.56% rate reported in another study [25]. The rate of implant-related complications that required reoperation after primary use of the TGN was 11.45%. It is also in accordance with previously reported results ranging from 8% to 16.6% [16, 17, 22, 26].

5. Conclusion

Within the limits of this study, Gamma3 nail has proved to be a safe and efficient implant for the treatment of pertrochanteric fractures. The improvement of its biomechanical characteristics has led to a significant decrease in observed complication rates, demonstrating superiority over its predecessor.

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