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The Failure Incidence of Trochanteric Fracture Fixation Using Gamma Nail or PFNA®

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Abstract

Aim: The importance of trochanteric fractures treatment consists in a relatively high frequency, especially in elderly patients. There is no "gold standard" implant for treating this type of fracture and various complications might occur in any particular case. The aim of this study was to evaluate the rates of implant related complications in patients treated for trochanteric fractures using two types of implants (Gamma 3® and PFNA®). The secondary objective was to assess the possible correlation between complication rates and technical parameters of insertion.

Methods: Patients who met inclusion criteria were selected retrospectively between September 2018 and December 2020.

Results: Ninety-five percent of patients were treated using a Gamma 3® nail while only 5% of them were treated using a PFNA® implant. Following AO classification, 60% of the patients presented an A1.3 fracture type and 29% presented an A1.2 fracture type. The global complication rate was 12.33% while specific incidence for each category of complications assessed in this group was as follows: 7.67% lateral protrusion of the lag screw, 3.67% cut-out, 0.67% impossibility of distal locking and 0.33% migration of distal locking screw. A significant difference p=0.018 was found between postoperative neck-shaft angles of the two groups of patients treated with the two types of implants.

Conclusion: Use of Gamma 3® nails in trochanteric fractures obtains a degree of reduction closer to the physiological neck-shaft angle compared to the PFNA® implant. The most frequent complication type in our group was lateral protrusion of the lag screw followed by cut-out.

Keywords: Trochanteric fractures; Gamma 3® and PFNA®; Lateral protrusion

Introduction

The increase of life expectancy in the last years is associated with bone structure modifications and other related complications such as fractures [1]. Trochanteric fractures represent 50% of total hip fractures and one of the most common fracture types in elderly patients [2], with a tendency to increase proportionally with the global number of elderly patients. It is estimated that hip fractures will rise to a total of 2.6 million by 2025 and up to 6.25 million by 2050. Demographic data suggests that, the majority of trauma patients presenting a trochanteric fracture are females, and the most common mechanism is through a fall at the same level, usually within households [3].

The major treatment in this type of proximal femoral fractures is by surgical means, using an intramedullary implant such: as Gamma 3® nail by Stryker, Proximal Femoral Nail/ Proximal Femoral Nail Antirotation (PFN®/PFNA®), Gliding nail or an extramedullary fixation - Dynamic hip screw, Medoff sliding plate, dynamic compression screw, trochanteric stabilization plate or blade plate (13^{O} or 95^{O}). Before choosing one of these implants, it is mandatory to evaluate the stability of the fracture and find its equivalent in the standard classifications such as AO/OTA, Boyd and Griffin or Evans. The stability of the trochanteric fractures is appreciated by assessing the integrity of the postero-medial column and of the lesser trochanter, respectively, on both face and profile radiographies [4,5]. The "gold standard" implant for treating the unstable fractures has not yet been established and also generates contrivances but in this type of trochanteric fractures, the use of an intramedullary nailing is more likely.

The treatment of trochanteric fracture using Gamma 3® nail offers the patient a less stressful surgery, low complications rate and reduced postoperative morbidity [6]. Various complications have been reported following the use of this type of implant in some patients. The primary aim of the study was to evaluate the rate of implant related complications in patients treated for trochanteric fracture using Gamma 3® and PFNA® implants and the secondary aim was to study the possible link between these complications and technical procedure aspects such as the position of the colum screw or the distance between the apex of the lag screw and the articular surface noted as Tip-Apex Distance (TAD).

Materials and Methods

The present study is a retrospective, observational analysis of 300 patients treated in our department using an intramedullary implant Gamma nail or PFNA®. From September 2018 until December 2020,

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665 patients were treated in our service for trochanteric fractures. Inclusion criteria for the current study were trochanteric fracture, use of a Gamma 3® or PFNA® implant for the procedure, presence of preoperative and postoperative radiographies in the hospital database and a minimum follow-up of 3 months. The exclusion criteria were as follows: absence of pre/postoperative radiography, subtrochanteric fractures with extension to the femoral shaft requiring a long nail for treatment and other types of implants used for osteosynthesis. Out of a total of 665 patients, 300 subjects qualified for the current study and the informed consent was obtained.

For all patients standard anteroposterior (AP) view radiographs were performed at the moment of the admission and postoperatively. We diagnosed the fracture type and chose the method of fixation according to AO classification.

All patients were operated under spinal anaesthesia, using a traction table specially designed for trauma patients. The external reduction was performed under fluoroscopic control before surgery. The traction was applied for keeping the leg straight with extended hip leaning out of the bed and for a better reduction of the fracture a 10o internal rotation was applied. Preoperatively, the reduction obtained by using external manoeuvres was visualized using fluoroscopy in two dimensions (anteroposterior and axial view). The skin incision was made 2 cm proximal from the greater trochanter to the iliac crest. The entry point was at the top of the greater trochanter and the guide wire was inserted under fluoroscopic control. The crucial point is represented by the entry point that in our patients was established using fluoroscopic control, at the tip of the grater trochanter at the intersection of anterior 1/3 with the posterior 2/3 [4,7,8]. The femoral shaft was reamed using flexible reamers with a diameter 1-1, 5 greater than the diameter of the nail in order to avoid complications related to implant insertion, such as intraoperative fractures or losing of the initial reduction.

Postoperatively, for those patients without any intraoperative complication, walking with progressive weight barring on the operated limb aided by a walking frame or crutches starting from the next day after surgery was authorized. The patients were evaluated clinically and radiologically at 6 weeks, 3 months and 6 months after surgery.

The analyzed parameters were patient age, sex, fracture type according to AO classification, implant type, pre-reduction neck-shaft angle - measured on the preoperative face radiography, postoperative neck-shaft angle on the face radiography, lateral protrusion of the lag screw according to the method used by Gordon et al. [9], TAD and patient history of diabetes mellitus, cardiopathy or neuropathy.

The implant related complications were categorized as lateral protrusion of the lag screw, cut-out, the impossibility of distal locking of the nail, the migration of the static screw and iatrogenic fractures.

Statistical analysis was done using IBM SPSS Statistics® 27. Normal distribution of variables was proofed using the Kolmogorov-Smirnov test. Variables were described in the form of either mean and standard deviation for normal distribution or median and interquartile range (IQR) for non-normal distribution. Frequencies were compared using the Pearson χ^2 test. Comparison of quantitative variables was done using Student's t-test (normal distribution) or Mann-Whitney U test (non-normal distribution), respectively, α=0.05.

Results

Between December 2020 and September 2018, 665 patients with trochanteric fracture were admitted in our service and surgically treated using an intramedullary implant. Our cohort consisted of 300 patients who have met the inclusion criteria, treated with either PFNA® or Gamma nail.

Our group consists of 218 women and 82 men. The sex ratio between males and females was 0.37:1, the median age was 81 years (IQR - 12), the minimum age was 38 years and the maximum age was 97 years. In the women's group the median age was 82 years (IQR - 10) and in the men's group the median age was 78 years (IQR - 14). The fracture type was established according to AO classification and the results are shown in Table 1.

The implants used for treating trochanteric fractures were Gamma nail in 285 patients (95%) and PFNA® in 15 patients (5%). The angle of insertion of the lag screw was 125o in 291 patients (97%), 130o in 8 patients (2.66%) and 135o in one patient (0.33%).

The median neck-shaft angle obtained after closed reduction and internal fixation was greater in the PFNA® group (133.11°) compared to the Gamma nail group (130.17°), p=0.0187.

Figure 1: Lag screw cut-out secondary to malpositioning of the cervical screw in superior third of the neck.

Figure 2: Lateral protrusion of the lag screw.

Table 1: Fractures type according to AO classification.

Fracture type according to AO classification	Number of fractures (n=300)	Percent of fractures type
A1.2	85	28.33%
A1.3	60	20.00%
A2.2	42	14.00%
A2.3	86	28.67%
A3.1	10	3.33%
A3.2	3	1.00%
A3.3	14	4.67%

Table 2: The major complications after internal fixation of trochanteric fractures.

Complications	Number of complications	Relative frequency
Lateral protrusion of lag screw	23	7.67%
Cut-out	11	3.67%
Distal locking failure	2	0.67%
Static screw migration	1	0.33%

We encountered a total of 37 postoperative complications. The global incidence of the internal fixation failure in our group was 12.33%. The major complications after internal fixation of the trochanteric fractures were lateral protrusion of the lag screw (7.67%), cut-out (3.67%), the failure of distal locking (0.67%), and the static screw migration (0.33%) (Table 2).

The median age of the patients presenting cut-out was 79 years (IQR - 17) and in those presenting lateral protrusion of the lag screw 82 years (IQR - 13). The types of complications encountered in each AO classification fracture are shown in Table 3.

The correlation between the lag screw localisation on the face radiography respectively in the superior third of the femoral neck, intermediary third or inferior third and the frequency of cut-out was studied using $\chi 2$ test with Yates correction. There was no difference in cut-out frequencies when comparing intermediary and inferior third lag screw placement. For the superior third implants, we observed 4 cases of cut-out and 4 cases without complications.

There was no association between implant related complications and other comorbidities such as diabetes (p=0.58), cardiopathy (p=0.651) or neuropathy (p=0.173).

The TAD median in patients without complications was 0.93 mm (IQR - 0.36) and in patients presenting cut-out the median value of TAD was 9.3mm (IQR - 1.3). There was no difference in TAD when comparing these specific subgroups (p=0.589).

Implant related complications rates were the same in both groups p=0.540 for cut-out and p=0.896 for lateral protrusion of the lag screw, without a tendency to these complications of implants.

Discussion

Trochanteric fractures are 1.5-4.6 times more likely to appear in elderly women than in men of the same age group. In the study of Mattison et al. between 2014 and 2016, 69% of trochanteric fractures in Sweden occurred in female patients with an average age of 84 years, caused by a fall at the same level in their households [3,10]. An important role in occurrence of various fracture types is played by the bone architecture and the osteoporosis degrees. Changes in proximal femur trabecula, the Ward triangle region and increasing degrees of osteoporosis leading to medio-cervical fractures are present at 45-60 years of age. Patients over 60 years present changes in the ogival system trabecula leading to an increased frequency of trochanteric fractures [11,12]. Our findings were consistent with the demographic data described in the literature; in our group of patients, trochanteric fractures occurred more often in women, with a median age of 82 years.

The indications for Gamma nail presented by Kempf et al. are as follow cervical-trochanteric fractures, fractures in coxa vara hips, pathological fractures, fractures in young patients and treatment of nonunion [13].

In order to avoid intraoperative complications, the patient was installed on the traction table in a manner that permitted a correct fluoroscopic control. The median of the neck-shaft angle obtained after closed reduction and internal fixation using Gamma nail was 130.17o and 133.11o in PFNA® group, with a statistical significant difference p=0.0187. The insertion of the lag screw was done in 97% of cases under 125° and the neck-shaft angle obtained was closer to 130° in patients treated with Gamma nail. The intraoperative complications described in the literature were femoral fracture, brackage of drill, reduction difficulties leading to an open reduction or the perforation of the acetabulum. Postoperative complications were represented by femoral fracture, nail brakeage, lag screw cut-out, distal screw brakeage, loss of reduction and non-union [14]. The femoral shaft fractures are more often associated with Gamma nail than other implant types. These are appreciated to occur in 3.2% of cases, mostly, due to its design that sometimes lacks correspondence to the geometry of the bone and its unadvised insertion using a hammer [15,16]. The insertion of the nail should be done after the reaming of the canal using a 1-1.5 mm higher reamer. It is important to mention that in our patients fractures of the femoral shaft attributed to the insertion of the implant did not occurred.

The ideal position of the lag screw in order to obtain a good stability of the implant and an efficient osteosynthesis in the lower

Table 3: Type of complication in trochanteric AO fracture types.

Complication type	Fracture type according to AO classification							
	A1.1	A1.2	A1.3	A2.2	A2.3	A3.1	A3.2	A3.3
Lateral protrusion of lag screw (n)	0	4	5	4	6	2	0	2
Cut-out (n)	0	5	1	1	3	0	0	1
Distal locking failure (n)	0	1	0	0	1	0	0	0
Static screw migration (n)	0	0	0	1	0	0	0	0

n: number.

half of the femoral neck tangent to the medial cortex on the AP view and on the midline on the axial view [7]. The cause of the implant failure in most cases is represented by the incorrect position of the lag screw. Cut-out (Figure 1) is one of the most frequent types of implant failure followed by the lateral protrusion (Figure 2). In our group, there were no significant differences in complication rates between implants. However, in other studies the incidence of cut-out and lateral protrusion of the lag screw in Gamma nail were more frequent compared with the frequency of the same complications in PFNA® [16]. The cut-out rate in our study group is 3.67% and a global complications rate of 12.33% comparable with other studies which describe a 1.1% rate of cut-out and 9.9% rate of major complications [17]. In our group of patients, complications like non-union, or nail breakage did not occurre.

PFNA® could represent an alternative for Gamma nail in treating unstable trochanteric fractures because of short operative time and limited blood loss. It is a stable implant that allows for a quick mobilization after surgery, especially in elderly patients, with good radiological and functional outcomes [18].

In order to enhance bone consolidation and obtain faster healing some techniques and materials can be used in treatment of proximal femoral fractures. High Frequency Pulsed Electromagnetic Fields (HF-PEMF) play an important role in bone healing, especially in the early phase. Thus, they should be applied from the first postoperative day [19]. Also in order to control osteoblasts function with the purpose to modulate bone regeneration through biological molecules or minerals various implants could be designed in such a manner that would allow for a personalized therapy [20,21]. This subject leads to a vast field of research that could represent the objective of future studies.

The limitations of the current study are represented by its retrospective and observational design and the heterogeneity between the two groups. For stronger statistical results, a prospective and experimental study on larger cohorts is required.

Conclusion

The major complications observed in our cohort after trochanteric fracture fixation using Gamma 3® nail or PFNA® were cut-out and lateral protrusion of the lag screw. The insertion of intramedullary implants affects the longevity and the stability of the fixation and has a key role in determining complication rates.

Declaration

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent was obtained from all individual participants included in the study.

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