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Reamed versus unreamed proximal femoral nailing for intertrochanteric fractures in geriatric patients. A retrospective case control study

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Cephalomedullary nail is the gold standard treatment for intertrochanteric fracture in geriatric population. The aim of the study was to investigate the differences of the reamed versus the unreamed short proximal femoral nailing (PFN), in terms of the duration of surgery and the outcome. The impact of patients and fracture characteristics to the outcome was also evaluated. A retrospective analysis of 158 elderly patients, who sustained intertrochanteric fracture of the femur, with a minimum follow up of one year, was performed. 78 patients underwent a reamed proximal femoral nailing (PFN) whereas 80 patients underwent an unreamed PFN. The duration of surgery, the outcome and the complications between the reamed and the unreamed nailing were compared. A logistic regression was also conducted to estimate the risk factors affecting mortality. The mean duration of surgery for reamed and unreamed G nail was 48,87 min (C.I.: 47,30-50,44) and 42,45 min (C.I.: 41,30-43,60) respectively. No statistically significant difference regarding the need for transfusion and complications, such as wound healing problems and screw cut out was identified between the two types of nailing. The most important factors affecting mortality were the ASA (beta coefficient: 3,127, p-value: 0,002) and the need for transfusion (beta coefficient: 1,367, p-value: 0,05). The only difference found between the reamed and the unreamed PFN was the operation time, which was less for the later one. Both types of fixation were similar in terms of outcome and complications.

Keywords: Intertrochanteric fractures, geriatric hip fractures, reamed proximal femoral nailing, unreamed proximal femoral nailing.

INTRODUCTION

Hip fractures are considered to be a worldwide epidemic due to the increased life expectancy of the world population. The increasing number of hip fractures represents a significant problem in national healthcare systems worldwide[1]. Burge et al (2007) appreciated that the cumulative annual cost for the treatment of hip fractures is 6 billion dollars in the United States[2].

The majority of hip fractures occur in the elderly as a result of a single fall. Osteoporosis, poor balance, medication side effects, and inconvenience towards maneuvering around environmental dangers are the main factors predisposing to a hip fracture[3]. The lifetime risk for sustaining a hip fracture is approximately 6% in men and 18% in women. Geriatric hip fracture patients have an increased incidence of mortality (37,1% in men and 26,4% in women) as compared to the general population[4]. The incidence of mortality has been estimated 19% in the first month post injury and it increases up to 20-30% in the first post-fracture year[5,6].

Intertrochanteric hip fractures consist of about the half of all types of hip fractures and 50% to 60% of them are unstable[7]. The primary goal of the treatment is to provide rapid mobilization of the patient in order to decrease the rate of complications. Conservative treatment, which was used in the past, has been largely abandoned today due to the high rate of morbidity and mortality as a result of prolonged prostratation[8].

Cephalomedullary nail is nowadays a widely accepted fixation technique for intertrochanteric fractures worldwide. It provides biomechanical stability and satisfactory clinical and functional outcomes[8,9]. Reamed nails have the main advantage of higher biomechanical stability, rapid fracture consolidation, and lower rate of complication[10,11]. The opponents of the reaming technique claim that it decreases bone blood flow, it increases the risk of bone necrosis, the

operative time, the blood loss and finally the risk of embolism[12,13].

The aim of this study is to compare the reamed versus the unreamed short intramedullary nail in terms of operation time, blood loss, and postoperative complications. Additionally, the most important factors influencing mortality were investigated.

MATERIAL & METHODS

The study was performed in the Orthopaedic department of the General Hospital of Heraklion "Venizeleio-Pananeio" from January 2018 to December 2021. We retrospectively reviewed 158 elderly patients with femoral intertrochanteric fractures, who were treated using a short cefallomedullary nail. An informed consent was given to each patient prior to the operation. Due to the retrospective character of the study, an approval by the Institutional Ethical Committee was given in January 2022, when the gathering of data was initiated. The patients fulfilled the following criteria: I. age > 70 years, II. Low energy injury (fall from own height). III. Internal fixation with a short cephalomedullary implant. IV. Intertrochanteric fracture classified by OTA/AO types 31-A1, 31-A2, 31-A3[28]. Subsequently, patients less than 70 years old, who sustained high energy injuries, pathological fractures as well as multiple fractures or they underwent fixation techniques other than short proximal femoral nail (PFN), such as DHS, were excluded from the study.

78 patients were treated with a reamed PFN (Gamma 3 Trochanteric short nail, Stryker, length of 180mm) and 80 patients treated with an unreamed PFN (EVO-NAIL, Gruppo Bioimpianti Italy, length of 195mm). The choice of implant used for fixation was random. The minimum follow-up was one year (range: 12-26 months). None of the patients was lost during the follow up time, apart from 12 patients who died. Patients were assessed at 4 and 12 weeks and at 6 and 12 months post operation. The mean age of the patients in the reamed and the unreamed group was 83,88 years old (range: 74-91) and 84,06 years old (range: 73-94) respectively. Average body mass index (BMI) was 25,4 and 25.7 for the reamed and unreamed groups respectively. Eighteen patients (11,4%) were classified as American Society of Anesthesiologists score (ASA) I, 66 patients (41,8%) as ASA II, 64 patients (40,5%) as ASA III and 10 patients (6,3%) as ASA IV. 29 patients (18,4%) sustained a type A1 fracture, 95 patients (60,1%) a type A2 fracture and 34 patients (21,5%) a type A3 fracture according to the AO peritrochanteric hip fracture classification[28]. Type of fracture and ASA were similar between the unreamed and the reamed group of patients with a Pearson's chi square test 0,895 and 0,705 respectively.

A standard preoperative evaluation was implemented on admission (blood tests, cardiologic evaluation, OTA/AO classification of fracture type). The patients were finally classified according to the ASA system. A pre or postoperative Hemoglobin of less than 8 g/dl was an indication for transfusion. The time period from injury to surgery ranged from 0 to 6 days, depending on patients co-morbidities and it was similar between the two groups. All patients received 1gr of intravenous cephalosporin (cefuroxime or ceforanide), one hour before surgical incision until their discharge. Low molecular weight heparin was given for deep vein thrombosis prevention, as per lower limb fracture care protocol.

Operative technique

Under anesthesia, which was mainly epidural, the patients were placed in supine position on a fracture operative table and a closed reduction was performed under fluoroscopy. The surgical technique for each type of nail was followed according to the instructions of each company. In the group of the unreamed intramedullary nail, the canal diameter of the entire femur was estimated preoperatively, in order to select the most appropriate nail for each patient. In the majority of the women a nail of 10 mm diameter was applied, whereas in the majority of the men a nail of 11mm was used. The nail was inserted using just an opening reamer, with no further reaming of the canal. In the group of the reamed group the reamer started from 11mm and was raised up to 15,5 mm. 95% of the nails used in both groups were 125˚. Nails of 130˚ were used in the rest of the cases. A static distal screw was used in all patients. The proximal screw was placed in the center of the femoral head and it is static by definition. On the first post operative day all patients started the rehabilitation protocol, which included weight bearing as tolerated. Patients were discharged 5 to 7 days post surgery.

Statistical analysis

The duration of surgery, the need for transfusion and the complications between the reamed and the unreamed type of nailing were investigated. The difference of the duration of surgery was estimated using the t test for independent samples. The Fischer exact test was used to evaluate the difference of the complications among

the two types of fixations. The difference regarding the heterotopic ossification (HO) rate and the transfusion rate were investigated separately, using the Fischer's exact test and the Pearson's chi square test respectively.

In addition, the correlation of the screw cut out to the type of fracture was investigated using the Pearson's chi square test. The significance of the fracture type to the duration of surgery was studied as well. The impact of risk factors, such as the type of fracture, the ASA, the patient's age, the time period from injury to surgery, the need for transfusion and the complications occurrence, to the mortality rate was evaluated using the binary logistic regression model. The IBM SPSS statistics 25 program was used to perform the statistical analysis.

RESULTS

The mean duration of surgery for the reamed and the unreamed G nail was 48,87 min (C.I.: 47,30-50,44) and 42,45 min (C.I.: 41,30-43,60) respectively. The mean difference was 6,42 min (C.I.: 4,50-8,35), and it was statistically significant (p-value: 0,015), (table I). Eight patients (5,1%) developed a post operative wound hematoma, eight patients (5,1%), developed a screw cut out and seven patients (4,4%) developed heterotopic ossification (table II). No statistically significant difference of these complications was found among the reamed and the unreamed group of patients (p-value: 0,206). Oral antibiotic treatment was administrated to the eight patients who developed wound hematoma. Surgical drainage was necessary in three of these patients. Six out of the eight patients who developed screw cut out were revised to a hip hemiarthroplasty. Removal of implants was performed in the other two patients. Heterotopic ossification (HO) was identified in six patients of the reamed group and only in one patient of the unreamed group. The Fischer exact test revealed that this difference was very close to statistical significance (p-value: 0,062), (table III). No difference in terms of transfusion was found between the two groups (p-value: 0,950), (table IV).

The probability of screw cut out in relation to the type of fracture was not statistically significant (p-value: 0,313), (table V). A statistically significant increase regarding the duration of surgery was found for A3 fractures (mean: 52,15 min, C.I.: 49,37-54,92) as opposed to the A1 and A2 fractures (mean: 40,18 min, C.I.: 40,18-44,51 and 43,22, C.I.: 43,22-45,34, respectively), (table VI). 12 (7,6%) out of 158 patients died within one year post operation. The binary logistic regression model showed that the most important factors affecting mortality were the ASA (beta coefficient: 3,127, p-value: 0,002) and the need for transfusion (beta coefficient: 1,367, p-value: 0,05), (table VII). The R square though was calculated 0,575,

Table I. — Duration of surgery in the reamed and the unreamed PFN group of patients.

	Reaming	N	Mean	Std. Deviation	Std. Error Mean
Duration of surgery (min)	Reamed	78	48,87	6,955	,788
	Unreamed	80	42,45	5,182	,579

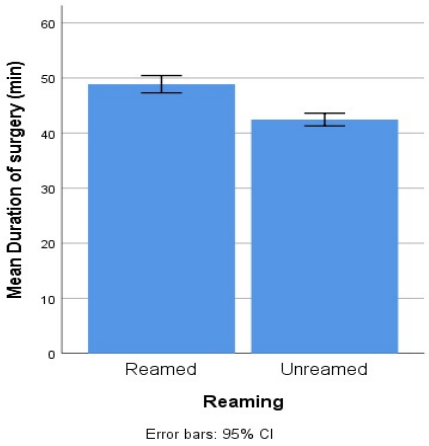


Table II. — Complications of the reamed and unreamed PFN

	Reaming		
	Reamed	Unreamed	Total
No complications	63	72	135
Hematoma	5	3	8
Screw cut out	4	4	8
HO	6	1	7
	78	80	158

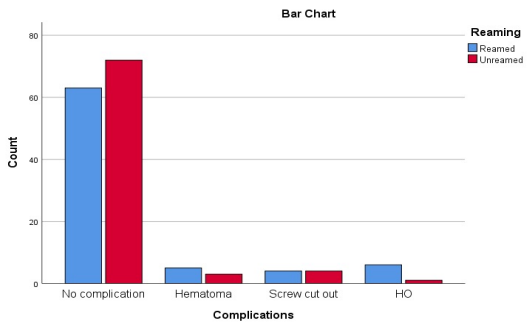


Table III. — Comparison of HO rate between the reamed and unreamed PFN group of patients

Reaming * Heterotopic Ossification Crosstabulation				
Count		Heterotopic Ossification		
		No HO	HO	Total
Reaming	Reamed	72	6	78
	Unreamed	79	1	80
Total		151	7	158

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3,871[a]	1	,049		
Continuity Correction[b]	2,499	1	,114		
Likelihood Ratio	4,262	1	,039		
Fisher's Exact Test				,062	,054
Linear-by-Linear Association	3,847	1	,050		
N of Valid Cases	158				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 3,46. b. Computed only for a 2x2 table.

Table IV. — Transfusion rate of the reamed and unreamed PFN group of patients

Transfusion units * Reaming Crosstabulation				
		Reaming		
		Reamed	Unreamed	Total
Transfusion units	no unit	41	44	85
	1 unit	24	23	47
	2 units	11	10	21
	3 units	2	3	5
Total		78	80	158

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	,350[a]	3	,950
Likelihood Ratio	,351	3	,950
Linear-by-Linear Association	,016	1	,899
N of Valid Cases	158		

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 2,47.

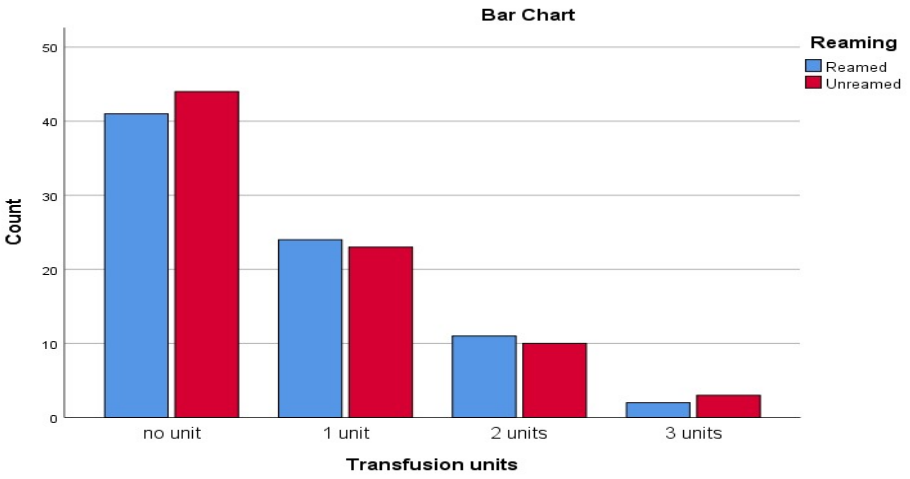


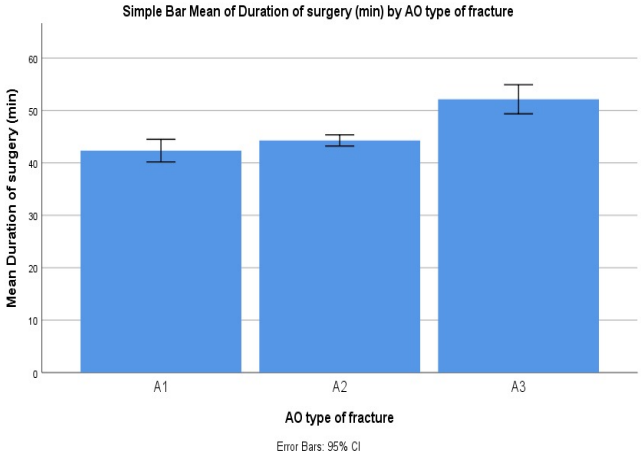
Table V. — Screw cut out in relation to the fracture type.

AO type of fracture * Screw cut out Crosstabulation				
No cut out		Screw cut out		Total
		No cut out	Cut out	
AO type of fracture	A1	27	2	29
	A2	89	6	95
	A3	34	0	34
Total		150	8	158

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2,326[a]	2	,313
Likelihood Ratio	4,005	2	,135
Linear-by-Linear Association	1,670	1	,196
N of Valid Cases	158		

a. 3 cells (50,0%) have expected count less than 5. The minimum expected count is 2,47.

Table VI. — Duration of surgery in relation to the fracture type.



which means that the factors included in the model can explain only the 57,5% of mortality.

DISCUSSION

Geriatric fractures, including hip fractures are increasing due to high life expectancy. This situation is a challenge for the national health systems, in terms of the cost of treating these injuries as well as their significant rate of morbidity and mortality[2]. It is well documented that delayed hip fracture surgery increases the rate of hospital readmission and mortality[6,14,16]. Panula et al (2011) report that geriatric hip fractures have a mortality rate of 27,3% within the first post-operative year and that at a mean time of 3,7 years post operation the percentage of mortality is 3-fold higher than the general population. Hwang et al (2019) suggest that patients with three or more co morbidities (heart disease, dementia, chronic renal failure) have increased mortality[17,18]. Quality of life after a hip fracture is impaired in terms of preinjury daily living activities,

Table VII. — Logistic regression for mortality

Variables in the Equation							
		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Age	,132	,145	,826	1	,363	1,141
	AO type of fracture	,061	,735	,007	1	,934	1,063
	Time to surgery (days)	-,954	,552	2,991	1	,084	,385
	ASA	3,127	1,031	9,196	1	,002	22,795
	Transfusion units	1,367	,696	3,854	1	,050	3,922
	Complications	-,227	,672	,114	1	,736	,797
	Constant	-18,732	11,658	2,582	1	,108	,000

a. Variable(s) entered on step 1: Age, AO type of fracture, Time to surgery (days), ASA, Transfusion units, Complications.

Model Summary			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	41,766[a]	,239	,575

self-care and mobility[19]. Guo et al (2015)[8] mention that only 30% of geriatric hip fractures can return to pre-fracture status of activity, while Amarilla- Donoso et al (2020) used the health related quality of life(HRQoL) after hip geriatric fracture to conclude that patients present significant impairment in functional capacity for basic activities of daily living[20].

The main cause of osteoporotic fracture is a single fall from own height. Vertigo and sedative medication predispose elderly patients to falls[21]. Hip fractures represent more than 50% of all osteoporotic fractures[15]. There is wide consensus that surgical treatment of osteoporotic intertrochanteric fracture is of paramount importance, as the results of conservative treatment display an increased rate of morbidity (decubitus ulcer, pneumonia, thromboembolic disease) and mortality[22]. Surgical stabilization of the fracture provides early mobilization, decreases mortality and allows gradual functional ability recovery[9].

Up to date two surgical techniques have been described, as the most optimal options, for the surgical stabilization of osteoporotic femoral intertrochanteric fractures: extramedullary and intramedullary fixation systems. In the past, the sliding compression screw was the implant of choice. Since the early nineties the cephalomedullary nailing started to become more popular[23]. Proximal femoral nailing (PFN) as opposed to the sliding hip screw (SHS) possesses the theoretical advantage of less invasive technique, biomechanical superiority, quicker mobilization and weight bearing[15].

Numerous clinical trials and meta- analyses in the literature have compared these two surgical techniques in an effort to identify the most efficient one[24]. Parker et al (2008) in a systematic review found that sliding hip screw is superior, resulting in a lower percentage of complications and reoperation[25]. Matre et al (2013) mention a higher incidence rate of reoperation in intramedullary implants than in SHS in simple two part intertrochanteric fractures and they recommend the SHS as the most optimal option for this type of intertrochanteric fractures[26]. Recently the AAOS guidelines recommended SHS or PFN for stable fractures and PFN for unstable fractures, while NICE guidelines suggest SHS for A1 and A2 fracture types and PFN for A3 fractures[24]. Arirachakaran et al. (2017) support that there are no evidence-based studies reporting the superiority of one technique against the other[27].

To the best of our knowledge, there are few studies which compare directly the reamed versus the unreamed nail in intertrochanteric fractures[8,12]. Proponents of the unreamed intramedullary nailing for femoral shaft fractures highlight the advantages of shorter operative time, less blood loss, less transfusion rate and embolism. These advantages may also be valid to intertrochanteric geriatric fractures with the application of the unreamed short intramedullary nail[12, 23]. Pitts et al (2020) studied the effect of reaming in geriatric intertrochanteric fracture treated with long IMN on the duration of surgery, blood transfusion, and complications. The authors mention that the only difference between the two techniques was less operative time by 16,7 minutes for the unreamed group as opposed to the reamed one[9]. Their results are in agreement to our study. We found that the mean operation time for the reamed and the unreamed nail was 48,87 min and 42,45 min respectively (p-value:0,015). In A3 type of fractures the operative time was longer compared with the A1 and A2 types, irrespective to the type of nail. Less operative time may have an impact to a better outcome. The transfusion rate, fracture consolidation, postoperative complications and mortality did not differ significantly between the two types of nail.

Screw cut out was found 5,1% and it was similar between the reamed and the unreamed nail as well as among the different types of fracture. We believe that the former complication was the result of: I. Improper screw placement. II. Poor bone quality. III. Insufficient compliance to the postoperative rehabilitation protocol due to comorbidities, such as dementia, sarcopenia etc.

Heterotopic ossification (HO) was also a complication occurred in our study. Six patients of the reamed group and one patient of the unreamed group developed this complication. Although this difference was significant, it did not reach statistical significance (p-value: 0,062). HO did not have any clinical impact to the patients though. We believe that the predominance of HO in the reamed group of patients was due to the bone debris produced by the reamer insertion into the medullary canal. Thus, meticulous irrigation of the trochanteric region after the phase of femoral canal reaming should be performed.

This study has some limitations: I. It is retrospective. II. Relatively small sample size (158 patients). III. All fractures were treated in one center. Future work should focus to better designed multicenter prospective randomized controlled trials, comparing directly the reamed and unreamed proximal femoral nailing, in order safer and more representative conclusions to be extracted.

CONCLUSION

Intertrochanteric geriatric fractures constitute an important socioeconomic and medical problem. Cefallomedullary nail is proven to be a very good

option of treating these injuries. Our study shows that the shorter operative time is the main advantage of the unreamed PFN as compared to the reamed one. Unreamed PFN is not inferior to the reamed PFN in terms of outcome and complications.

Conflict of interest: The authors declare that there is no conflict of interest.

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