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Evaluation of the results of intertrochanteric femur fractures fixation by dynamic hip screw versus gamma nail

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Abstract
Background: Femoral intertrochanteric fractures account for approximately half the hip fractures in elderly patients. The aim of this study is to evaluate the results of the treatment of intertrochanteric fractures in adults using Dynamic Hip Screw (DHS) and Gamma nail (GN) and evaluate radiologically the effect of these implants on normal proximal femoral morphology.
Methods: This prospective randomized study was carried out on 40 patients ranged from 18 to70 years old (20 patients were managed by Dynamic Hip Screw (DHS) and 20 patients were managed by GN). Patients were subjected to: history taking, physical examination, mechanism of trauma, the harris hip score (HHS), radiographic evaluation.
Results: there was significant difference regarding operative time, number of gauzes soaked with blood, number of C-arm shots and follow up time and insignificant difference Regarding gender, age or occupation, comorbid diseases and mechanism of injury or side of lesion, HHS score, postoperative complications, and postoperative changes of proximal femur,
Conclusions: In femur fractures fixation, DHS and GN are useful in the treatment of trochanteric femoral fractures, although the results were slightly in favor of DHS fixation (in stable fractures), GN has shorter operative duration, less blood loss, earlier weight bearing despite of higher number of C-arm shots needed.

Keywords: Intertrochanteric femur fractures, fixation, dynamic hip screw, gamma nail

Introduction
Older persons with osteoporosis often sustain simple falls at home that result in intertrochanteric (IT) fractures. Subtrochanteric in nature, meaning they reach into the region beyond the lesser trochanter. Fractures in the intertrochanteric region are less likely to develop osteonecrosis and delayed healing than femoral neck fractures because of the rich blood supply in this area. Basi cervical fractures, which occur just above the intertrochanteric line, have an increased risk of osteonecrosis as they occur intracapsular and malunion due to head rotation during implant insertion [1].
Treatment of trochanteric fractures presents unique difficulties. Other proximal femoral fractures are included in many studies, confounding data interpretation. Historically, all patients with a trochanteric fracture have been grouped together, regardless of the underlying etiology [2].
The dynamic hip screw (DHS) is a less expensive implant designed to give robust and secure internal fixation of a range of inter-trochanteric, subtrochanteric, and basilar neck fractures [3].
Many companies have released third-generation intramedullary implants to treat trochanteric fractures. In 2004, after several revisions, a new "Gamma nail (GN)" (the Gamma 3) was released. The GN system is based on more than 20 years of GN experience. This Module is the third generation of intramedullary long and short GNs fixation. The development of the successful trochanteric and long gamma intramedullary nails as well as the small stature versions followed precisely a step-by-step improvement based on the clinical experience and outcome [4].

The aim of this work was evaluating the results of the treatment of different types of IT fractures in adults using DHS and GN and evaluate radiologically the effect of these implants on normal proximal femoral morphology.

Patients and Methods

This prospective randomized study was carried out on 40 patients ranged from 18 to 70 years old diagnosed by radiography as having recent intertrochanteric fracture femur (within 2 weeks) including both low and high velocity injury with normal or osteoporotic bones (20 patients were managed by DHS and 20 patients were managed by GN). At Tanta University Hospital and Al-Menshawy General Hospital.

The Ethical Committee of Tanta University Hospitals approved the study. The patient signed a consent form after receiving necessary information.

Exclusion criteria were medically unfit patients who cannot undergo anesthesia and surgery in general, comminuted fractures, pathological fractures, neglected fractures (more than 2 weeks).

Any associated fractures around hip, skeletally immature patients, and presence of tumor-like, patients refused to participate.

Patients were subjected to: history taking, physical examination, mechanism of trauma, radiographic evaluation, grading of fractures using Harris Hip Score (HHS) to more precisely evaluate hip function (excellent = 90–100 points, good =80–89 points, fair =70–79 points, bad <70 points).

In 45-50 years, age group there were 2 males and 1 female treated with GN fixation while 2 males were treated with DHS fixation. In 51-55 years, age group there were 1 male and 3 females treated with GN fixation while 1 male and 2 females were treated with DHS fixation. In 56-60 years, age group there were 2 males and 2 females treated with GN fixation, while 4 males and 1 female were treated with DHS fixation. In 61-65 years, age group there were 1 male and 1 female treated with GN fixation, while 3 males were treated with DHS fixation. In 66-70 years, age group there were 4 males and 3 females treated with GN fixation, while 1 male and 6 females were treated with DHS fixation.

Methods: spinal anesthesia was used in all traction table surgeries. All patients received preoperative single-shot antibiotic prophylaxis (1.5 g cefuroxime I.V.) and low-molecular-weight heparin for thromboembolic prophylaxis. The DHS and GN implants were placed according to the guidelines provided by the respective implant manufacturers. For both implants, we aimed to place the sliding screw in the middle of the neck when viewing it from the side, in the lower third of the neck when viewing it from the front, and within 5 mm of the subchondral bone when viewing it from the A-P projection. After an X-ray check on the first postoperative day, patients in both groups were allowed to begin ambulation.

In order to predict implant failure and fixation failure (lag screw cut-out, penetration, or loosening), all post-operative radiographs were evaluated for fracture reduction quality (good, acceptable, or poor) and implant position in the femoral head (tip-apex distance [TAD]) or neck (superior, central or inferior) [5].

The anteroposterior (AP) view was used to capture images of the pelvis, and the tube was placed 1 m away. The patient was lying on his back with a 20-degree internal rotation of his lower extremities. Radiographs of both healthy and fractured hips (AP Pelvis) were used to do the morphometric analysis, during which measurements were recorded and the implant's effect on the normal morphology of the proximal femur was assessed.

Femoral neck breadth was one of the measured variables (FNW). Femoral neck length (FNL). Length of the femoral axis (FAL). Perspective of the neck in relation to the shaft (NSA). Longitude between the greater trochanter and the pubic symphysis (GTPSD). The parameters evaluated were chosen based on previous literature. Intra-operative blood loss was minimized by strict application of surgical technique and meticulous hemostasis, infection was minimized by prophylactic antibiotics prior to administration of anesthesia and post-operatively as well.

Statistical analysis

SPSS (Statistical Package for the Social Sciences) version 20 was used to analyse the data. Means and standard deviations were used to characterize quantitative variables. Absolute frequencies were used to define categorical variables, while chi-square and Fisher's exact tests were used for comparisons. Chi-square for trend testing was employed to compare ordinal data between the groups. Parametric test assumptions were checked using the Kolmogorov-Smirnov (distribution-type) and Levene (homogeneity of variances) tests. The Mann–Whitney U test (for non–normally distributed data) and the independent sample t test (for normally distributed data) were used to compare quantitative data from the two groups. P0.05 was chosen as the threshold for statistical significance. If $p \leq 0.001$, then there was a highly significant difference.

Results

There is statistically non-significant difference between the studied groups regarding sex, age, or occupation Table 1.

Table 1: Shows patient demographic data.

Parameter		Groups		Test	
		Gamma nail group	Dynamic Hip screw (DHS) group	χ^2/t	p
		N=20 (%)	N=20 (%)		
Age (year)Range		59.7 ± 8.176	60.5 ± 6.669	-0.339	0.736
Sex	Male	10 (50%)	11 (55%)	0.1	0.752
	Female	10 (50%)	9 (45%)		
Occupation	Housewife	7 (35%)	7 (35%)	1.272	0.259
	Worker	7 (35%)	11 (55%)		
	Skilled worker	4 (20%)	2 (10%)		
	Semi/professional	2 (10%)	0		

Data are presented as mean± SD or frequency (%). χ2 Chi square test, t independent sample t-test

There was statistically non-significant relation between age, sex group and outcome in either group Table 2.

Table 2: Relation between age, sex and outcome in the studied groups.

Age	Gamma nail group				DHS group			
	Excellent N=3	Good N=13	Fair N=3	Poor N=1	Excellent N=4	Good N=14	Fair N=0	Poor N=2
45 – 50	2 (66.7)	1 (7.7)	0 (0)	0 (0)	0 (0)	2 (14.3)	0 (0)	0 (0)
51 – 55	0 (0)	3 (23.1)	1 (33.3)	0 (0)	2 (50)	1 (7.1)	0 (0)	0 (0)
56 – 60	0 (0)	4 (30.8)	0 (0)	0 (0)	0 (0)	4 (28.6)	0 (0)	1 (50)
61 – 65	0 (0)	1 (7.7)	1 (33.3)	0 (0)	0 (0)	3 (21.4)	0 (0)	0 (0)
66 – 70	1 (33.3)	4 (30.8)	1 (33.3)	1 (100)	2 (50)	4 (28.6)	0 (0)	1 (50)
P	0.364				0.752			
Comorbidity								
Male	2 (66.7)	7 (53.8)	1 (33.3)	1 (100)	2 (50)	8 (57.1)	0 (0)	1 (50)
Female	1 (33.3)	6 (46.2)	2 (66.7)	0 (0)	2 (50)	6 (42.9)	0 (0)	1 (50)
P	0.669				0.958			

Data are presented as frequency (%).

There were statistically non-significant differences between the studied groups regarding comorbid diseases and mechanism of injury or side of lesion, HHS score, postoperative complications, and postoperative changes of proximal femur Table 3.

Table 3: Comparison between the studied groups regarding presence of comorbid diseases, trauma-related data, HHS score, postoperative complications, and postoperative changes in proximal femur.

Parameter		Groups		Test	
		Gamma nail group N=20 (%)	Dynamic Hip screw (DHS) group N=20 (%)	χ^2	P
Comorbid diseases	None	8 (40)	11 (55)	1.283	0.903
	Cardiac	2 (10)	1 (5)		
	Diabetes	4 (2)	3 (15)		
	Hypertension	4 (20)	4 (20)		
	Diabetic hypertensive	2 (10)	1 (5)		
Mechanism of injury	Simple fall	11 (55)	11 (55)	0.234	>0.999
	Fall from stairs	5 (25)	6 (30)		
	RTA	4 (20)	3 (15)		
Side of lesion	Right	11 (55)	10 (50)	0.1	0.752
	Left	9 (45)	10 (50)		
HHS score	Poor	1 (5)	2 (10)	0.115	0.734
	Fair	3 (15)	0 (0)		
	Good	13 (65)	14 (70)		
	Excellent	3 (15)	4 (20)		
Complications	None	16 (80)	15 (75)	0.448	0.503
	Delayed union	1 (5)	0 (0)		
	Valgus deformity	1 (5)	1 (5)		
	Varus deformity	0 (0)	1 (5)		
	Superficial infection	2 (10)	3 (15)		
Postoperative changes	Non-significant	13 (65)	9 (45)	2.135	0.144
	Mild	5 (25)	9 (45)		
	Significant	2 (10)	2 (10)		

Data are presented as frequency (%).

There is statistically non-significant relation between comorbidity, side of lesion and outcome in either group Table 4.

Table 4: Relation between comorbidity, side of lesion and outcome in the studied groups

		Gamma nail group				DHS group			
		Excellent N=3	Good N=13	Fair N=3	Poor N=1	Excellent N=4	Good N=14	Fair N=0	Poor N=2
Comorbidity	**Absent**	1 (33.3)	5 (38.5)	2(66.7)	0 (0)	3 (75)	6(42.9)	0 (0)	2(100)
	Present	2 (66.7)	8 (61.5)	1(33.3)	1(100)	1 (25)	8(57.1)	0 (0)	0 (0)
p		0.581				0.142			
Side	Right	2(66.7)	7 (53.8)	1(33.3)	1(100)	2(50)	7(50)	0 (0)	1(50)
	Left	1(33.3)	6 (46.2)	2(66.7)	0 (0)	2(50)	7(50)	0 (0)	1 (50)
p		0.669				>0.999			

Data are presented as frequency (%). P for chi square test

There was statistically non-significant difference between the studied groups regarding ipsilateral or contralateral hip measurements or change in these parameters between both limbs.

There was statistically significant difference between the studied groups regarding operative time, number of gauzes soaked with blood, number of C-arm shots and follow up time Table 5.

Table 5: Comparison between the studied groups regarding contralateral hip measurements, operative data and follow up time.

Parameter		Groups		Test	
		Gamma nail group	Dynamic Hip screw (DHS) group	t	p
		N=20 (%)	N=20 (%)		
FAL	Ipsilateral	116.5 ± 19.8	118.85 ± 14.97	-0.423	0.675
	Contralateral	119.19 ± 19.77	121.55 ± 14.97	-0.427	0.672
	Change	-2.685 ± 0.104	-2.705 ± 0.068	-0.702‡	0.487
FNL	Ipsilateral	36.5 ± 15.16	39.65 ± 12.3	-0.721	0.475
	Contralateral	36.23 ± 15.17	39.88 ± 12.32	-0.743	0.462
	Change	-0.128 ± 0.051	-0.226 ± 0.145	-2.134‡	0.05
FNW	Ipsilateral	37.85 ± 10.96	42.45± 8.56	-1.479	0.148
	Contralateral	38.27 ± 10.93	42.87 ± 8.55	-1.483	0.147
	Change	-0.420 ± 0.128	-0.422 ± 0.06	-0.63‡	0.095
GTPSD	Ipsilateral	178.2 ± 21.54	176.6 ± 16.89	0.261	0.795
	Contralateral	181.96 ± 21.54	180.18 ± 16.87	0.259	0.797
	Change	-3.56 ± 0.071	-3.78 ± 0.103	-0.610‡	0.546
Operative data	Operative time	56.8 ± 6.43	77.35 ± 9.55	-7.984	<0.001*
	Number of soaked gauzes	4.1 ± 0.85	7.95 ± 0.83	-14.511	<0.001*
	Number of C-arm shots	47.5 ± 5.74	28.2 ± 3.87	12.457	<0.001*
Follow up (month)		8.5 ± 1.933	8.8 ± 2.19	-0.459	0.649

Data are presented as mean ±SD. *p< 0.05 is statistically significant. t Independent sample t test ‡Mann Whitney test

Discussion

There are an estimated more than 150,000 cases of intertrochanteric (IT) fractures per year in the United States alone, making this a common type of injury among the elderly. IT Fractures always occur in patients with a history of falls or bone disease [6], the pain and inability to walk are 2 common clinical signs. Mortality rates from IT fractures within 6 months varied between 12% and 41%, with a sharp increase in risk beyond age 50 [7].

Peritrochanteric femur fractures have increased in the elders. Timely care with proper procedures providing fracture stabilization and early patient mobilization is becoming increasingly crucial for these fractures to prevent the risks of extended immobilization [8].

Extramedullary fixation DHS, compression hip screw (CHS), percutaneous compression plate (PCCP), Medoff sliding plate, and less invasive stabilization system (LISS)) and intramedullary fixation (GN, proximal femoral nail (PFN), and proximal femoral nail anti-rotating (PFNA)) [9].

Internal fixation with intramedullary implants like the GN or extramedullary implants like the DHS is currently used in the operative therapy of most peritrochanteric fractures. Both devices have the advantages of keeping the fracture ends covered and having a little impact on blood flow to the broken bones. Both methods adhere to the lag screw's dynamic compressive concept, stabilizing implantation at the fracture site by securely connecting the femoral head to the femoral shaft. The optimal internal fixation for peritrochanteric fractures is still a matter of debate. This is especially true for unstable fractures such reverse intertrochanteric fractures [10].

In our study, there was statistically non-significant difference between the studied groups regarding gender, age, occupation, and mechanism of injury or side of lesion. 55% within each group had fractures due to simple falls. 20% within nail group and 15% within DHS group had trauma due to road traffic accident (RTA) with non-significant difference between the studied groups regarding side of lesion and follow up time, postoperative complications, larger percentage within each group were not complicated (80% within nail group, versus 75% within DHS group). 10% within nail group and 15% within DHS group had superficial infection .

Fractures of the greater trochanter, fracture displacement due to nail insertion, and fractures of the femur shaft are all unique complications of GN. The most serious risk of GN fixation is a fracture of the femoral shaft at the end of the intramedullary portion of the implant. The two femoral shaft fractures in our GN cohort were both the result of falls [11].

Winnock *et al.* [12] studied the treatment of trochanteric fractures by Gamma 3 nail in 61 patients, 35 were males while 26 were females, they found no significant correlation between the sex of the patients and the final functional outcome of the patients., 29 had right side fractures while 32 were left side sided, 35 were males while 26 were females, they found no significant correlation between the side of fracture and the final functional outcome of the patients.

Giessauf *et al.* [13] studied 62 patients with trochanteric fractures fixed with the Gamma 3 nail, patient's age ranged from 23-79 years with mean of 57.6 years, 43 patients (67%) had excellent and good functional results, while 29 patients (33%) had fair and poor functional results.

Varela *et al.* [14] studied the results of treatment of trochanteric fractures with Gamma 3 nail in 80 patients, he found that 5 of his patients (6.25%) had to change their occupation to a less physical occupation.

Al-Yassari *et al.* [15] found that 85.7% of falls occurred at home due to a simple fall, and Yllianakis *et al.* [16] found that falls occurred at home more frequently (67% of the time). The mechanism of injury had no effect on the outcomes. Patients younger than 18 had the highest energy requirements for fractures, had no incidences of severe infection, and sequelae were limited to hematoma collection.

Cheng and Sheng [17] compared DHS and GN and found that follow-up duration ranged from 3 to 19 months (mean follow-up duration = 10.06 months), regarding HHS score, there is statistically non-significant difference between the studied groups, larger percentage within each group (65% and 70% within GN and DHS groups respectively had good score). Excellent score occurred in 15% and 20% within nail group and DHS group respectively. Also, no significant difference at the comparison between GN and DHS.

Liu *et al.* [18] compared the fixation outcome of the GN and dynamic hip screw (DHS) in treating peri trochanteric fractures. There were 19 cases of wound infection among the 594 fractures managed with GNs, and 20 cases were observed among the 619 fractures managed with DHS. Also found no obvious advantages of the GN over the DHS in treating peri trochanteric fractures.

Domingo *et al.* [19] reported local complication percentage of

10% with 29 cases of hematoma and onl one case of deep infection.

Our study indicated that the GN and DHS share no obvious statistical difference in the aspect of postoperative complications. We recommended that DHS fixation is a safer and more dependable procedure than GN fixation vis-a-vis the complications after operation and that it may be the first option for the treatment of peri trochanteric fractures.

Regarding operative time and blood-soaked gauzes there's statistically significant difference between the studied groups. Higher operative time and more blood-soaked gauzes are needed in dynamic hip screw .

Regarding C-arm shots (radiological exposure) there's statistically significant difference between the studied groups. More C-arm shots (higher radiological exposure) in GN .

Kukla *et al*. [20] compared GN to DHS, arguing that the DHS is a viable, cost-effective choice for stable proximal femoral fractures while the better biomechanics of the GN are relied upon for unstable fractures.

Ovesen *et al*. [21] who analysed treated 146 intertrochanteric fractures with either a trochanteric gamma nail (TGN) or a dynamic hip screw (DHS). Even while most intertrochanteric fractures are managed by less experienced physicians rather than hip/trauma specialists, these doctors still favored the DHS. In some cases of intertrochanteric fractures, the TGN may be beneficial.

Also, Saarenpää *et al*. [22] evaluated the short-term results of trochanteric femoral fracture treatment using GN and dynamic hip screw (DHS) fixation, and concluded that both procedures are effective.

Kempf *et al*. [23] the GN approach for fracture fixation has certain limitations, however it can be used almost universally without the need for additional devices and without opening the fracture site. Due to its mechanical stability, early weight bearing is possible in most circumstances. While the incidence of malunions is higher than with DHS fixation, the severity is tolerable because of the lack of significant functional impact. Unger *et al*. [4] studied trochanteric femoral fractures in the elderly and concluded that the GN was found to have a low implant-associated complication rate.

Our study limitations included that: there were no other studies discovered that evaluated clinical outcome using the Harris hip score, the sample size was limited, and patients were not compliant with follow-up sessions. However, we found that the Harris hip score was the most useful in comparing our findings to those of previous research with trochanteric implants.

Conclusions

Internal fixation of IT fractures is better than conservative treatment. Both methods are useful in the treatment of trochanteric femoral fractures, although the results were slightly in favour of DHS fixation (in stable fractures), GN has an advantage than DHS since it has shorter operative duration, less blood loss, earlier weight bearing despite of higher number of C-arm shots needed, Age and gender play an important role in changes in proximal femur morphology after fixation.

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Author's Contribution

Not available

Conflict of Interest

Not available

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