Extramedullary versus Intramedullary bone fixation Treatment of peritrochanteric fractures

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Abstract

Background
In the last few decades the incidence of peritrochanteric fractures has increased markedly because of increased rate of high velocity trauma. Both DHS and PFN provides a gold standard treatment modalities for these fractures. The aim of this study is to Assess of efficacy and complications of treatmeant of preitrochantric fracture by DHS versus PFN.
Materials and methods
Nineteen studies were identified for analysis from 2007 to 2017 that meet our points of comparison. Outcomes from the included studies have been combined using the systematic review manger software. Outcome measures of both fixation techniques were compared with calculation of the relative risk. Evidence of publication bias has been sought using the funnel plot method.
Results
Comparing the calculated relative risk for each fixation technique showed that PFN has less complications and better efficacy than DHS, as it has less risks of fixation failure, wound infection, less duration of surgery and less incidence of non-union compared to DHS.
Conclusion
The present study supports that treatment of unstable peritrochanteric fractures with PFN is better than DHS. More randomized controlled studies are needed to conclude higher evidence.

Keywords
Peritrochantric fractures; dynamic hip screws; Proximal Femoral Nail.

Introduction

Nearly half of hip fractures in the elderly are intertrochacnteric fractures; with more than 50% of these fractures are unstable [1,2]. Fractures of intertrochanteric region are more common than femoral neck since it has a thinner cortical bone and it occurs more commonly in elderly due to decrease bone density in old age[3]. Trochanteric fractures surgery aims to achieve early recovery and prevention of further complications.

The most common system used for classification of intertrochanteric fractures is AO system [4]. AO classification divides intertrochanteric fractures into four types: stable trochanteric (Type A1), unstable trochanteric (Type A2), fractures at the lesser trochanter (Type A3) and subtrochanteric fractures. In the last few decades dynamic hip screws was the gold standard in fixation of trochanteric fractures [5]. But in unstable fracture higher rates of failures, with incidence as high as 23% have been reported when using dynamic hip screws [6]. Other important concern with the DHS is the extended surgical approach [8,9].

On other hand, intramedullary nailing system has theoretically clinical and mechanical advantages than dynamic hip screw [7]. Most authors depends on nailing system on treatment of unstable trochanteric fractures, as its provide higher fracture stability in this conditions [8,9,10]. However, numerous complications reported from intramedullary nailing system such as intraoperative intertrochantric fractures, difficultly in targeting the cephalic screw, postoperative fractures at the distal end of the nail and tendinuous lesions of the abductors muscles due to large metaphyseal diameter of the nail [11].

The aim of this study is to assess and compare the efficacy and complications of treatmeant of preitrochantric fractures by DHS versus PFN.

Materials and Methods

This review was done using standard methodology outlined and reported findings in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement guidelines.

Identifications of the studies:

We preformed the literature search using the following search terms: Extramedullary treatment of peritrochantric fractures, intramedullary treatment of peritrochantric fractures and dynamic hip screws versus intra medullary nail. Search inquiries were limited to the title and abstract and the language was restricted to English. The electronic search involved the Pub Med and Cochrane Library.

Criteria of accepted studies:

Type of studies: clinical trial, comparative study, clinical study and systematic reviews.
Types of interventions: DHS versus PFN.

Types of outcome measures:

1. Rate of complications.
2. Rate of Non-union,
3. Duration of surgery.
4. Duration of hospital stay.
5. Duration of fluoroscopy during operation
6. Rate of Mal-union.

Inclusion criteria:

1. Publications from the year 2007 till 2017.
2. Full text articles.
3. English literature only**.**

Exclusion criteria:

1. Duplicated articles for the same authors.
2. Non-English papers.
3. Publications before the year of 2007.
4. Articles and papers with no clinical data.

Methods of the review:

Locating and selecting the studies:-

Abstracts of articles identified using the above search strategy were viewed, and articles that appear of fulfill the inclusion criteria were retrieved in full, when there was a doubt, a second reviewer was assessed the article and consensus was reached.

Data Extraction:-

Using the following Keywords: Extramedullary treatment of peritrochantric fractures, intramedullary treatment of peritrochantric fractures and dynamic hip screws versus intra medullary nail.

Evidence of publications bias:-

Was sought using the funnel plot method. A funnel plot is a simple scatter plot of the intervention effect estimates from individual studies against some measure of each study's size or precision. The funnel plot is a plot of the estimated effect size on the horizontal axis versus a measure of study size (standard error for the effect size) on the vertical axis. In the presence of bias, the plots are asymmetrical.

Statistical Analysis:

Data entry, processing and statistical analysis was carried out using MedCalc ver.15.8

(MedCalc, Ostend, Belgium). A meta-analysis was preformed to calculate direct estimate of treatment effect. According to heterogeneity of treatment effect across trials using

I^2 –statistics; a fixed effect model ($P \geq 0.1$) or random effect model($P < 0.1$) was used. Generally p values less than 0.05 (5%) was considered to be statistically significant.

P-value: Level of significance:

- $P > 0.05$: Non-significant (NS).
- $P < 0.05$: Significant (S).

Testing for heterogeneity:

Studies included in meta-analysis we tested for heterogeneity of the estimates using the following tests:

1. Cochran Q chi square test: A statistically significant test (p-value <0.1) denoted heterogeneity among the studies.
2. I-square (I^2) index which is interpreted as follows;

- I^2 = 0% to 40%: unimportant heterogeneity
- I^2 = 30% to 60%: moderate heterogeneity
- I^2 = 50% to 90%: substantial heterogeneity
- I^2 = 75% to 100%: considerable heterogeneity

Pooling of estimates:

Incidence of events was presented in terms of rates or proportions with their 95% confidence limits (95% CI). Estimates from included studies were pooled using the DerSimonian laird random-effects method (REM) or the Mantel-Haenszel fixed-effects method (FEM) depending on the presence or absence of significant heterogeneity, respectively.

Results

We founded 123 records, of them 115 unique records identified (duplicate removed) by the database searches, 96 records were excluded based on title and abstract review, leaving 19 studies that met all inclusion criteria **Table (1)**.

Table (1): General characters & demographic data of included studies. Type of the fracture has been classified according to AO/OTA classification.

Author	Type of fracture	Mean follow up	Number of Cases		Mean age	
			DHS	PFN	DHS	PFN
Aktselis et al.,[12]	31A2-2,A2-3	12m	35	36	83.1	82.9
little et al.,[13]	A1, A2 , A3	12m	98	92	84.2	82.6
Wegiung et al.,[14]	31-A1	48m	112	110	73.05	72.02
Xu et al.,[15]	31-A2	12m	55	51	77.9	78.5
Chua et al.,[16]	A2,A3	12m	38	25	77	75
Jonnes et al.,[17]	A2	12m	15	15	60	60
Avakian et al.,[18]	A1	8m	98	51	84.6	82.8
Foulongne et al.,[19]	A1, A2 , A3	3m	30	30	84.5	85.5
Yeganeh et al.,[20]	A3	6m	54	60	63.5	66.68
Palm et al.[21]	A3	12m	153	158	83	84
Parker et al.,[22]	A1	12m	300	300	81.4	82.4
Matre et al.[23]	A1,A2,A3	12m	343	341	84.1	84.1
Sinan et al..[24]	A2-1,A2-2,A2-3	6m	102	96	76.86	77.22
Orcun et al.,[25]	A1, A2 , A3	24m	86	95	72.4	70.3
Zeng et al.[26]	31-A1,31-A2,31-A3	12m	112	110	75.16	74.34
Bhakat,[27]	31-A2,31-A3	24m	30	30	67.8	67.8
Kumar et al.[28]	A1, A2 , A3	24m	25	25	69.3	69.3
Qiang et al.,.[29]	A1, A2 , A3	11m	38	37	61	61
Gupta and valisetti,[1]	A1, A2 , A3	12m	240	160	72.4	70.2

Treatment outcomes:

Treatment outcomes that were assessed and compared in this study include failure of fixation, wound infection, duration of the surgical procedure, and non-union rates

1- Regarding failure of fixation:

We found that the test of heterogeneity proved statistically significant because p value was less than 0.05, so the random effect model was considered. According to that model, there was a statistically significant difference in the risk of failure of fixation between the two surgeries (z=2.331, p=0.02), so the risk of failure of fixation in the DHS group is 1.7 times that of the PFN group (RR (relative risk 1.689 and 95% CI of 1.087 to 2.625) **Table (2)**.

Table (2): Meta-analysis: relative risk - Failure of fixation.

Study	DHS	PFN	Rela-tive risk	95% CI	Z	P	Weight (%)	
							Fixed	Random
Xu et. al.(2010)	1/55	5/51	0.185	0.0224 to 1.534			1.61	3.54
Zorik Avakian et. al.(2011)	1/98	2/51	0.260	0.0242 to 2.802			1.27	2.91
Henrik palm et. al.(2011)	22/153	6/158	3.786	1.579 to 9.082			9.37	10.86
Parker M.J et. al.(2011)	17/300	9/300	1.889	0.856 to 4.170			11.43	11.77
Orcun sahin et. al.(2011)	6/86	7/95	0.947	0.331 to 2.708			6.49	9.13
Ranjeeteshkumar et. al.(2012)	2/25	1/25	2.000	0.194 to 20.672			1.31	3.00
Ivan tjun huat et. al.(2013)	1/38	2/25	0.329	0.0315 to 3.438			1.30	2.97
Ionnis Aktselis et. al.(2013)	3/35	0/36	7.194	0.385 to134.399			0.84	2.02
Uijjalbhakat et. al.(2013)	2/30	1/30	2.000	0.191 to 20.899			1.30	2.97
Sinan zehir et. al.(2014)	11/102	12/96	0.863	0.400 to 1.862			12.12	12.03
Venkatesh Gupta et. al.(2015)	16/240	6/160	1.778	0.711 to 4.446			8.53	10.42
Wegiung YU et. al.(2016)	42/112	17/110	2.426	1.474 to 3.993			28.89	15.28
Xianshang Zeng et. al.(2017)	37/112	9/110	4.038	2.047 to 7.964			15.54	13.08
Total (fixed effects)	161/1386	77/1247	1.966	1.526 to 2.532	5.226	<0.001	100.00	100.00
Total (random effects)	161/1386	77/1247	1.689	1.087 to 2.625	2.331	0.020	100.00	100.00

2- Regarding wound infection:

We found that the test of heterogeneity proved statistically insignificant because p value was more than 0.05, so the fixed effect model was considered. According to that model, there was a statistically significant difference in the risk of wound infection between the two surgeries (z=2.319, p=0.02), so the risk of wound infection in the DHS group is 1.7 times that of the PFN group (RR (relative risk 1.763 and 95% CI of 1.092 to 2.846) **Table (3)**.

3- Regarding duration of surgery:

We found the test of heterogeneity proved statistically significant because p value was more than 0.05, so the random effect model was considered. According to that model, there was a statistically significant difference in the duration of surgery between the two surgeries (z=2.650, p=0.008), so the duration of surgery in the DHS group is 1.2 times greater than that of the PFN group (SMD is 1.207 and 95% CI of 0.34 to 2.101) **Table (4)**.

Table (3): Meta-analysis: relative risk – Wound infection.

Study	DHS	PFN	Rela-tive risk	95% CI	z	P	Weight (%)	
							Fixed	Random
N.J.little et. al.(2008)	10/98	5/92	1.878	0.667 to 5.286			24.35	24.35
Yz Xu et. al.(2010)	3/55	1/51	2.782	0.299 to 25.894			5.24	5.24
Zorik Avakian et. al.(2011)	0/98	2/51	0.105	0.00514 to 2.148			2.86	2.86
Parker M.J et. al.(2011)	4/300	4/300	1.000	0.252 to 3.962			13.77	13.77
Orcun sahin et. al.(2011)	1/86	0/95	3.310	0.137 to 80.202			2.57	2.57
Ranjeeteshkumar et. al.(2012)	2/25	0/25	5.000	0.252 to 99.166			2.92	2.92
Kjell Matre et. al.(2013)	3/343	2/341	1.491	0.251 to 8.869			8.21	8.21
Uijjalbhakat et. al.(2013)	2/30	0/30	5.000	0.250 to 99.960			2.91	2.91
Sinan zehir et. al.(2014)	11/102	4/96	2.588	0.853 to 7.853			21.18	21.18
Venkatesh Gupta et. al.(2015)	3/240	0/160	4.676	0.243 to 89.930			2.98	2.98
Wegiung YU et. al.(2016)	1/112	1/110	0.982	0.0622 to 15.508			3.43	3.43
Cyril Jonnes et. al.(2016)	1/15	0/15	3.000	0.132 to 68.263			2.67	2.67
Xianshang Zeng et. al.(2017)	2/112	2/110	0.982	0.141 to 6.850			6.92	6.92
Total (fixed effects)	43/1616	21/1476	1.763	1.092 to 2.846	2.319	0.020	100.00	100.00
Total (random effects)	43/1616	21/1476	1.777	1.066 to 2.961	2.206	0.027	100.00	100.00

Table (4): Meta-analysis: continuous measure- Duration of surgery.

Study	DHS	PFN	Total	SMD	SE	95% CI	t	P	Weight (%)	
									Fixed	Random
N.J.little et. al.(2008)	98	92	190	-0.721	0.149	-1.016 to -0.427			12.17	8.47
E.foulongne et. al.(2009)	30	30	60	-0.426	0.258	-0.942 to 0.0896			4.08	8.32
Yz Xu et. al.(2010)	55	51	106	-1.090	0.207	-1.501 to -0.680			6.32	8.40
Zorik Avakian et.al.(2011)	98	51	149	-0.618	0.175	-0.964 to -0.271			8.80	8.44
Parker M.J et. al.(2011)	300	300	600	-0.240	0.0818	-0.400 to -0.0789			40.46	8.52
Orcun sahin et. al.(2011)	86	95	181	3.631	0.242	3.154 to 4.108			4.64	8.34
IonnisAktselis et. al.(2013)	35	36	71	1.321	0.260	0.803 to 1.839			4.02	8.31
Ivan tjun huat et. al.(2013)	38	25	63	1.630	0.293	1.044 to 2.215			3.16	8.25
Uijjalbhakat et. al.(2013)	30	30	60	3.575	0.414	2.746 to 4.404			1.58	7.98
Sinan zehir et. al.(2014)	102	96	198	2.409	0.186	2.042 to 2.777			7.81	8.42
Qiang Wang et. al.(2014)	38	37	75	2.609	0.312	1.986 to 3.231			2.78	8.22
Ali yeganeah et. al.(2016)	54	60	114	2.617	0.254	2.113 to 3.121			4.18	8.32
Total (fixed effects)	964	903	1867	0.374	0.0521	0.272 to 0.476	7.188	<0.001	100.00	100.00
Total (random effects)	964	903	1867	1.207	0.456	0.314 to 2.101	2.650	0.008	100.00	100.00

4- Regarding non union:

We found the test of heterogeneity proved statistically insignificant because p value was more than 0.05, so the fixed effect model will be considered. According to that model, there was a statistically significant difference in the risk of non union between the two surgeries (z=2.086, p=0.037), so t he risk of non union in the DHS group is 1.9 time that of the PFN group (relative risk 1.913and 95% CI of 1.040 to 3.519) **Table (5)**.

Table(5): Meta-analysis: relative risk- Non-union

Study	DHS	PFN	Rela-tive risk	95% CI	Z	P	Weight (%)	
							Fixed	Random
Wegiung YU et. al.(2005)	4/112	2/110	1.964	0.367 to 10.507			15.33	15.33
Orcun sahin et. al.(2011)	2/86	3/95	0.736	0.126 to 4.303			13.84	13.84
Parker M.J et. al.(2011)	1/300	1/300	1.000	0.0628 to 15.915			5.63	5.63
Ranjeeteshkumar et. al.(2012)	1/25	0/25	3.000	0.128 to 70.300			4.33	4.33
Kjell Matre et. al.(2013)	10/343	3/341	3.314	0.920 to 11.937			26.26	26.26
Venkatesh Gupta et. al.(2015)	2/240	2/160	0.667	0.0949 to 4.685			11.34	11.34
Ali yeganeah et. al.(2016)	8/54	2/60	4.444	0.986 to 20.024			19.03	19.03
Xianshang Zeng et. al.(2017)	0/112	1/110	0.327	0.0135 to 7.952			4.24	4.24
Total (fixed effects)	28/1272	14/1201	1.913	1.040 to 3.519	2.086	0.037	100.00	100.00
Total (random effects)	28/1272	14/1201	1.848	0.958 to 3.563	1.833	0.067	100.00	100.00

Discussion

With the increase number of the old age population and road traffic accidents the number of hip fracture especially peritrochanteric fractures have been increased and the number of hip fractures surgeries especially PFN and DHS surgeries have been increased. In this review, we examined the available published studies to compare between DHS versus PFN in treatmeant of peritrochanteric fractures. After analysis of the included papers we founded that there was statistically significant increase of the incidence of fixation failure, wound infection, duration of surgery and fracture non union with DHS.

As regard fixation failure, this Meta analysis showed that PFN has less failure of fixation rate than DHS. Despite the difference between studies, the final result of our Meta analysis we concluded that the ratio of failure of fixation in DHS is 1.7 times that in PFN group. As regard the wound infection, this Meta analysis concluded that the ratio of failure of fixation in DHS is 1.7 times that in PFN group. As regard duration of surgery, this Meta analysis concluded that the duration of surgery of in DHS is 1.2 time longer than in PFN group. As regard the non union rates, this Meta analysis concluded that the ratio of risk of non union in DHS is 1.9 times that in PFN group.

The proper fixation device for peritrochanteric fractures is still controversial at present. Jones et al. [30] compared the intramedullary nail (IMN), which involved gamma nail, intramedullary hip screw (IMHS), and PFN, with sliding hip screw for treatment of extracapsular peritrochanteric fractures. They concluded that there was no statistically significant difference in the cut-out rate between the IMN and SHS while total failure rate and reoperation rate were greater with IMN. Parker and Handoll [31] also compared gamma and other cephalocondylic intramedullary nails with extramedullary implants for extracapsular hip fractures in adults and concluded that there was no significant difference between the groups in outcomes of blood loss and transfusion, fixation complications, and post-operation complications and hospital stay. A similar meta analysis by Huang et al (32) showed also comparable results between the two fixation methods.

There were many limitations in this meta-analysis. The number of included studies included seemed not so sufficient and the quality of the trials was generally low. Many studies include were not consistent in the method of reporting of complication and this heterogeneity should affected the results of the study. Furthermore, the difference in follow-up duration of included studies also reduced the power of our research.

Conclusion

Despite the known concept that PFN and DHS are equally effective in the treatment of trochanteric fractures. the result of this Meta analysis found that PFN and DHS are equally effective in the treatment of trochanteric fractures PFN showed statistically significant less incidences of wound infection, failure of fixation and non union complications, but DHS has longer duration of surgery than PFN. Further randomized controlled studies are needed to present higher evidence.

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