Functional Outcome and Revision Rate of Proximal Femoral Nail Antirotation (PFNA) versus Dynamic Hip Screw (DHS) for Type A1 Intertrochanteric Femoral Fracture: A Systematic Review and Meta Analysis

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ABSTRACT

Introduction: Intertrochanteric fractures (IFF) are difficult for orthopedic surgeons to treat. Only a few studies have looked specifically at the treatment of stable trochanteric fractures, and the majority of them found no differences in implant failure or reoperation rates between the PFNA and the DHS. The goal of this study is to examine the functional outcomes and revision rates of these two operations for Type A1 Intertrochanteric Femoral Fracture
Methods: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria were used to perform the systematic review. All statistical analyses were performed using the Review Manager version 5.3 software. We used PubMed, Google Scholar, and the Cochrane Library to conduct our research
Results: From multiple databases, the electronic search yielded 147 records. Four Studies were included in our study. ROM Outcome was measured using Harris Hip Score (HHS). No significant difference between PFNA and DHS in HHS (Heterogeneity, I2 = 99 percent; WMD, -1.02; 95 percent Confidence Interval (CI), -6.72 to 4.69; P=0.73). Rate of revision also found no significant difference between the two groups (Heterogeneity, I2=57 percent; WMD, 1.37; 95 percent Confidence Interval (CI), 0.40 to 4.69; P = 0.61).
Conclusion: PFNA and DHS are both viable options in the treatment of stable intertrochanter femur fractures, as both treatments have a similar 1-year functional outcome.

Keywords: PFNA, DHS, Type A1 Intertrochanteric Femoral Fracture

INTRODUCTION

Intertrochanteric fractures (IFF) are difficult for orthopedic surgeons to treat. The treatment of trochanteric fractures was revolutionized by the development of the dynamic hip screw (DHS) in 1964; and DHS remained the standard implant of choice for many years due to the low risk of fixation failure and non-union by providing controlled compression at the fracture site.[1]

The dynamic hip screw (DHS) has long been regarded as one of the most popular trochanteric fracture treatments. Recent research has shown that intramedullary nails, such as the proximal femoral nail antirotation (PFNA), are effective at stabilizing unstable fractures.

The DHS, on the other hand, is still regarded an acceptable implant for stable trochanteric fractures.[2]

In many investigations comparing intramedullary nails with extramedullary implants in trochanteric fractures, implant failure rates were found to be very similar. For the DHS, these range from 0% to 6%, while for the PFNA, they range from 0% to 3%. Another study conducted a comprehensive analysis comparing intramedullary nails and extramedullary implants for extracapsular hip fractures and found that intramedullary nails had a greater rate of surgical complications, however only one research involved the PFNA. Only a few studies have looked specifically at the treatment of stable trochanteric fractures, and the majority of them found no differences in implant failure or reoperation rates between the PFNA and the DHS.[3] However, some studies have suggested that the PFNA may be preferable in stable trochanteric fractures due to a shorter operation time, less blood loss, less postoperative pain, faster weight bearing, and improved functional recovery in the generally frail older hip fracture patient.[2]

Failed PFNA or DHS fixations of intertrochanteric fractures should be treated with a conversion to total hip arthroplasty (CTHA) whenever possible, according to a common approach of revision. CTHA has previously been reported to be an effective treatment for treating failed DHS or PFNA fixations of intertrochanteric fractures. However, it is unknown whether the success rates for converting PFNA or DHS to a THA are different.[3,4]

There hasn't been a meta-analysis to compare the outcomes of these two operations in Type A1 Intertrochanteric Femoral Fracture. The goal of this study is to examine the functional outcomes and revision rates of these two operations for Type A1 Intertrochanteric Femoral Fracture, as well as to look into the secondary functional outcomes of the two treatments.

MATERIALS AND METHODS

Searching Strategy

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria were used to perform the systematic review (Figure 1). A thorough literature search was conducted to find a full-length, peer-reviewed study in English comparing the clinical outcomes of PFNA and DHS. We used PubMed, Google Scholar, and the Cochrane Library to conduct our research. This comprehensive review and meta-analysis compare the clinical outcomes of PFNA and DHS in TypeA1 Intertrochanteric Femoral Fracture. ("PFNA"), AND ("DHS"), AND ("Stable Intertrochanteric Fracture") were among the search terms that matched the MeSH rule and keyword utilized.

Inclusion Criteria

This study included one-of-a-kind articles that detailed (1) patients of any age, gender, or race with a stable intertrochanteric fracture. The AO/OTA classification system was used to classify trochanteric fractures as types 1, 2, and 3 fractures, and patients selected for the present study were all patients with type A1 fracture; (2) intervention-PFNA versus DHS; (3) studies that reported a favorable outcome with a continuous variable, as measured by the Harris Hip Score (HHS), and a dichotomous variable, as measured by the revision rate; and (4) studies that were written in English. Those with fractures other than intertrochanteric femur fractures, infection, or congenital deformity were excluded. Intertrochanteric femur fractures in people who were not osteoporotic were eliminated. Nonhuman in vivo and in vitro studies, as well as noncomparative studies, were committed.

Evaluation of Quality

Study quality and risk of bias were assessed using criteria published by the Oxford Center for Evidence-based Medicine, perspicacity as defined by the GRADE Working Group, and sanction by the Agency for Healthcare Research and

Quality (AHRQ). While the evidence is divided into four categories: "class I" for high-quality RCTs, "class II" for moderate to low-quality RCTs and good-quality cohorts, "class III" for moderate or low-quality cohorts and case-control studies, and "class IV" for case series.

RESULTS

Literature search, Study selection and Study Characteristics

From multiple databases, the electronic search yielded 147 records. The remaining four studies were included in qualitative and quantitative synthesis after the identification, screening, eligibility, duplicate elimination, and exclusion processes. The remaining publications were removed from the study because they lacked mean and standard deviation data and did not meet the inclusion and exclusion criteria.

Statistical Analysis

All statistical analyses were performed using the Review Manager version 5.3 software (RevMan; The Cochrane Collaboration Oxford, England). We conducted a sensitivity analysis to better examine the overall results due to the study's heterogeneity. The I2 statistic was used to assess study heterogeneity, which was classified as low (25 percent to 50 percent), moderate (50 percent to 75 percent), or high (>75 percent). When little heterogeneity was observed in trials, we used fixed-effect models to determine overall MDs/ORs. We applied the random effects model in other circumstances. P values less than.05 were considered statistically significant in studies. The results of our meta-analysis were represented by forest plots.

ROM Outcome

We used a subgroup analysis to compare the functional outcomes of PFNA and DHS. (7-10 In terms of HHS, we discovered no significant difference between the two methods (Heterogeneity, I2=99 percent; WMD, -1.02; 95 percent Confidence Interval (CI), -6.72 to 4.69; P = 0.73).

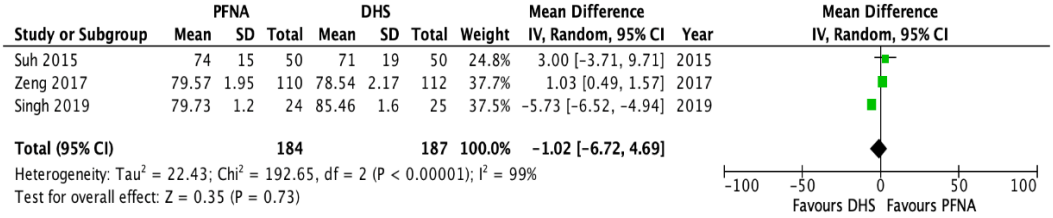

Figure 1: shows a 12-month postoperative analysis of the Harris Hip Score.

Rate of Revision

In the stable Intertrochanteric fracture, we ran a subgroup study to compare the revision rate in PFNA vs DHS. The mean revision rates for PFNA (n=784) and DHS (n=766) were 2.68 percent and 2.48 percent, respectively, from four studies included in this subgroup analysis. In terms of revision rate, Figure 2 indicated no significant difference between the two techniques (Heterogeneity, I2 = 57 percent; WMD, 1.37; 95 percent Confidence Interval (CI), 0.40 to 4.69; P = 0.61).

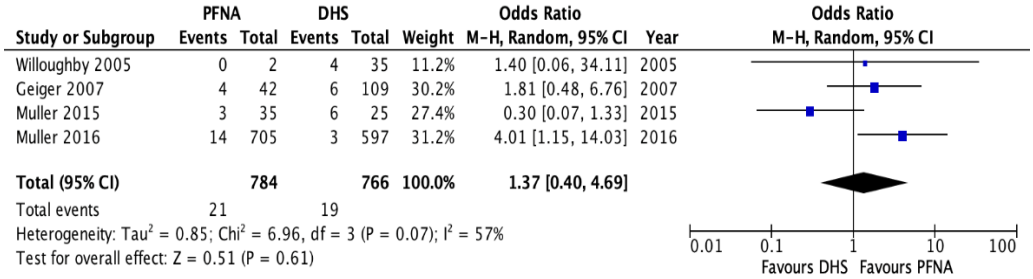

Figure 2: Revision Rate Analysis

Study characteristics for functional Harris Hip Score assessment of Primary PFNA vs. DHS

No.	Reference	Patient Characteristics					Procedure		Fracture Type		Intraoperative			
		Sample Size	Age		Sex		PFNA	DHS	PFNA	DHS	Blood Loss (cc)		Operation Time (min)	
			PFNA	DHS	Male	Female					PFNA	DHS	PFNA	DHS
1	Suh *et al.* (2015)[6]	100	73.8±9.5	77.3±8.8	45(45%)	55(55%)	50 (50%)	50 (50%)	AO A2.2: 35 (70%) AO A2.3: 15 (30%)	AO A2.2: 38 (76%) AO A2.3: 12 (24%)	NA	NA	NA	NA
2	Zeng *et al.* (2017)[3]	222	74.34± 8.18	75.16± 8.80	85(38.29%)	137(61.71%)	110(49.55%)	112 (50.45%)	AO A1.1: 32 (29.09%) AO A1.2: 48 (43.64%) AO A1.3: 30 (27.27%)	AO A1.1: 36 (32.14%) AO A1.2: 42 (37.5%) AO A1.3: 34 (30.36%)	NA	NA	NA	NA
3	Singh *et al.* (2019)[1]	49	72.76 ± 9.5	69.33 ± 5.7	25(41.67%)	35 (58.33%)	24 (48.98%)	25 (51.02%)	AO A1.1-A1.3: 22 (73.33%) AO A2.1: 8 (26.67%)	AO A1.1-A1.3: 20 (66.67%) AO A2.1: 10 (33.33%)	116 ± 48.6	207.24 ± 81.3	54.66 ± 19.20	71.1 ± 24.81

No	Reference	Outcome				Complications		Follow Up Period (Month)
		HHS 12 Months		Other Outcome				
		PFNA	DHS	PFNA	DHS	PFNA	DHS	
1	Suh *et al.* (2015)[6]	74±15	71±19	Koval Score: 2.5±2.2 VAS: 2.8±3.6 LLD: 3.0±4.1	Koval Score: 3.0±2.3 VAS: 2.8±3.8 LLD: 5.1±6.3	NA	NA	12
2	Zeng *et al.* (2017)[3]	79.57 ±1.95	78.54± 2.17	NA	NA	Total: 11 (10%) Femoral shaft fracture after implant removal: 3.64%. Others: lateral cortex fracture, malunion, nonunion, heterotrophic ossification, osteolysis, infection.	Total: 39 (34.82%) Femoral shaft fracture after implant removal: 12.5%. Others: lateral cortex fracture, LLD, malunion, varus collapse, screw cut-out, implant failure	±38
3	Singh *et al.* (2019)[1]	79.73 ± 1.20	85.46 ± 1.60	SF-12 PCS: 43.56 ± 11.25 MCS: 51.89 ± 12.56	SF-12 PCS: 47 ± 10.89 MCS: 53.46 ± 11.54	Total: 4 (13.33%) Varus collapse, lateral migration of screw, nonunion, reoperation.	Total: 9 (30%) Lateral migration of screw, infection, femoral shaft fracture, reoperation, decubitus, hyponatremia, atrial fibrillation, pneumonia	12

Study characteristics for revision rate assessment of Primary PFNA vs. DHS

No.	Reference	Patient Characteristics							Procedure		Revision Rate		Cause of Revision	Follow Up Period (months)
		Sample Size	Age		Sex		Fracture Type		PFNA	DHS	PFNA	DHS		
			PFNA	DHS	Male	Female	PFNA	DHS						
1	Zeng *et al.* (2005)[8]	37	±87		12(33%)	25(67%)	AO 31-A3		2 (5.4%)	35 (94.6%)	0 (0%)	4 (11%)	Mostly loss of position of the implant/fracture and pain making mobility unmanageable	NA
2	Geiger *et. al.* (2007)[9]	151	75 ±12	79±9	45 (29.8%)	106 (70.2%)	AO A1: 7 (17%) AO A2: 29 (69%) AO A3: 6 (14%)	AO A1: 57 (52%) AO A2: 48 (44%) AO A3:5 (4%)	42 (27.81%)	109(72.19%)	4 (9.5%)	6 (5.5%)	Cutting out of the screw in osteoporotic bone and postoperative hematoma.	12
3	Muller *et al.* (2015)[10]	60	90-99		23 (19%)	98 (81%)	Femoral neck (50.4%) Pertrochanteric (45.5%) Subtrochanteric (4.1%)		35 (58.3%)	25 (41.7%)	3 (8.57%)	6 (24%)	Hematoma, infection.	>24
4	Muller *et al.* (2016)[11]	1302	84.8 (57-95)		Female 23x >>		Proximal femur, spiral most common		705 (54.15%)	597 (45.85%)	14 (1.99%)	3 (0.5%)	Hematoma, fracture dislocation, periprosthetic fracture	120

No.	Reference	HHS 12 Months		Complications	
		PFNA	DHS	PFNA	DHS
1	Yu *et al.* (2016)[5]	85.40 ± 2.39	85.40 ± 2.39	Total: 25 (20.83%) Fracture most common. Others: dislocation, heterotrophic ossification, infection, pulmonary embolism, nerve injury.	Total: 16 (22.86%) Fracture most common. Others: infection, heterotrophic ossification, nerve injury.
2	Zeng *et al.* (2017) (a)[3]	82.54 ± 2.49	81.91 ± 4.36	Total: 12 (16.7%) Postoperative periprosthetic fractures most common. Others: prosthetic instability, dislocation, limb length discrepancy (>2.5 cm), abductor tendon deficiency, heterotopic ossification, and aseptic loosening	Total: 27 (37.1%) Post- operative periprosthetic fractures most common. Others: prosthetic instability, dislocation, limb length discrepancy (>2.5 cm), heterotopic ossification, aseptic loosening and late deep infection requiring removal of hardware.

DISCUSSION

There is currently no agreement on which implant (a DHS or a PFNA) is the best for Type A1 Intertrochanteric Femoral Fracture.[4] The study was started to see if there were any differences in outcomes between DHS and PFNA in the treatment of stable IFFs (type AO/OTA 31.A1).[5] The hypothesis was that DHS would have more complications and a worse outcome than PFNA in the treatment of stable IFFs (type AO/OTA 31.A1). Many writers who compared DHS and PFNA devices in stable IFF found no significant differences in the outcomes of either DHS or PFNA implant therapies.[5]

Early mobilization, prompt union, and restoration of optimal functional outcome are all goals of fixation, as are minimizing problems and achieving healing. Many internal factors, such as the patients' age, general health, and existing comorbidities, have a role in the outcomes. However, the availability and price of an implant should always be considered, as well as the peculiarities of each particular patient. Due to its unique feature of controlled collapse at the fracture site and low rate of non-union, the Dynamic Hip Screw (DHS) was widely utilized as the standard implant of choice in the 1980s. However, many surgeons observed a significant proportion of DHS reoperations due to fixing failure, particularly in unstable fractures. Various adjustments and developments have been undertaken to address these difficulties, including the introduction of PFNA in the hopes of improving postoperative outcomes.[1] Intramedullary fixation with PFNA is thought to lower the probability of implant fatigue failure due to the advantages of closed insertion through a tiny incision and a shorter lever arm. It also looked to be superior due to its capacity to diffuse and alleviate concentrated stress caused by the intramedullary fixation's biomechanical features.[1,6]

It has been suggested that postoperative HHS be used to determine functional outcome in patients with stable IFFs. After one year, Yu et al discovered a significant difference in postoperative HHS across the groups.[5] The postoperative HHS represents key functional outcomes relating to the ability to preserve the patient's independence, despite the variations being transient and small. In numerous trials comparing the DHS and PFNA devices in stable IFFs, postoperative HHS has been inconsistent. The authors found no difference in postoperative HHS between the groups in an RCT comparing the PFNA devices versus the DHS devices in stable IFFs at 0.6-1 postoperative year. However, in a recent randomized clinical trial, the authors discovered a significant difference in postoperative HHS after one year.[5]

The efficacy of these methods has been compared in some cohorts and clinical trials, with mixed results. We show that both methods are similarly effective in terms of 12-month Harris Hip Score in this systematic review and meta-analysis, which suggests that both surgeries are comparable in terms of postoperative pain, function, deformity, and range of motion.[7] However, particular precautions should be taken in the case of DHS. Fracture displacement may occur as a result of the draw of the iliopsoas, gluteus medius, and short external rotator muscles on the proximal fragment, despite the fact that it is less expensive than PFNA. This is especially true in unstable fractures. When a force is conveyed to the fracture line, other issues to watch for include varus collapse, retroversion, future deformity, or nonunion. Furthermore, when putting the implant, care should be exercised because a fracture of the lateral wall could turn a stable intertrochanteric femur fracture into an unstable one. In these cases, despite acceptable initial reduction and satisfactory fixation, using a DHS device could increase the risk of problems.[7]

Despite the fact that several studies have demonstrated that PFNA is superior to DHS in treating stable IFFs, there has been a trend toward more DHSs in stable. In the past, there has been a higher rate of

reoperation after DHS than after PFNA. At the latest follow-up, the PFNA and DHS groups had reoperation percentages of 6.4 and 13.4%, respectively, which were comparable to rates in recent research. This conclusion is consistent with prior clinical findings on reoperation rates. Most studies found that when a DHS was used instead of a PFNA, the rates of reoperation and post-operative femoral fractures after implant removal were greater.[5]

There are various drawbacks to this study: (1) The majority of the research are of level III evidence. (2) The studies included are highly heterogeneous, particularly for primary 1-year HHS. (3) Because of the study's limitations, all forms of intertrochanteric femur fractures were considered. Given that PFNA is now recommended over DHS for unstable intertrochanteric femur fractures, this may contribute to the heterogeneity of the research involved.[4,5] However, to the best of our knowledge, this is the first study to formulate a meta-analysis on the subject. This study also gains points for a thorough review of the revision rate and secondary functional outcome. In the future, it is hoped that this study would influence future research by allowing researchers to undertake well-designed trials with a larger number of samples.

CONCLUSION

We can conclude from this study that PFNA and DHS are both viable options in the treatment of stable intertrochanter femur fractures, as both treatments have a similar 1-year functional outcome. PFNA, on the other hand, may benefit from minimal blood loss, shorter surgery times and lower revision rate. DHS have higher risk to turn stable fracture into unstable. Some perioperative complications, including as peri-implant femoral fracture, infection, and implant failure, should constantly be monitored

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