Original Article

Pertrochanteric Hip Fracture Fixation with 3 Hole and 4 Hole DHS Side Plates - A Retrospective Patient Record Review

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Abstract

Introduction: Dynamic hip screw fixation (DHS) with a 4-hole side plate and 4 bi-cortical screws is considered by many to be the standard implant for extracapsular hip fractures. The 4-hole side plate, however, has several disadvantages including longer incision, increase in operating time, bleeding and increased wound morbidity. Biomechanical studies have shown that most of the force in a 4-hole DHS fixation is borne by the proximal three screws. This study (specifically) compares the outcome of fixation using 3-hole and 4-hole DHS in extracapsular hip fracture fixations (with the hypothesis being that 3-hole plate is adequate even in unstable intertrochanteric fractures. **Patients and Methods:** A total of 72 consecutive patients who had DHS fixation with either a 3 hole or 4 hole DHS side plate and who were either directly operated or supervised by a single consultant were recruited. Fractures were classified using the AO fracture classification system as stable (AO/OTA 31A1–31A2.1) and unstable (31A2.2–31A3.3 subtypes) for ease of comparison. Failure was defined as metalwork breakage, nonunion, screw cut-out or pull out or any other complications of bone healing requiring a revision. **Results:** A total of 23 patients (68.1%) were female, whereas 49 patients (31.9%) were male. Fractures in 33 patients were classified as stable with the (AO/OTA 31A1–31A2.1) and unstable in 39 patients with (31A2.2–31A3.3 subtypes). Thirty-three (45.8%) patients had fixation with 3-hole side plate, whereas 39 (55.2%) patients had fixation with 4-hole side plate. In the 3 hole group, 17 patients had stable fractures, whereas 16 patients had unstable fracture configuration while in the 4-hole DHS side plate group, 16 patients had stable fracture configuration, whereas 23 patients had unstable fracture. The mean change in hemoglobin was lower for the 3-hole DHS group (3 hole-6.64 g/l versus 4Hole 12.41 g/l) ($t = 1.732$, $P = 0.090$, $P \leq 0.05$). One patient in each group also had metalwork failure with screw cut-out through the head and the other being (screw breakage) complete failure of the screw necessitating conversion to total hip arthroplasty. **Conclusion:** Three-hole DHS plate offers comparable outcome with its 4-hole counterpart even with unstable intertrochanteric fractures, with slightly less blood loss and smaller scars.

Keywords: Cannulated hip screw, change in hemoglobin, dynamic hip screw, extracapsular hip fracture, intertrochanteric fracture, metalwork failure, pertrochanteric fracture, revision hip

Introduction

Over 65,000 patients suffer hip fracture in the UK yearly and this is associated with significant morbidity and Mortality.[1] Nonoperative management has been largely abandoned and rigid fixation which guarantees early mobilization is considered the standard of care.[2,3] Extracapsular hip fracture is considered the most common with incidence as high as 50 per 100,000 in a number of countries.[4]

Dynamic hip screw fixation (DHS) with a 4-hole side-plate and 4 bi-cortical screws is considered by many to be the standard implant for extracapsular hip fractures.[5-7] The 4-hole side plate, however, has some slight disadvantages including longer incision, increase in operating time, bleeding, increased wound morbidity (pain and cosmesis), and potentially cost. Biomechanical studies done comparing 2 hole to 4 hole fixation have revealed similar load to failure characteristics[8] and most of the force is borne by the proximal three screws.[6]

Access this article online

Quick Response Code:

Website: www.njmonline.org

DOI: 10.4103/NJM.NJM_120_21

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How to cite this article: Akinyemi TO, Mannan S, Ayeni FA. Pertrochanteric hip fracture fixation with 3 hole and 4 hole dhs side plates - A retrospective patient record review. Niger J Med 2022;31:144-8.

Submitted: 09-Jul-2021 **Revised:** 24-Jul-2021
Accepted: 17-Jan-2022 **Published:** 29-Apr-2022

Fixation with 2-hole DHS though favoured by existing literature has not been popular because of concern of inadequate fixation, especially in intertrochanteric fractures with unstable configuration. Laohapoonrungsee in his study found good overall outcome in patients fixed with 2 hole DHS, but all the failures were in the unstable fracture group.[9] Furthermore, over 80% of patients in the study with mild-to-moderate collapse had unstable fracture pattern. Therefore, based on the concerns stated above, we have used predominantly the 3-hole DHS in our practice with the aim of overcoming the shortcomings of the 2-hole side plate; however, most surgeons use a 4-hole plate simply as a routine.

While 2-hole DHS has been regarded as the standard of care for stable intertrochanteric fracture, our literature search only yielded a handful of studies specifically looking at the role of 3 hole DHS in unstable fracture configuration despite studies showing most of the forces are borne by the proximal three screws.[10-12] Based on this fact, we hypothesize that the addition of an extra screw with a 4-hole DHS might not be of any additional benefit in unstable fracture configuration.

The aim of this study therefore was to compare the outcome of surgery using the 3 hole and the 4 hole DHS.

Patients and Methods

This is a retrospective study carried out on 72 consecutive patients who underwent DHS fixation using either a 3 or 4 hole DHS plate over a year period in a small district general hospital. This study was registered as a quality improvement project with the clinical audit department of the hospital. Our firm has a database containing data of operated patients. This database contains demographic data, fracture type, complications, and reoperations.

All patients with extracapsular hip fractures during the study period were included. Any inappropriate fixation necessitating immediate reoperation, poor fixation, inadequate reductions, and patients who died while on admission were excluded. Extremely unstable fractures which requires longer than 3–4 hole plates and patients with hematologic conditions that could cause increased blood loss were excluded. All patients on anticoagulants had corrections or reversal as appropriate before the procedure. Details of patients who met the inclusion criteria were extracted from the database, radiographs were obtained from the Picture Archiving and Communication system (PACS) and blood results evaluated through Integrated Clinical Environment (ICE) software used by the hospital. All patients were either directly operated or supervised by a single consultant orthopaedic surgeon.

Using the radiograph available on PACS, the underlying fractures were classified using the AO fracture classification system which has been found to be an efficient classification system with good inter- and intra-observer reliability.[13] This was also be further subclassified into stable (AO/OTA 31A1–31A2.1) and unstable (31A2.2–31A3.3 subtypes)[4] for ease of comparison. Pre- and postoperative haemoglobin was evaluated using results available on the ICE system.

All patients had closed reduction with a fracture table under image intensifier and fractures were fixed using the lateral approach and following standard protocols.[14] 135-degree DHS with either 3-or 4-hole side plate (Stryker Omega3) were used for all patients and all the holes filled with 4.5 mm cortical screws. All patients were encouraged to weight bear from day 1 as pain allowed. This follows the departmental rehabilitation protocol which is in line with the national guideline.

These patients were operated under the National Health Service which has network with local general practice (GP) clinics. The robust health and clinical network allow easy monitoring and follow-up of patients. Therefore, patients were encouraged to schedule follow-up appointments if they noticed increasing groin pain, difficulty mobilizing, or problems with wounds. Intraoperative fluoroscopy images were retrieved along with postoperative X-rays where available, the GP records were also looked at to ascertain if they had been seen for problems related to the operated hip. During this review, communication and clinic letters as well as available radiologic images on PACS were also meticulously searched. Failure was defined as metalwork breakage, nonunion, screw cut-out or pull out or any other complications of bone healing requiring a revision. For the purpose of this study, the last follow up date for this patient was determined as the last day of analysis of the study which was a year after the last operation was carried out.

All obtained data were entered into an Excel spreadsheet and analyzed to compare blood loss and rate of metal work failure with SPSS Version 25 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp) using the independent sample *t*-test and frequencies.

Results

A total of 72 patients who had hip fixation with DHS during this period and met the inclusion criteria were recruited into the study. Twenty-three patients (31.9%) were male, whereas

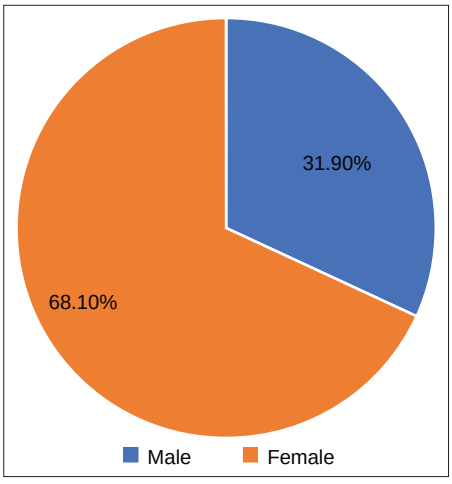

Figure 1: Pie chart showing patients gender

49 patients (68.1%) were female, as shown in [Figure 1]. The age range of patients in this study was 46–97 years with a mean of 84.6 years. The 3-hole DHS group had an age range of 46–96 years, with a mean age of 83.5 years, whereas the 4-hole DHS side plate group had a range of 66–97 years with a mean age of 85.6 years. The mean age of both groups was therefore comparable.

A total of 33 patients had their fracture classified as stable with the (AO/OTA 31A1–31A2.1) and 39 fractures were considered unstable with (31A2.2–31A3.3 subtypes [Table 1]). Thirty-three (45.8%) patients had fixation with 3 hole side plate, while 39 (55.2%) patients had fixation with 4 hole side plate see [Table 2]. In the 3 hole side plate group, 17 patients had stable fractures, whereas 16 patients had unstable fracture configuration while in the 4 hole DHS side plate group, 16 patients had stable fracture configuration while 23 patients had unstable fracture.

The mean change in haemoglobin was lower for the 3 hole DHS group (3 hole-6.64 g/l, 4Hole 12.41 g/l). This change however was not significant ($t = 1.732$, $P = 0.090$, $P \leq 0.05$) as shown in [Table 3]. One patient in each group also had metalwork failure with screw cut-out through the head and the other screw breakage (rather than pull-out), both necessitating conversion to total hip arthroplasty [Figure 2]. This complication was noticed within one year of the original surgery. A summary of the patient characteristics and outcome is shown in [Table 4].

Table 1: Distribution pattern of the fractures

	Frequency (%)
Extracapsular (stable)	33 (45.8)
Extracapsular (unstable)	39 (55.2)
Total	72 (100)

Table 2: The distribution of the plate used

DHS side plate	Frequency (%)
3 hole	33 (45.8)
4 hole	39 (55.2)
Total	72 (100)

DHS: Dynamic hip screw

Table 3: Difference in haemoglobin between the two groups

	Hole-type	*n*	Mean	SD	df	*t*	*P*
Change in haemoglobin	3 hole	33	6.64	6.547	47.73	1.732	0.090
	4 hole	39	12.41	19.563			

Statistical technique: Independent samples *t*-test (unequal variances assumed). SD – Standard deviation, *n* – Frequency

Table 4: Summary of patient characteristics and outcome

Characteristic	Value	Percentage
Mean age (years)		
Male	83.5	
Female	85.5	
Mean age range/group		
3 hole DHS	46-96	
4 hole DHS	66-97	
Gender		
Male	49 patients	31.9
Female	23 patients	68.1
Fracture pattern		
Stable	33 patients	45.8
3 hole DHS	17 patients	
4 hole DHS	16 patients	
Unstable	39	54.2
3 hole DHS	16	
4 hole DHS	23	
Mean change in haemoglobin (g/l)		
3 hole DHS	6.64	
4 hole DHS	12.41	
Metalwork failure		
3 hole	1 patient	3
4 hole	1 patient	2.6

DHS: Dynamic hip screw

Discussion

DHS is the standard fixation method for extracapsular hip fracture, although another acceptable alternative is the intramedullary nail (IM).[15] IM nail though a suitable alternative is usually preferred for subtrochanteric and reverse oblique fractures, as well as fractures with lateral wall involvement, though associated with increased complications of blood loss and greater reoperation rate.[16] DHS allows controlled collapse at the fracture site thus allowing improved stability and early mobilisation without the complications associated with IM nailing.[17] Because of the benefits of the DHS, and in line with established guidelines, the patients in this study were operated using either a 3 hole or 4 hole DHS.

McLoughlin in his landmark study found no biomechanical difference between the 2 hole and the 4 hole side plate and therefore advocated the use of the 2 hole DHS side plate.[8] Yian *et al*. however, observed better distribution of tensile forces with 3 hole plate fixation.[18] Despite McLoughlin's findings many surgeons still prefer the 4 hole side plate because of its greater rigidity and stability especially in unstable fracture configurations. The 3 hole side plate therefore provides a midpoint between the possibility of inadequate fixation associated with 2 hole fixation and the possible problems associated with a 4 hole side plate i.e., using an unnecessary additional screw.

Many studies have been done comparing 2 hole side plate to 4 hole side palate but to the best of our knowledge only a few compared 3 hole with 4 hole fixation.[10] A cadaveric study by Olsen *et al*.[10] compared 3 hole versus 4 hole DHS and found no difference in the stress to failure. This study was however a cadaveric study and will be difficult to determine if this will be the ideal behaviour in living tissue. Blood loss was also impossible to measure in this situation. As the barrel plate is shorter in the 3 hole configuration, it potentially will be associated with a shorter

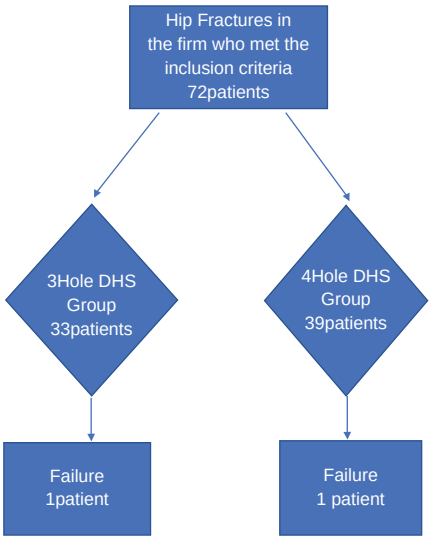

Figure 2: Patients flowchart

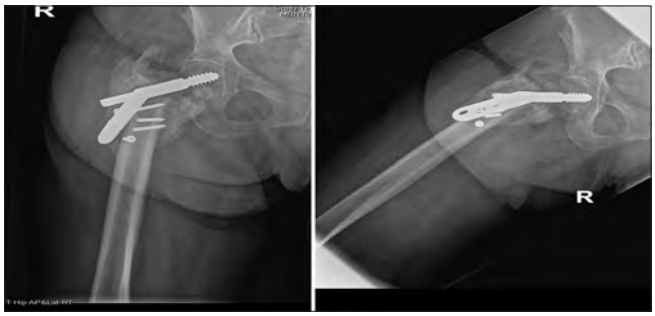

Figure 3: Showing metal work failure in one of the patients

Figure 4: Showing screw cut-out in one of the patients

incision and less blood loss. This indeed correlates with the result of our study. Even though this study showed no significant difference in the blood loss between the 2 groups (t = 1.732, P = 0.090), the postoperative mean haemoglobin was marginally higher in patients operated with the 3 hole side plates (mean loss of 6.64 g/l in the 3 hole group versus 12.41 g/l in the 4 hole group). This suggests that a 3 hole DHS might be a suitable alternative to the traditional 4 hole side plate. In addition, there was no difference in failure rate in the 2 groups as one patient in each group had a failure. However, the 2 failures were in the unstable fracture group. The exact reasons why these 2 failed was not clear, however, most mechanical failure is because of Varus collapse and fixation with more screws may allow further neutralisation of the tensile forces [Figures 3 and 4].[19] We however attribute the failure in our series to fatigue failure of the metal work (i.e., would have failed even with 4 or 5 screw holes as screw breakage was the issue, and not screw pull out) and lag screw cut-out through the head (which is related to TAD-Tip Apex distance, not the length of plate) perhaps placing the bottom-most drill hole and screw first, to be sure about centralization of plate on femur shaft would give a better hold and improved bi-cortical fix.

Hip fractures have been found more in individuals 50 years and above as this is associated with increased risk of osteoporosis precipitated by age, reduced activities, and other factors. This is in keeping with the result of this study where 68.1% of our patients were females who are more at risk of osteoporosis as they advance in age.

Limitations of this study

We recognized that this study is indeed limited because of its retrospective nature. It was therefore difficult to control confounding factors such as comorbidities (osteoporosis, chronic kidney disease, etc.) which might affect the outcome measures. True randomization could not also be achieved because of this. Furthermore, as our study did not set out to determine other complications of DHS fixation, this was therefore not evaluated in this study.

Notwithstanding, this study gives an idea of the potential benefit of using shorter side plates and can indeed serve as a template for designing a proper randomized controlled trial to further evaluate this potential benefits.

Conclusion

Three-hole DHS plate offers comparable outcome with its 4 hole counterpart in extracapsular hip fractures. It also has the additional benefit of reduced blood loss and be more minimally invasive. Based on the result of this study, it is recommended that 3-hole DHS should be used even in unstable fractures and should become the standard of care, as most surgeons would like the safety provided by an extrascrew hole and 6 cortices of hold.

It is our hope that adopting 3 hole DHS plate as the standard will provides a more rigid construct with better stability and lower risk of failure (as compared to a 2 hole plate) as well as reduced blood loss and smaller scar, as well as reduced time of surgery (as compare to a 4 hole plate). Carefully designed randomized control trials will be needed to further evaluate these findings.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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