

Dynamic hip screw versus proximal femur locking compression plate in intertrochanteric femur fractures (AO 31A1 and 31A2): A prospective randomized study

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Abstract

Introduction: Intertrochanteric fractures are common in elderly population and pose a significant financial burden to the society. Anatomically contoured proximal femur locking compression plate (PFLCP) is the latest addition in the surgeons' armamentarium to deal with these fractures. It creates an angular stable construct, which will theoretically lessen the risk of failure by screw cut-out and varus collapse, the common mode of DHS failure. We compared DHS with PFLCP in AO type 31A1 and 31A2 intertrochanteric fractures. **Materials and Methods:** A randomized prospective study was carried out between June 2011 and June 2013. 26 cases each of DHS and PFLCP were included. **Results:** Functional and radiological outcome was similar in both groups. **Conclusion:** Both DHS and PFLCP are good choices for stable intertrochanteric fractures, and both lead to excellent functional outcomes, but non-union might be more common with PFLCP.

Key words: Dynamic hip screw, intertrochanteric fractures, medialization, proximal femur locking compression plate, varus

INTRODUCTION

Intertrochanteric fractures are common injuries occurring predominantly as low-energy injuries in the elderly, mostly due to direct injury to hip (e.g. fall). The financial burden to the society is tremendous.^[1,2] Cooper was the first one to classify hip fractures into extracapsular (intertrochanteric) and intracapsular (femoral neck).^[3] Since the 1800s, a lot has changed in the way these fractures are managed. From conservative treatment (including hip spica and pin traction) with bed rest, to the operative fixation with modern surgical techniques and implants, we have come a long way. Early

attempts at surgical management were marred by poor asepsis, lack of intraoperative imaging, poor implant design and quality, and incomplete understanding of fracture mechanics. Langenbeck was the first to internally fix an intertrochanteric fracture with a nail.^[4] The modern era of hip fracture fixation began in 1925 when Smith Peterson introduced a triflanged nail.^[5] The real benefit of fixation lies not in improving union rates (intertrochanteric fractures rarely go into nonunion, even when treated conservatively), but in improving functional outcome and mortality rates, which are attributed to the early mobilization and better nursing care possible after surgery.

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Many implants have been used for fixation: Smith Peterson nail, Jewett nail, trochanteric buttress plate, angled blade plate, Gotfried percutaneous compression plate enders nail, dynamic hip screw (DHS), Medoff plate, cephalomedullary nails, and proximal femur locking plates. Pugh and Massie first developed the DHS in 1950s by modifying the sliding hip screw systems^[6,7] and quickly became the gold standard. Even as widespread use of DHS revealed some complications, it is still considered the gold standard by many.^[8-10] DHS is the most commonly used implant worldwide for fixation of intertrochanteric fractures. The two important complications related to DHS are uncontrolled collapse and lag screw cut-out (with or without varus collapse).^[11] Others include medialization of shaft, uncontrolled lateralization of proximal fragment. Although intramedullary nails are fast becoming the preferred choice for unstable fractures, their use is also associated with many complications: screw cut-out/blade cut-out (including Z effect and reverse Z effect), varus deformity, lateral wall blowout during reaming, difficult insertion in curved femurs, peri-implant fracture (subtrochanteric fractures in short nails), and implant breakage.^[12-14]

Anatomically contoured locking plates (proximal femur locking compression plate [PFLCP]) have been developed to provide an angular stable construct and prevent screw cut-out and varus failure.

MATERIALS AND METHODS

A randomized prospective comparative study was carried out in a Level I trauma center between June 2011 and June 2013. A total of 52 patients (26 in DHS group and 26 in PFLCP group) were enrolled based on inclusion and exclusion criteria. The method of randomization was odd-even number based. Inclusion criteria were patients who gave consent for inclusion into the study, age >18 years, and closed intertrochanteric fractures. Exclusion criteria were patients refusing to give consent, AO type 31A3 fractures, neurovascular injury, open fractures, associated ipsilateral or contralateral major limb injury (including fractures) affecting the treatment or rehabilitation protocol, associated upper limb fractures requiring surgery, and major systemic illness (malignancy, chronic kidney, liver disease, etc.). The study was approved by the Institutional Review Board and Ethics Committee. Ethical standards according to the Helsinki declaration of 1964 (and its later amendments) were conformed to. Informed consent was obtained from all patients.

All patients were put on skin traction upon admission and a thorough history and clinical examination was done along

with the relevant preoperative work-up. The radiographs obtained included AP pelvis X-ray, and AP and lateral views of the affected hip. The fractures were classified according to the AO classification.

Cefoperazone sulbactam 1 g was used as prophylactic antibiotic (administered 30 min before incision). All surgeries were done on a traction table to aid in reduction. All surgeries were performed by a single surgeon (RS). The surgical approach was the same in all cases (lateral approach), except somewhat more distal exposure in PFLCP group, depending on the length of the plate. A drain was routinely used in all cases and removed at 48 h.

In bed, mobilization was allowed from 1st postoperative day. In DHS group, toe-touch weight bearing was allowed earlier, usually within 7 days, while in PFLCP group, we allowed toe-touch weight bearing only at 6 weeks or later (depending on fracture pattern and stability of fixation). Progressive weight bearing was increased based on progress of healing on radiographs. Follow-up was done at 6, 12, 16, and 24 weeks, and 3 monthly thereafter till radiological union. The functional evaluation was done using Harris Hip Scoring system.

RESULTS

Twenty-six patients were enrolled in each group, with a minimum follow-up of 12 months. The mean age was 55.23 years for DHS group (24–76 years) and 56.46 years for PFLCP group (23–78 years), with the maximum number of patients between 60 and 70 years of age (38.46% in DHS group and 42.3% in PFLCP group). Males outnumbered females in both groups (17:9 DHS group, 15:11 PFLCP group). Mechanism of injury was a fall in most cases (77% DHS group, 73% PFLCP group). AO scheme was used to classify the fractures; in DHS group, 13 were type 31A1 and 13 were type 31A2, while in PFLCP group, 12 were type 31A1 and 14 were type 31A2 [Table 1].

The mean duration of surgery was less than an hour in DHS group while it was 93 min in PFLCP group. Postoperative blood transfusion was required in only 7.69% patients in DHS group while in PFLCP group it was 23%. Radiological union was achieved in mean duration of 17.6 weeks in DHS group and 18 weeks in PFLCP group. Functional outcomes using Harris hip score were good to excellent in 84.7% patients in DHS group and 88.4% in PFLCP group. 38.7% of patients with Type 31A2 fractures in DHS group developed significant limb shortening of more than 2 cm after radiological union while none in PFLCP group demonstrated any significant shortening [Table 2].

Table 1: Analysis of preoperative parameters

Parameter	DHS	PFLCP	P
Age (years)			
Mean (range)	55.23 (24–76)	56.46 (23–78)	0.7444 (NS), <i>t</i> -test
Sex ratio (male:female)	17:9	15:11	
Male (%)	65.38	57.69	0.7761 (NS), Fisher's exact test
Female (%)	34.6	42.3	
Side (left:right)	14:12	14:12	1 (NS), Fisher's exact test
Left (%)	53.85	53.85	
Right (%)	46.15	46.15	
Mechanism of injury (fall:RTA)	20:6	19:7	1 (NS), Fisher's exact test
Fall (%)	77	73	
RTA (%)	23	27	
Associated injuries			
Distal radius fracture	2	1	
Clavicle	1		
AO classification			1 (NS), Fisher's exact test
31A1.1	3	4	
31A1.2	6	5	
31A1 (stable)			
31A1.3	4	313	
31A2 (unstable)			
31A2.1	7	7	
31A2.2	2	4	
31A2.3	4	3	

RTA: Road traffic accident, NS: Not significant, DHS: Dynamic hip screw, PFLCP: Proximal femur locking compression plate

Table 2: Analysis of peri- and post-operative parameters

Parameter	DHS	PFLCP	Results
Duration of surgery (min)			
Mean (SD)	57.69 (13.06)	93.08 (2.89)	$P < 0.0001$ (<i>t</i> -test) (highly significant)
Range	40–90	70–110	
Blood loss (ml)			
Mean (SD)	236.54 (55.78)	305.77 (79.15)	$P = 0.0006$ (<i>t</i> -test) (highly significant)
Range	150–350	200–450	
Need for postoperative blood transfusion (%)	2 (7.69)	6 (23.07)	$P = 0.2485$ (Fisher's exact test) (NS)
Duration of hospital stay (days)			
Mean (SD)	7.73 (1.76)	8.19 (2.04)	$P = 0.3862$ (<i>t</i> -test) (NS)
Time to radiological union (weeks)			
Mean (SD)	17.56 (1.98)	18.04 (1.80)	$P = 0.3707$ (<i>t</i> -test) (NS)
<i>n</i>	26	25	
Range	15–22	15–22	
Functional outcome (Harris Hip Score)			
Mean (SD) (%)	88.88 (9.22)	88.23 (7.58)	$P = 0.7812$ (<i>t</i> -test) (NS)
Excellent 90–100 (%)	17 (65.38)	14 (53.84)	
Good 80–89 (%)	5 (19.28)	9 (34.61)	
Fair 70–79 (%)	3 (11.53)	2 (7.69)	
Poor <70 (%)	1 (3.84)	1 (3.84)	
Significant limb shortening (>2 cm) (measured at the time of radiological union) (number of cases)			
31A1	0	0	Similar results (NS) $P = 0.009$ (ANOVA) (significant)
31A2 (%)	5 (38.46)	0	
Medialization of shaft (number of cases)			
31A1	0	0	NS $P = 0.347$ (ANOVA) (NS)
31A2	1	0	

NS: Not significant, DHS: Dynamic hip screw, PFLCP: Proximal femur locking compression plate, SD: Standard deviation

No mortality was recorded in our series. No general complication from surgeries such as septicemia, deep vein thrombosis, pulmonary embolism, stroke, and myocardial infarction was encountered. Nonspecific hip pain was noticed in 2 cases of PFLCP and 1 case of DHS. Varus deformity was observed in 1 case of DHS group

(AO 31A2.3 fracture). Superficial wound infection was noted in 2 cases of PFLCP and 1 case in DHS group. There was 1 case each of implant cut-out and medialization of shaft in DHS group. One case of nonunion occurred in PFLCP group (AO 31A2.3). It was managed with bone grafting with retention of implant. The patient was a heavy

smoker with history of steroid use for skin disorder. The complications are summarized in Table 3. Figures 1a and b show intraoperative fluoroscopy images during placement of PFLCP; and Figures 2a and b, and 3a and b show radiographs (preoperative and postoperative) of two cases managed with PFLCP. Figures 4a and b show radiographs (preoperative and postoperative) of a case managed with DHS.

DISCUSSION

Mechanisms of DHS and PFLCP are quite different in the sense that DHS allows controlled collapse of fracture while locking plate is an angular stable construct preventing any shortening or collapse. Hence, there is less propensity of limb shortening in PFLCP. Owing to the locking construct, theoretically, PFLCP also has a lower risk of varus collapse and screw cut-out. However, clinically, this has shown not to be the case.^[15] Although earlier biomechanical studies showed PFLCP to be equivalent or stronger than other fixation constructs

in pertrochanteric and neck fractures,^[16,17] more recent studies have shown intramedullary nails to be superior.^[18,19]

The current dictum for management of intertrochanteric fractures is, “No lateral wall, No hip screw”.^[20] These include reverse oblique fractures and fractures extending to subtrochanteric region. The absence of a stable lateral buttress causes medialization of shaft and varus collapse of head and screw cut-out. In these fractures, either a nail or a locking plate should be used, not a DHS. We did not include AO 31A3 fractures in our study as it would have interfered with the randomization process, and also because we routinely nail such fractures at our institution.

Varus deformity was seen in 1 case of DHS group. Superficial wound infection was observed in 2 cases of PFLCP and 1 case in DHS group. There was 1 case each of implant cut-out and medialization of shaft in DHS group [Table 3].

Table 4 summarizes the findings of recent studies discussing this matter.

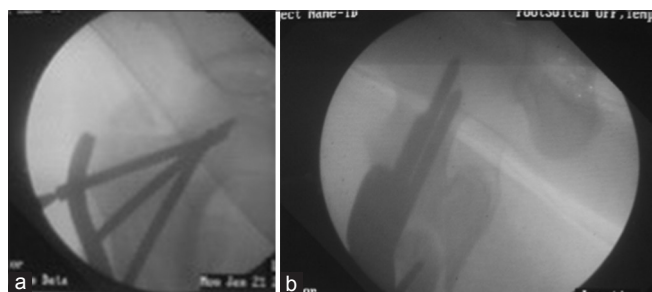


Figure 1: (a and b) Intraoperative fluoroscopy images



Figure 2: (a and b) Pre- and post-operative radiographs of a case treated with proximal femur locking compression plate

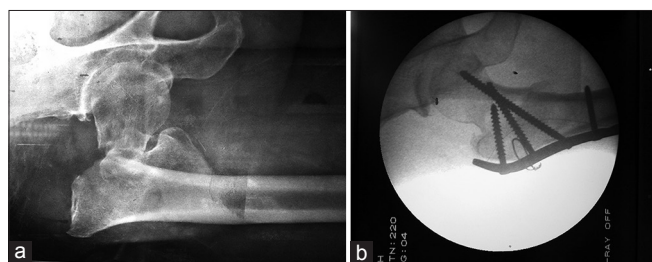


Figure 3: (a and b) Pre- and post-operative radiographs of another case treated with proximal femur locking compression plate

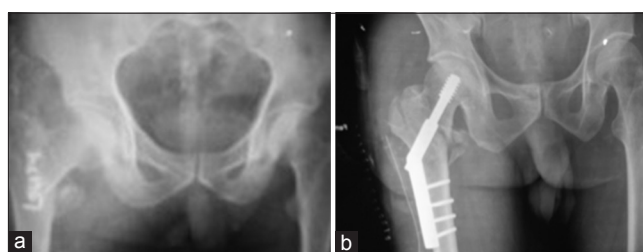


Figure 4: (a and b) Pre- and post-operative radiographs of a case treated with dynamic hip screw

Table 3: Complications following surgery

Complications	DHS		PFLCP	
	Number of cases	Percentage	Number of cases	Percentage
Varus deformity	1	3.84	-	-
Superficial wound infection	1	3.84	2	7.69
Unspecific hip pain	1	3.84	2	7.69
Implant cut-out	1	3.84	-	-
Medialization	1	3.84	-	-
Nonunion	-	-	1	3.84

DHS: Dynamic hip screw, PFLCP: Proximal femur locking compression plate

Table 4: Review of recent studies comparing dynamic hip screw with proximal femur locking compression plate for Intertrochanteric fracture fixation

Study	Cases	Results	Complications	Final verdict
Dhamangaonkar <i>et al.</i> (2013) ^[21]	40 cases of unstable intertrochanteric fractures	Mean time to union 14.6 (PFLCP) and 16.5 (DHS) weeks. Functional hip score good to excellent in 18 (PFLCP) and 11 (DHS) cases	Medialization of shaft in 0 (PFLCP) and 15 cases (DHS) Implant cut-out one in each. Mean shortening 0.3 (PFLCP) and 1.4 (DHS) cm	PFLCP has lower risk of limb shortening and shaft medialization
Mardani-Kivi <i>et al.</i> (2013) ^[22]	104 cases (44 PFLCP–14 stable, 30 unstable, 60 DHS–24 stable, 36 unstable)	Better functional score in DHS group at 6 months (Harris Hip Score–84.06 PFLCP, 88.04 DHS)	Implant failure–10 in PFLCP, 3 in DHS. Shortening of >2 cm–6 in PFLCP, 2 in DHS	Higher incidence of limb shortening and implant failure with PFLCP
Zhong <i>et al.</i> (2014) ^[23]	83 cases (AO 31A1 to A3–51 cases, AO 32–32 cases) (PFLCP–13 stable 31A1, 14 unstable 31 A2-3, DHS–8 stable 31A1, 16 unstable 31A2-3)	100% union in stable fractures (mean time PFLCP–3.3, DHS–4.3 months) 9 nonunions in unstable fractures (PFLCP–4 cases/28.6%, DHS–5 cases/31.3%)	In unstable fractures-PFLCP–4 nonunions (28.6%), 5 deformities (35.7%), 3 implant breakage (21.4%), 0 screw cut-out DHS–5 nonunions (31.3%), 5 deformities (31.3%), 3 implant breakage (18.9%), 1 screw cut-out (6.3%)	DHS fixation is preferable for stable intertrochanteric fractures. For unstable intertrochanteric fractures, the value of PFLCP fixation needs to be confirmed by further clinical studies
Huang <i>et al.</i> (2015) ^[24]	90 cases of unstable intertrochanteric fractures (PFLCP–30, PFNA–30, DHS–30)	Mean union time–PFLCP 101.10, DHS 107.12, PFNA 90.80 days. Harris Hip Score excellent to good–PFLCP 25 (83.30%), DHS 21 (70%), PFNA 28 (93.30%)	PFLCP–3 varus (10%), 1 loosening (3.3%), 2 DVT (6.7%) DHS–5 varus (16.7%), 2 loosening (6.7%), 1 DVT (3.3%) PFNA–1 varus (3.3%), 0 loosening, 0 DVT	PFNA is better than PFLCP and DHS with respect to operative time, blood loss, duration of union, earlier weight bearing, and postoperative complications
Asif <i>et al.</i> (2016) ^[25]	60 case of unstable intertrochanteric fractures (PFLCP–25, DHS–35)	PFLCP–union in 23 cases (92%), Harris Hip Score–PFLCP 14 (56%) excellent, 8 (32%) good. DHS	PFLCP–3 implant failure, 0 medialization, 3 varus collapse, mean shortening of 0.18 cm DHS–3 head screw cut-out, 7 medialization, 8 varus collapse, mean shortening of 1 cm	Treatment of unstable intertrochanteric fractures with PFLCP can give good healing, with a limited occurrence of complications
Our study	52 cases PFLCP–12 stable and 14 unstable. DHS–13 stable and 13 unstable	PFLCP–Union in 96.16% DHS–Union in 100% Functional hip score good to excellent in 84.7% (DHS) and 88.4%(PFLCP) cases Significant shortening in 38.46% patients with 31A2 fracture in DHS group	Varus deformity in 1 case of DHS group Superficial wound infection in 2 (PFLCP) and 1 (DHS) cases. 1 case each of implant cut-out and medialization of shaft in DHS group	Functional outcomes in both DHS and PFLCP group are comparable Risk of shortening in unstable fractures is less in PFLCP group

DHS: Dynamic hip screw, PFLCP: Proximal femur locking compression plate, DVT: Deep vein thrombosis, PFNA: Proximal femoral nail antirotation

Limitations of our study include limited sample size, no correlation of results to severity of osteoporosis, and inclusion of both stable and unstable fractures.

We have made following observations when using PFLCP to fix intertrochanteric fractures, especially the unstable ones:

- Delayed weight bearing: Toe touch walking is to be delayed till at least 6 weeks in unstable fractures with limited posteromedial cortical contact (earlier weight bearing might be done in undisplaced fractures or where perfect posteromedial cortical continuity has been reestablished before fixation). Progressive weight bearing is to be increased based on progression of healing. Full unassisted weight bearing should be permitted only after union
- Low threshold for open reduction: Once plate is applied, there is no scope for collapse and subsequent increase in cortical contact. Hence, if any doubt exists, open reduction must be done before fixation to ensure adequate posteromedial contact
- Avoid fixing in distraction: No collapse is possible postoperatively. Although most fractures will heal even with slight distraction, there will always be a risk of implant breakage before fracture heals
- Careful plate positioning: Optimal positioning of plate and proximal head screws must be ensured in AP and lateral projections. Proximal screws should be as long as possible (preferably within 5–10 mm of subchondral bone), inferior most head screw (Kickstand screw) should skirt and engage the calcar

Table 5: Advantages and disadvantages of both implants

DHS		PFLCP	
Advantages	Disadvantages	Advantages	Disadvantages
Long track record surgeon familiarity High union rate	Shortening Varus collapse, screw cut-out and medialization in unstable fractures	Biomechanically stronger locked construct No shortening; theoretically less risk of varus collapse and cut-out	Early weight bearing not permissible Any fracture gap is not tolerated due to absence of secondary collapse
Permits early weight bearing	Poor results in reverse oblique fractures, and fractures with subtrochanteric extension	Can be used for fractures extending to subtrochanteric region, and for reverse oblique fractures	May have a higher nonunion rate

DHS: Dynamic hip screw, PFLCP: Proximal femur locking compression plate

- Low threshold for bone grafting: Although we could find only one study describing primary autologous bone grafting in unstable intertrochanteric fractures,^[26] we are of the opinion that it might be a useful procedure. Because many surgeons would consider it an overkill, a useful strategy is to assess the need for bone grafting at around 2 months of time, when decision is being made to progressively increase the weight bearing of the patient.

Table 5 summarizes the advantages and disadvantages of both these implants.

CONCLUSION

We conclude that DHS and PFLCP are both good choices for stable intertrochanteric fractures, and both lead to excellent functional outcomes. The choice depends on surgeon's preference and comfort level with the routine use of the implant. NICE (National Institute for Health and Care Excellence) guidelines^[27] state DHS as the implant of choice for stable fractures. There is lesser risk of shortening in unstable fractures treated with PFLCP. However, the controversy is still on and large multicenter prospective trials comparing DHS, PFLCP, and intramedullary nails are needed to reach a conclusion. One must understand that each device has its unique set of limitations and complications. In our opinion, both are comparable with regard to functional outcome, but nonunion might be more common with PFLCP.

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Conflicts of interest

There are no conflicts of interest.

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