

Original Article

Comparison of percutaneous compression plating and dynamic hip screw for treating femoral intertrochanteric fractures in elderly patients

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Abstract: Objective: The study seeks provide a comparison between percutaneous compression plate (PCCP) fixation and dynamic hip screw (DHS) fixation for the purpose of treating fractures of the osteoporotic intertrochanteric femoral bone. Methods: Thirty-six senior patients with intertrochanteric fractures were gathered as participants for the present research, distributed under the PCCP (n = 30) group or DHS (n = 22) group between July 2011 and December 2013. Operation time, incision length, blood loss, time to fracture union, and serum hemoglobin (Hb), and albumin (Alb) levels were compared between groups. The hip scoring system used to evaluate the results was that of the Harris system. Results: A follow-through was made for all patients for the average span of 12 months with an actual range of 6 to 18 months. Compared with the DHS group, the PCCP group had shorter operative times, smaller incision lengths, and less blood loss ($P < 0.05$). The study noted no significant differences between groups in terms of fracture healing time or serum Hb and Alb levels. Conclusion: PCCP fixation results in superior clinical outcomes compared with DHS fixation for the stable intertrochanteric fracture treatment in elderly patients.

Keywords: PCCP, DHS, intertrochanteric femoral fractures

Introduction

Hip fractures, primarily trochanteric and femoral neck fractures, are common among people in their advanced age years because their bones become thinner and weaker due to calcium loss [1]. With the increased population of senior citizens and expanded average life expectancy, the incidence of the hip fractures has been rising [2]. According to the American Academy of Orthopedic Surgeons, the incidence of hip fractures in the USA occurs at an approximate rate of over 280,000 per year [3]. Common health outcomes for older persons who fracture a hip include mortality, disability, and functional decline [4].

Intertrochanteric fracture is considered the most commonly occurring kind of fracture, and affects the area between the femoral neck and lesser trochanter [5]. The fracture occurs secondary to direct blows, strikes, or falls affecting

the hip side; the prognosis is poor due to high mortality and morbidity rates. Surgery is necessary to promote early mobilization and avoid potentially fatal complications. However, regardless of the advancements in operative management, the fracture's morbidity rate is still high [6].

A number of implant designs were created to promote early ambulation, decrease the incidence of complications, and help in the fixation of fracture. These designs include the anatomic plate (AP), the percutaneous compression plate (PCCP), proximal femoral nail (PFN), and the dynamic hip screw (DHS) [7]. Yet apparently there exists no concurrence as to which kind is the most appropriate treatment for fractures under the intertrochanteric classification. Recent discoveries in orthopedic surgery suggest that advanced implants result in successful intertrochanteric fracture treatments, such as the frequently used PCCP and DHS implants

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that yield satisfactory outcomes [8]. Nevertheless, surgeons remain concerned about whether to utilize the aforementioned options (i.e., PCCP and DHS). To note, since the 1960s, DHS has emerged to become the customary implant for fixating intertrochanteric femoral fractures [9]. Even with the emergence of advanced surgical methods and other device options, it remains the commonly consulted option. Good control for compression, deep screw insertion, and the absence of puncture in the femoral head for the necessary impingement in the affected area are among the noted advantages of DHS [10].

Recently, surgeries that require minimal penetrations or are considered less invasive have been found to yield satisfactory outcomes for treating intertrochanteric fractures [11, 12]. For a certain period now, PFN devices with less incisions have been utilized. Likewise, the less-invasive DHS approach and device are believed to provide a better solution to the concern for complications [13]. Among elderly patients, soft tissues are relatively more tender and this must be taken into utmost consideration since tissue healing is equally critical in treating intertrochanteric fractures [14, 15]. In the same manner, when selecting for implants, soft tissue preservation plays a significant role. To note, though, no comparative research exists yet that captures the post-treatment damage on soft tissue for the utilization of DHS and PFN devices. Thus, the purpose of the present research is to provide an evidence-based comparison of the aforementioned devices' soft tissue invasiveness, in the light of providing relevant information to surgeons and helping them decide what device should be used for treating stable intertrochanteric fractures among the elderly.

Methodology

Participants

This is a retrospective analysis of 52 patients (29 male and 23 female, mean age 74.3 ± 9.5 years) who sustained a hip fracture described as unilateral extracapsular (i.e., OTA/ASIF 31A2 and 31A1) caused by low-energy trauma. All underwent surgical treatment with PCCP or DHS fixation between July 2011 and December 2013. A total of 33 fractures were brought about by falls from standing and 19 fractures

were caused by motor vehicle collisions, all of which are closed fractures.

Of the total number of patients, 22 were under the DHS group while the remaining 30 belonged to the PCCP group. In the latter group, 13 (43%) were female and 17 (57%) were male, whose ages averaged 75.8 ± 9.6 years. In reference to the AO/OTA fracture classification system, the present sample consisted of 18 31A1 fractures and 12 31A2 fractures. Additionally, in the DHS group, 12 (55%) patients were male and the remaining 10 (45%) were female. The group's mean age is 73.2 ± 9.3 years. There were 13 31A1 fractures and 9 31A2 fractures. Patients with the following conditions were excluded for the following: existence of life-threatening illnesses, occurrence of previous surgery or fracture on the same problem leg, work disability before the injury, ages under 60 years, presence of pathologic fractures, reverse oblique or subtrochanteric fracture patterns (OTA/ASIF 31A3), and absence of consent caused by confusion or dementia. The present study was approved by our Institutional Review Board. Furthermore, all patients extended their informed consent before the conduct of surgery.

Surgical techniques

The surgery was performed under general anesthesia with each patient assuming the supine position on an operating table with orthopedic traction. Intraoperatively, rotational and tractional adjustments were made to obtain and maintain reduction, as displayed on both lateral views and anteroposterior views. In the process, the lower limb's force line, anterversion and neck-shaft angle, as well as the satisfactory fluoroscopy views were closely monitored.

In the DHS fixation group, the incision level (4-5 cm in length) following the reduction of fraction was determined under fluoroscopic guidance. Using surgical scissors, the vastus lateralis muscle was cut along the femur's axis, carefully done so without peeling the periosteum, and the fascia lata was slit. This was followed by the insertion of a 1358 angle guide that targeted the femoral neck's lower part. The guide pin's depth was later determined under fluoroscopy. In the process of reaming the head and femoral neck, the soft tissue was safeguarded. Just as

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Table 1. Comparison related index between the DHS and PCCP groups

Group	The length of incision (cm)*	Intraoperative hemorrhage (ml)*	Operation time (min)*	Hemoglobin decrease (g/L)	Albumin decrease (g/L)	Fractures healing time (week)
PCCP	6.3 ± 1.2	98.7 ± 25.3	62.9 ± 11.7	14.2 ± 3.8	5.6 ± 0.8	15.1 ± 2.2
DHS	13.8 ± 2.8	286.3 ± 53.9	70.7 ± 12.6	12.3 ± 2.7	5.9 ± 1.3	16.3 ± 2.5

*There existed significant differences between the PCCP group and the DHS group ($P < 0.05$).

how the angled guide was inserted, the hip screw was put through in the same manner. In the hope of minimizing injury to soft tissue, the 3-hole plate's barrel was ushered to the hip screw by direct palpation. Specifically 3 distal cortical screws were placed and during the tapping and drilling, the soft tissue was sheltered by a drill sleeve (4.5 mm in size).

In the PCCP fixation group, an incision was done, about 2 cm, on the thigh's lateral angle, at the level of the lesser trochanter's upper border after the closed reduction process. Under the vastus lateralis muscle, the plate, along with its distal edge, was drilled and affixed to the bone. Held parallel to the plate, a guide frame was positioned and all screws and drills were to be anchored on the frame. A second incision, spanning the same length as the first, was then performed to carry out the insertion of a bone clamp, which was needed to attach the plate to the bone. Likewise, the clamp was fixed to the guide frame. The initial neck screw was placed in the inferior neck border, an area proximate to the calcar femorale. After measuring the length, a telescoping hip screw was positioned next through a hole and 3 more shaft self-tapping screws were planted through the guide frame. The previously placed bone clamp was lifted. Only then was the second hip screw drilled through in a position superior to the first.

Postoperative management

After surgery, patients could eat and gain weight as allowable and prompted to start walking with the aid of a frame on the first day after operation. Without regard for the implant used, the rehabilitation program was consistent across all patients. The following observations were recorded: operative time, incision length, intraoperative blood loss, serum Hb and Alb levels, and post-surgery complications. The discharging of patients was either directed to a rehabilitation facility or a residence.

Follow-through visits were consecutively done per month, from the 1st to the 6th month following the operation. Thereafter, the next visit was scheduled on the 12 month and then annually after it. In every visit, radiographs showing both lateral and plain AP views were secured. Researchers took note of the changes concerning complications, implant placements and movements, and fixation problems. Additionally, the score of the patient's walking ability (based on the Harris Hip Score system), the range of motion of the hip, and the pain related to both thighs and hip were all documented at every postoperative control.

Statistical analysis

SPSS 16.0 software (SPSS Inc., Chicago, IL, USA) was run to statistically analyze the data. In comparing quantitative variables, Student's t-test was undertaken and the expression of data included the mean ± standard deviation. As for the descriptive, categorical variables, the statistical analysis used was either the Fisher's exact test or the Chi Square test, depending on the context. Lastly, the significant difference was set at $P < 0.05$.

Results

In terms of preoperative demographics, there existed no significant differences between the PCCP group and the DHS group. Furthermore, at the last follow-up visit (i.e., at least 6 months following the surgery), neither of the groups experienced nonunion, malunion, and complications connected to the implant procedure. With regards to serum marker levels, still post-operatively, decreased Hb and Alb levels 24 hours were found similar between the two groups ($P > 0.05$). However, intraoperative results, including blood loss, length of incision, and duration of surgery, indicated significant across-group differences ($P < 0.05$; **Table 1**; **Figure 1**).

Every patient was visited for a follow-up assessment after the operation, the mean duration

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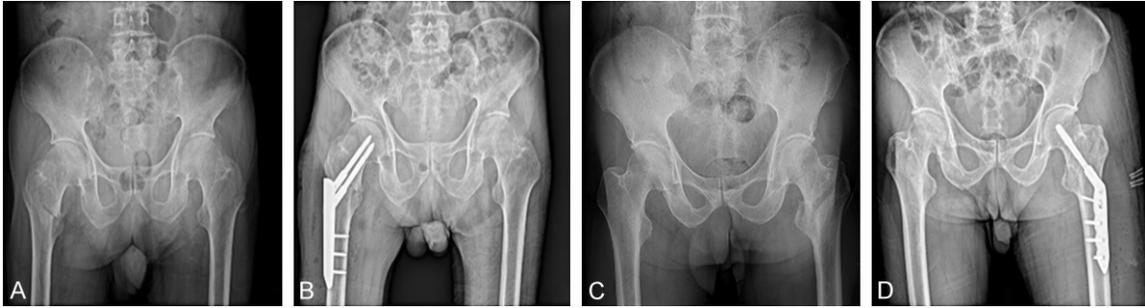


Figure 1. X-ray images of PCCP and DHS treatment of intertrochanteric fractures of the femur. A 91-year-old male patient was injured by falling down. A: Pre-surgery; B: 1 week post-surgery; A 78-year-old male patient was injured by traffic accident. C: Pre-surgery; D: 1 week post-surgery.

Table 2. Comparison of Harris hip score between the DHS and PCCP groups

Group	Excellent	Good	Satisfactory	Unsatisfied	Rate of excellent and good effect (%)
PCCP	16	12	1	1	93.3
DHS	8	9	3	2	77.3

being 13 months. None of the patients experienced post-surgery complications (e.g., coxa vara, breakage of screws in the femoral head, wound infection, and serious venous thrombosis). By the time of final follow-up visit, all fractures had healed with a healing time of 15.1 ± 2.2 weeks in the PCCP group and 16.3 ± 2.5 weeks in the DHS group (ns, $P > 0.05$). According to the Harris hip score, the rate of excellent and good effects in the DHS group and the PCCP group was 77.3% and 93.3%, respectively (ns, $P > 0.05$; **Tables 1 and 2**).

Discussion

Intertrochanteric fractures are common among individuals with osteoporosis; such fractures carry high morbidity and mortality rate. Yet they can be effectively treated with advanced implants, as the recent orthopedic surgery improvements show. Taking into account the fact that the elderly generally have a poor functional status with multiple medical disorders, controlled or rigid fixation, and paired with early mobilization, the standard treatment is for intertrochanteric fractures since these lead to the functional decline and disability/mortality. Among the methods for intertrochanteric fracture treatments, the DHS and PCCP procedures are not only frequently used but also effectively yield satisfactory results.

The DHS, which is a device often preferred for intertrochanteric fracture treatments, has a sliding lag screw positioned on a plate in the lateral cortex. This design meets AO biomechanical requirements, which subjects it to bending movement generated by the hip contact force and distance from the humeral head center to the lateral femoral cortex. However, a sliding system means that the fixation is relatively unstable, as well as the axial, lateral, and rotational aspects [16]. Thus, the DHS is not suitable for patients with osteoporosis due to poor holding force of the lag screw, which is prone to cause screw out, cutting of the femoral head, varus, and other complications [17]. More important to consider is the fact that lag screw cutting and plenty of soft tissue stripping results in blood supply disintegration to the femoral head, thereby increasing the risk of osteonecrosis. Meanwhile in late 1990s, Gotfried discovered and crafted the PCCP device [18]. The implant's design makes a less invasive surgery possible. The procedure requires only 2 small incisions for the insertion of the plate built with a distal cutting edge. The PCCP device, in comparison to DHS, offers patients with rotational stability via the 2 hip screws and provides lateral cortical support because of the screws' relatively small diameter and the plate's proximal extension. Using a specifically-designed posterior reduction device, the fracture's anatomic reduction (or close anatomic) is then obtained. Therefore, in the patients with osteoporosis, use of the PCCP is recommended.

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One important determining factor is the invasiveness of soft tissue, provided that the results are similar for intertrochanteric fractures among elderly. The rationale is that the theoretical positive outcomes of soft tissue preservation among aged patients encompass the following: operative time, incision length, and intraoperative loss of blood throughout the stretch for care [19]. The present research compared the soft tissue invasiveness determinants, and found that the PCCP group had a smaller incision length, less intraoperative blood loss, and shorter operative times relative to the DHS group. The findings suggest that the PCCP technique for intertrochanteric hip fracture fixation is more beneficial for patients.

Serum Hb and Alb levels are also frequently utilized in examining the impacts of perioperative bleeding [20]. In this study, these two serum markers were compared between groups to determine the invasiveness of both DHS and PCCP in senior patients having a stable intertrochanteric fracture. Both devices showed similar postoperative serum Hb and Alb levels, without a significant difference between groups. These findings appear to be inconsistent with the reduced tissue trauma as well as reduced bleeding related to the PCCP technique. However, these serum markers may change slowly in the plasma, and do not react immediately to the level of invasiveness.

With regards to fracture healing time, the PCCP as a fixation implant retained the greatest degree of blood supply to the femoral head. The present research found a tendency towards less time to return of normal activities under the PCCP condition. Despite the statistical insignificance of the trend, it was noted that the healing duration of PCCP was shorter than that of the DHS group, which was more conducive to early exercise, subsequently reducing postoperative complications of bedrest in elderly patients. These results are consistent with the findings in some studies in the literature. Brandt et al. undertook a prospective randomized clinical trial for the purpose of comparing the PCCP and DHS, and found that the PCCP appeared similar to the DHS with regards to bone healing [21]. This indicates that they have similar long term clinical outcomes. In addition to the Harris hip score, the rate of excellent and good effects in PCCP and DHS

group (93.3% and 77.3%, respectively) was also statistically insignificant. Therefore, this study was consistent with previous reports. Knobe et al. comparatively examined PCCP and DHS fixation for treating osteoporotic pertrochanteric femur fractures and found that the PCCP yielded better results than the DHS in terms of Harris hip score [22]. In analyzing the causes, it may be related to the relatively brief period of follow-up and small sample size. Thus, further research with a larger sample size is required to more effectively compare the rate of excellent and good effects.

This study has several limitations that should be considered. First, selective bias might have been introduced by the exclusion of unstable fractures that could not be satisfactorily reduced. Second, the number of subjects was relatively small and the follow-up period relatively short, and a larger study sample and longer follow-up period may be needed for statistical assessment in the future. Although these limitations are important, this study contributes to the evaluation of internal fixation for treating of osteoporotic intertrochanteric femoral fractures.

Conclusion

The study did not find a significant difference between the PCCP and DHS groups in terms of decrease in hemoglobin and albumin levels, as well as fracture healing time. Operation times were shorter with smaller incisions and blood loss during operation was minimal. Although the rate of excellent and good effects between the PCCP and DHS groups yielded no statistical significance, these effects trended to be higher in the PCCP group. Therefore, in treating osteoporotic intertrochanteric femoral fractures, the PCCP technique is superior to the DH method since there was a decreased blood loss, shorter operative time, and shorter incision length. Priority should be given to PCCP fixation when fracture types, especially elderly type 31A1 and 31A2 fractures, are encountered.

Disclosure of conflict of interest

None.

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References

- [1] Cumming RG, Nevitt MC, Cummings SR. Epidemiology of hip fractures. *Epidemiol Rev* 1997; 19: 244-257.
- [2] Shah MR, Aharonoff GB, Wolinsky P, Zuckerman JD, Koval KJ. Outcome after hip fracture in individuals ninety years of age and older. 2001. *J Orthop Trauma* 2003; 17: S6-11.
- [3] Cummings SR, Rubin SM, Black D. The future of hip fractures in the united states. Numbers, costs, and potential effects of postmenopausal estrogen. *Clin Orthop Relat Res* 1990; 252: 163-166.
- [4] Leytin V, Beaudoin FL. Reducing hip fractures in the elderly. *Clin Interv Aging* 2011; 6: 61-65.
- [5] Cornwall R, Gilbert MS, Koval KJ, Strauss E, Siu AL. Functional outcomes and mortality vary among different types of hip fractures: a function of patient characteristics. *Clin Orthop Relat Res* 2004; 425: 64-71.
- [6] Jensen JS. Classification of trochanteric fractures. *Acta Orthop Scand* 1980; 51: 803-810.
- [7] Raaymakers EL. Hip fracture. *N Engl J Med* 1996; 335: 1995.
- [8] Zhang L, Shen J, Yu S, Huang Q, Xie Z. Percutaneous compression plate versus dynamic hip screw for treatment of intertrochanteric hip fractures: a meta-analyse of five randomized controlled trials. *ScientificWorldJournal* 2014; 2014: 512512.
- [9] Gotfried Y. Percutaneous compression plating for intertrochanteric hip fractures: treatment rationale. *Orthopedics* 2002; 25: 647-52.
- [10] Alobaid A, Harvey EJ, Elder GM, Lander P, Guy P, Reindl R. Minimally invasive dynamic hip screw: prospective randomized trial of two techniques of insertion of a standard dynamic fixation device. *J Orthop Trauma* 2004; 18: 207-212.
- [11] Simecek M, Simecek K, Svoboda V, Peterka T. PCCP--first choice of the treatment of trochanteric fractures in our orthopaedic department. *Rozhl Chir* 2010; 89: 150-158.
- [12] Cabot A, Cabot JC. Minimal incision acromioplasty. *Orthopedics* 2002; 25: 1347-1350.
- [13] Schumpelick W, Jantzen PM. A new principle in the operative treatment of trochanteric fractures of the femur. *J Bone Joint Surg Am* 1955; 37-A: 693-8.
- [14] DiPaola M, Rozbruch SR, Helfet DL. Minimal incision technique using a two-hole plate for fixation of stable intertrochanteric hip fractures. *Orthopedics* 2004; 27: 270-274.
- [15] Ropars M, Mitton D, Skalli W. Minimally invasive screw plates for surgery of unstable intertrochanteric femoral fractures: a biomechanical comparative study. *Clin Biomech* 2008; 23: 1012-1017.
- [16] Calderon A, Ramos T, Vilchez F, Mendoza-Lemus O, Peña V, Cárdenas-Estrada E, Acosta-Olivo C. Proximal femoral intramedullary nail versus DHS plate for the treatment of intertrochanteric fractures. A prospective analysis. *Acta Ortop Mex* 2013; 27: 236-239.
- [17] Kazemian GH, Manafi AR, Najafi F, Najafi MA. Treatment of intertrochanteric fractures in elderly highrisk patients: dynamic hip screw vs. external fixation. *Injury* 2014; 45: 568-572.
- [18] Gotfried Y. Percutaneous compression plating of intertrochanteric hip fractures. *J Orthop Trauma* 2000; 14: 490-495.
- [19] Antonini G, Giancola R, Berruti D, Bianchi E, Pecchia P, Francione V, Greco P, Russo TC, Pietrogrande L. Clinical and functional outcomes of the PCCP study: a multi-center prospective study in Italy. *Strategies Trauma Limb Reconstr* 2013; 8: 13-20.
- [20] Hong JY, Suh SW, Park JH, Shin YS, Yoon JR, Yang JH. Comparison of soft tissue serum markers in stable intertrochanteric fracture: dynamic hip screw versus proximal femoral nail-a preliminary study. *Injury* 2011; 42: 204-208.
- [21] Brandt SE, Lefever S, Janzing HM, Broos PL, Pilot P, Houben BJ. Percutaneous compression plating (PCCP) versus the dynamic hip screw for pertrochanteric hip fractures: preliminary results. *Injury* 2002; 33: 413-418.
- [22] Knoke M, Munker R, Schmidt-Rohlfing B, Sellei RM, Schubert H, Erli HJ. Surgical outcome in pertrochanteric femur fracture: the impact of osteoporosis. Comparison between DHS and percutaneous compression plate. *Z Orthop Unfall* 2008; 146: 44-51.