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Dynamic hip screw vs. proximal femur plate: Surgical outcomes in Pauwel's Type III femoral neck fractures

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Abstract
Background: Femoral neck fractures, comprising 3.6% of all body fractures and 57% of hip fractures, are increasingly common among younger adults due to high-energy trauma. Pauwel's type III fractures, characterized by a steep vertical angle, are particularly challenging, with high non-union rates and complications resulting from severe shear forces. Accurate measurement of Pauwel's angle is essential for predicting outcomes. This study compares Dynamic Hip Screw (DHS) and Proximal Femur Plate (PFP) fixation methods in treating Pauwel's type III fractures, focusing on intraoperative factors, outcomes, and complications.
Patients and Methods: This prospective study conducted at Al-Kindy Teaching Hospital, Baghdad, included 16 adults with Pauwel's type III fractures. Over one year (April 2023–2024), patients were divided into two groups: Group A (7 patients) received PFP fixation, while Group B (6 patients) underwent DHS fixation with an anti-rotation screw. Preoperative evaluations included routine exams, imaging, and anesthesiologist consultations. Surgery was performed under anesthesia, followed by rehabilitation and regular follow-ups. Data on surgery time, blood loss, and complications were collected and analyzed using SPSS, with a p-value <0.05 considered significant.
Results: Groups A and B were similar in demographics, fracture characteristics, and mechanisms of injury. Group A had a slightly longer surgery time (1.45 vs. 1.32 hours) and more intraoperative blood loss, though differences were not statistically significant. Postoperative assessments showed comparable fracture healing times (12.2 vs. 13.1 weeks) and Harris Hip Scores. Group A experienced higher postoperative complications, including non-union (14.28%) and infection (14.28%), while Group B had one case of mal-union (16.66%). None of these differences were statistically significant, though Group A showed a trend toward more complications.
Conclusions: Both DHS and PFP fixation methods are effective for treating Pauwel's type III femoral neck fractures. The study found no significant differences in operation time, blood loss, healing, or functional outcomes between the two methods, though Group A exhibited a slightly higher rate of complications.

Keywords: Dynamic hip screw, proximal femur plate, Pauwel's type iii fractures, surgical outcomes

Introduction
Femoral neck fractures, representing 3.6% of all body fractures and 57% of hip fractures, are becoming increasingly prevalent due to various causes, including car accidents and trauma [1]. While traditionally associated with the elderly, high-energy trauma has led to a rise in these fractures among younger adults as well [2]. These fractures cause severe pain, loss of mobility, and a significant reduction in quality of life [3]. Pauwel's type III fractures, characterized by a steep vertical orientation, are particularly challenging due to their high risk of non-union and complications, with non-union rates reported between 10% and 30% [4, 5]. The vertical alignment subjects these fractures to high shear forces, complicating surgical fixation and leading to poor functional outcomes such as femoral neck shortening, avascular necrosis, and a high risk of reoperation [6].
Pauwel's classification, introduced in 1935, is crucial for guiding treatment and predicting complications. Type III fractures, common in younger patients following high-energy trauma, are characterized by their steep angle. This classification helps in understanding the relationship between fracture orientation and complications related to internal fixation [7, 8].

Vertical femoral neck fractures (OTA classification 31-B2.3) often occur in young adults and are particularly problematic due to the high shear forces they experience, which increase the risk of hardware failure and the need for revision surgery [9]. Fixed-angle devices are generally recommended for enhancing stability in Pauwel's type III fractures [10].

Epidemiologically, femoral neck fractures are mostly seen in older adults after low-energy falls, with approximately 280,000 cases occurring annually in the U.S. This number is expected to rise to 500,000 annually over the next 40 years due to an aging population [11]. However, a bimodal distribution exists, with 2-3% of these fractures occurring in individuals under 50 years old due to high-energy trauma [12].

The blood supply to the femoral head primarily comes from the medial and lateral circumflex arteries, branches of the profunda femoris. These arteries form an extracapsular ring that supplies the femoral neck and head through retinacular arteries [13]. Disruption of this blood flow, especially affecting the lateral epiphyseal artery, significantly increases the risk of osteonecrosis [14]. The foveal artery, while significant in children, has a minimal role in adults [15].

Femoral neck fractures are classified by location—subcapital, transcervical, and basicervical. The Garden classification, often used for subcapital fractures, divides them into four types based on displacement [16]. The AO/OTA classification categorizes fractures by location and fracture line angle, while Pauwel's classification assesses the angle to determine shear and compressive forces [17].

Accurate measurement of the Pauwel's angle is crucial but challenging due to variability in preoperative radiographs [18]. Modifications to the original Pauwel's method, using the femoral shaft's anatomic axis as a reference, have been proposed but also face limitations [19]. A unified standard for measuring the Pauwel's angle is needed to improve classification reliability [20]. Femoral neck fractures in the elderly are typically caused by low-energy trauma, such as falls, while younger individuals often sustain these fractures from high-energy impacts [21]. Clinical evaluation involves assessing limb shortening, external rotation, and the patient's overall condition. Comorbidities in geriatric patients significantly impact mortality rates [22].

Radiographic diagnosis requires an AP pelvis view, an AP hip view, and a cross-table or frog-lateral view. MRI is preferred when standard radiographs fail to detect a fracture [23]. CT and bone scans are no longer recommended [24].

Treatment typically involves internal fixation using cannulated compression screws, DHS, or proximal femur locking plates [25]. The 3-screw method is commonly used due to minimal soft tissue damage, but Pauwel's type III fractures are challenging due to increased shear forces and higher complication rates [26].

Aim of the Study

This study aims to compare DHS and PFP Fixation in adults with Pauwel's type III femoral neck fractures, focusing on intraoperative variables, clinical results, functional outcomes, complication rates, and radiological variables.

Patients and Methods

Study Design, setting and Timing

This prospective study, conducted at Al-Kindy Teaching Hospital in Baghdad, Iraq, over a one year period from April 2023 to April 2024, involved 16 adult patients with Pauwel's type III femoral neck fractures. Participants were assigned to two treatment groups based on the availability of fixation implants and senior orthopedic surgeons' decisions: Group A received PFP fixation (initially 8 patients), while Group B underwent DHS fixation with an anti-rotation screw (initially 8 patients). Follow-up losses reduced Group A to 7 patients and Group B to 6 patients.

Study population

Participants in this study were selected if they had a closed femur fracture classified as Pauwel's type III, were between 18 and 65 years old, and completed follow-up with the researcher. Exclusion criteria included pathological femur fractures, age outside the 18 to 65-year range, ipsilateral femur fractures, open fractures, a history of prior femoral neck fractures, restricted hip movement preoperatively, or loss to follow-up. Diagnosis and classification of fractures were confirmed preoperatively through physical examination and imaging, including AP and lateral X-rays and CT scans.

Preoperative Preparation

Upon admission to the orthopedic ward, patients underwent routine examinations and laboratory tests, including CBC, virology screen, chest X-ray, ECG, blood glucose levels, PT, PTT, INR, and renal function tests. Preoperative assessment included a consultation with an anesthesiologist for fitness to undergo surgery. Data such as age, gender, mechanism of injury, and side of injury were recorded. Imaging of the affected hip was performed to evaluate fracture displacement. No traction was applied to the affected limb before surgery. Routine infection control measures included broad-spectrum antibiotics, analgesics, and symptomatic treatment. Patients were required to fast for at least 8 hours prior to surgery. Informed consent was obtained from each patient or their family after explaining the surgical procedure and the research objectives.

Operation Methods

Surgery was conducted under general or spinal anesthesia with patients positioned on a radiolucent orthopedic table and C-arm fluoroscopy in place. A Foley urinary catheter was inserted, and the patient was placed supine, with feet padded and secured in fracture table boots, and the contralateral leg flexed and abducted with perineal post support. Initial fluoroscopic images were taken to ensure accurate positioning. For PFP fixation (Group A), a lateral incision 5-7 cm below the vastus ridge was made, followed by dissection through the iliotibial band and fascia lata to expose the femur. The fracture was reduced, and a locked plate was applied using 2 or 3 temporary pins, then secured with screws, and the wound was closed in layers after confirming hemostasis. In (Group B), DHS fixation involved the use of a cannulated drill and guide pin for DHS and anti-rotation screw insertion. The guide pin was carefully positioned to prevent perforation, and the lag screw was introduced with compression, with the wound being closed after verifying hemostasis and proper fixation.

Postoperative Follow-Up

Patients were discharged to the orthopedic ward with postoperative antibiotics, analgesics, and anticoagulants. Rehabilitation instructions included avoiding weight-bearing for 6-8 weeks, followed by partial weight-bearing for another month. Follow-ups occurred on Days 1, 7, and 14 for stitch removal, and at 1, 3, and 6 months with radiological assessments. The Harris Hip Score was used to evaluate hip function.

Data Collection

Intraoperative variables, including operation time, estimated blood loss, and complications, were meticulously recorded. Blood loss was assessed through the use of suction canisters and by evaluating blood-soaked sponges.

Data Analysis

Data were initially documented on paper forms, subsequently entered into Microsoft Excel for organization, and then analyzed using IBM SPSS Statistics, version 27. Descriptive statistical analysis involved calculating frequencies and percentages for categorical data such as complications, and means with standard deviations for continuous variables including operation time and Harris Hip Scores. The Chi-square test was employed to analyze categorical data, while paired samples t-tests were used for continuous variables. A p-value of less than 0.05 was deemed statistically significant, indicating a meaningful difference or relationship.

Ethical Considerations

This study received ethical approval from the Iraqi Council of Medical Specialties and the Scientific Council of Orthopedic Surgery, with additional consent from Al-Kindy Teaching Hospital. Prior to data collection and surgical intervention, informed consent was obtained from each participant, ensuring they were fully aware of the study's purpose and their role in it.

Results

Table 1 presents the demographic variables of the study groups. Group A, which comprised 7 patients, had a mean age of 33.7 years with a standard deviation of 11.3 years, and ages ranged from 21 to 47 years. In contrast, Group B, consisting of 6 patients, had a mean age of 31.1 years with a standard deviation of 11.9 years, and ages ranged from 20 to 43 years. Gender distribution across the groups showed that in Group A, 71.4% of the patients were male and 28.6% were female. In Group B, 66.7% of the patients were male and 33.3% were female. This indicates a similar gender distribution between the two groups, with a slight predominance of males in both groups.

Table 1: Demographic variables of the two study groups

Group		Group A, N=7	Group B, N=6
Age (years)	Mean ± SD	33.7±11.3	31.1±11.9
	Range	21-47	20-43
Gender n (%)	Male	5 (71.4)	4 (66.7)
	Female	2 (28.6)	2 (33.3)

Table 2 presents the fracture variables for the study groups. In Group A, which consisted of 7 patients, the mechanism of injury was primarily due to falls from height (FFH) in 3 patients (42.9%) and road traffic accidents (RTA) in 4 patients (57.1%). In comparison, Group B, with 6 patients, experienced FFH in 2 patients (33.3%) and RTA in 4 patients (66.7%).

The difference in the mechanism of injury between the two groups was not statistically significant (P=0.784). Regarding the side of injury, in Group A, 4 patients (57.1%) had fractures on the left side, while 3 patients (42.9%) had fractures on the right side. In Group B, 3 patients (50%) had fractures on the left side, and 3 patients (50%) had fractures on the right side. The distribution of the side of injury was also not statistically significant between the groups (P=0.226).

Table 2: Fracture variables of the two study groups

Group		Group A (N=7)	Group B (N=6)	P-Value
Injury mechanism N (%)	FFH	3 (42.9)	2 (33.3)	0.784
	RTA	4 (57.1)	4 (66.7)	
Side N (%)	Left	4 (57.1)	3 (50)	0.226
	Right	3 (42.9)	3 (50)	

Table 3 presents an intraoperative comparison between the two study groups. Group A, which underwent PFP fixation, had an average operation time of 1.45±0.7 hours, while Group B, which received DHS fixation, had a slightly shorter operation time of 1.32±0.9 hours. The difference in operation time between the groups was not statistically significant (P=0.071). In terms of intraoperative blood loss, Group A experienced an average loss of 375±258 ml, compared to 341±386 ml in Group B, with the difference again not reaching statistical significance (P=0.082). Additionally, the number of intraoperative fluoroscopic screens used was 20±5 for Group A and 17±5 for Group B, with a p-value of 0.0601, indicating no significant difference between the two groups. These results suggest that while there were some variations in operation time, blood loss, and fluoroscopic use, none of these differences were statistically significant.

Table 3: Intraoperative comparison between two the study groups

Groups	Operation time (hours)	Intraoperative blood loss (ml)	Intraoperative fluoroscopic screens
Group A (N=7)	1.45±0.7	375±258	20±5
Group B (N=6)	1.32±0.9	341±386	17±5
P-value	0.071	0.082	0.0601

Table 4 presents the postoperative assessment results for two treatment groups. Group A, consisting of 7 patients, had a mean fracture healing time of 12.2 weeks with a standard deviation of 3.45 weeks, and a postoperative Harris Hip Score averaging 91.2 with a standard deviation of 7.9. In comparison, Group B, with 6 patients, exhibited a mean fracture healing time of 13.1 weeks (SD = 4.03) and a higher average Harris Hip Score of 95.4 (SD = 2.7). Statistical analysis reveals a p-value of 0.879 for fracture healing time, indicating no significant difference between the groups in terms of healing duration. Similarly, the p-value for the Harris Hip Score is 0.137, suggesting that the differences in functional outcomes between the groups are not statistically significant. These results imply that while Group B had a slightly longer healing time and a higher functional score, these differences were not statistically significant.

Table 5 presents the postoperative complications for Group A and Group B. In Group A, consisting of 7 patients, the incidence of fracture non-union was 14.28%, with one case reported, and post-operative infection was also observed in 14.28% of the patients, with one case noted. No instances of femoral head necrosis or mal-union were recorded in this group. In contrast, Group B, which included 6 patients, showed no cases of fracture non-union or post-operative infection, while mal-union occurred in 16.66% of patients, with one case documented. There were no cases of femoral head necrosis in Group B. The p-values for fracture non-union, mal-union, and post-operative infection were 0.077, 0.083, and 0.077, respectively, indicating that while the differences between the groups were not statistically significant, there were trends suggesting a higher incidence of complications in Group A for fracture non-union and post-operative infection.

Table 4: Postoperative assessment comparison

Groups	Fracture healing time (weeks)	Post-operative Harris hip score
Group A (N=7)	12.2±3.45	91.2±7.9
Group B (N=6)	13.1±4.03	95.4±2.7
P-Value	0.879	0.137

Table 5: Postoperative complications

Groups	Fracture non-union N (%)	Femoral head necrosis N (%)	Mal-union N (%)	Post op. Infection N (%)
Group A (N=7)	1 (14.28)	0	0	1 (14.28)
Group B (N=6)	0	0	1 (16.66)	0
P-Value	0.077	-	0.083	0.077

Discussion

Currently, the treatment options for femoral neck fractures predominantly involve internal fixation and hip joint replacement. For patients over 80 years of age with severe osteoporosis, hip joint replacement is generally preferred, whereas for those under 65, the primary treatment goals are anatomical reduction, rigid fixation, and preservation of the hip joint, particularly for those with an active lifestyle [27]. When selecting a treatment method, factors such as age, life expectancy, preoperative activity level, systemic conditions, osteoporosis, and financial constraints should also be considered [28].

Closed reduction and internal fixation using multiple cannulated screws offer several benefits, including ease of operation, minimal invasiveness, effectiveness, and low cost, making it a common choice for treating displaced femoral neck fractures [29]. The placement of screws follows the principle of "closely adjacent, parallel, inverted triangle, and screw heads in circular sector distribution," which optimizes the holding force of the screws to the cortical bone [30]. However, studies have indicated that three cannulated screws are insufficient for fixing Pauwels type III femoral neck fractures due to their inability to support the vertical shear forces at the fracture site [31, 32]. Anatomical reduction and stable, robust fracture fixation soon after injury are crucial for achieving favorable treatment outcomes [33, 34]. This study compared two fixation methods DHS and locked plate fixation for treating Pauwels type III femoral neck fractures.

In this study, both DHS and locked plate fixation resulted in high Harris Hip Scores, effective bone healing, and low complication rates, including femoral head necrosis, suggesting that both methods are effective for treating these fractures. Jiang et al. found that both DHS with an anti-rotation screw and locked plates effectively minimize fracture movement and manage shear forces [35]. Although locked plate fixation exhibited minimal invasiveness, small incision size, and reduced blood loss, it required longer intraoperative time and more fluoroscopic images, leading to a higher risk of radiation exposure. Despite these differences, statistical analyses revealed no significant differences in intraoperative variables between the two methods, likely due to the small sample size. Comparisons with other studies suggest that DHS operations typically require less operative time and result in less blood loss compared to locked plate operations [36].

In this study, all fractures healed satisfactorily. However, one patient in the locked plate group developed a postoperative infection, which was managed with antibiotics, and no plate withdrawal was noted. Although the sample size was insufficient for definitive conclusions, Dhamangaonkar et al. found similar results, with deep wound infections occurring in both plate and DHS groups [37]. Cannulated screws are often used for fixation, but they can be prone to collapse and lateral withdrawal, leading to fixation failure or thigh discomfort. This issue was not observed in the DHS-treated patients in this study. Increased Pauwels angles (type III) are associated with a lower risk of lateral withdrawal [38].

Study limitations include limited data and follow-up, potential selection bias, a small sample size reducing statistical power, and the inclusion of only Pauwels type III fractures. Additionally, the study did not compare other treatment options or perform a comprehensive cost analysis of the surgical techniques.

Conclusions

In this study, the comparison between DHS fixation and locked plate fixation for Pauwels type III femoral neck fractures revealed no statistically significant differences in key outcomes, including operation time, blood loss, fluoroscopic use, fracture healing time, and Harris Hip Scores. Both fixation methods demonstrated high functional scores and effective bone healing with low complication rates, indicating their efficacy in treating these fractures. Notably, while DHS had a slightly shorter operation time and less blood loss, the differences were not statistically significant, likely due to the small sample size. Postoperative complications were minimal, with a higher incidence of non-union and infection in the locked plate group, though these differences were also not statistically significant. The study underscores that both DHS and locked plate fixation are viable options for managing Pauwels type III fractures, with considerations for specific patient and procedural factors influencing the choice of technique.

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