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Watson-Jones Anatomical Approach for Open Reduction and Internal Fixation of Proximal Femoral Fractures without Image Intensifier in a Low-Resource Setting

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Abstract

Introduction: Standard procedures for surgical fixation of proximal femoral fractures (PFF) require an image intensifier which in developing countries remains a luxury. We hypothesized that, with a well-codified technique, the Watson Jones approach (WJA) without image intensifier nor traction table, can allow open reduction and internal fixation (ORIF) of PFF using Dynamic hip screw (DHS), with satisfactory outcome. **Patients and methods**: Forty one consecutive patients (mean age 59.5 ± 21.6 years, 61% males) who were followed in a Teaching Hospital for PFF treated by ORIF using the WJA and DHS from January 2016 to December 2020 were reassessed. The outcome measures were the quality of the reduction, the positioning of the implants, the tip-apex distance (TAD), the rate and delay of consolidation, the functional results using Postel Merle d'Aubigné (PMA) score, the rate of surgical site infection (SSI) and the overall mortality. Logistic regression was used to determine factors associated with mechanical failure. **Results**: The mean follow-up period was 33.8 ± 15.0 months. Fracture reduction was good in 31 (75.6%) cases and acceptable in 8(19.5%) cases. Implant position was fair to good in 37 (90.2%) patients. The mean TAD was 26.1 ± 3.9 mm. Three patients developed SSI. Consolidation was achieved in 38 (92.6%) patients. The functional results were good to excellent in 80.5% of patients. The overall mortality rate was 7.3%. There were an association between mechanical failure and osteoporosis (p = 0.04), fracture reduction (p = 0.003), and TAD (p = 0.025). In multivariate logistic regression, no independent factors were predictive of mechanical failure. **Conclusion**: This study shows that ORIF using DHS for PFF via the Watson-Jones approach without an image intensifier can give satisfactory anatomical and functional outcomes in low-resource settings. It provides and validates a reliable and reproducible technique that deserves to be diffused to surgeons in austere areas over the world.

Keywords

Proximal Femoral Fracture, Watson-Jones Approach, Dynamic Hip Screw, Low Resource Setting

1. Introduction

Proximal femoral fractures (PFF) constitute a major public health problem, with an increasing incidence in the developing world [1] [2] [3]. They are associated with high morbidity, mortality and cost [1] [3] [4]. Regarding their anatomic location, there are classified as extra-capsular fractures (ECF) or intra-capsular fractures (ICF) [5]. Specific subtypes include femoral neck fracture, intertrochanteric fracture and subtrochanteric fracture. For ECF, or ICF in young patients, anatomical reduction and stable internal fixation are the surgical goals; quality of the reduction and implant position are crucial predictors of outcome [6] [7]. Dynamic hip screw (DHS) is one of the standard fixations for ECF [8] [9]. Compared to more recent fixation techniques, it is easily available and affordable in most of the limited-resources settings.

Standard procedures for surgical fixation of PFF require fluoroscopic guidance and a traction table. However, in most of the low-income settings, image intensifiers are not always available and when they are, they face frequent breakdowns or regular electricity cuts. Open-hearth surgery often remains the only alternative. Therefore, orthopedic surgeons in the developing world should be able to operate on these patients with or without fluoroscopy, or to continue surgery in the event of image intensifier failure during surgery. In the developed world, The Watson-Jones approach is used for open reduction and internal fixation (ORIF) of displaced femoral neck fractures in young patients under fluoroscopic guidance with good results [6]. It allows direct fracture reduction and implant placement through a single incision. Therefore, it could be a relevant alternative for fracture fixation in the absence of an image intensifier. The main challenge is the accurate positioning of the lag screw within the femoral head. In this study, we present and evaluate a technique to overcome this challenge.

We hypothesized that, with a well-codified technique, the Watson Jones approach without an image intensifier nor traction table, can allow ORIF using DHS for PFF, especially ECF, with a satisfactory outcome.

2. Patients and Methods

2.1. Patients

This was a single-center, retrospective cohort study based on data from a prospectively compiled database. From January 2016 to December 2020, 49 adult patients with proximal femoral fractures were treated with the same technique described below, by 2 orthopaedic surgeons, at orthopedic department of the Yaoundé Emergency Center (Cameroon). The institutional ethical committee approved this study and all the patients available for follow-up provided written informed consent. The inclusion criteria were: patients aged 18 years or above, operated for PFF using the same technique (ORIF with DHS using Watson-Jones approach, without image intensifier nor traction table), and followed up for at least 1 year. We excluded patients unable to walk without assistance before the injury, polytraumatized patient with multiple fractures, patients who did not return for the final assessment or did not give informed consent.

2.2. Operative Technique

Pre-operative implants planning was made on standard full-size x-rays of the pelvis. The size and angle of the plate, as well as the length of the DHS screw, were measured using a goniometer on the contralateral non-injured hip, on anterior-posterior (AP) view.

After spinal or general anesthesia, the patients were positioned supine on the operative table, with a padded chopping block under the affected hip. No adjustment in patient positioning was made based to the fracture type. The surgical technique employed the Watson-Jones antero-lateral approach to the hip, allowing good exposition of the femoral neck, intertrochanteric region and lateral side of femoral shaft (**Figures 1-2**). The bone work started with open reduction of the fracture with traction, rotation and/or direct manipulations under visual control, followed by temporary fixation with pointed bone forceps and 2.5 mm Kirshner wires inserted out of the site of insertion of cervical lag screw.

Two slim Hohmann retractors were placed on the upper and the lower edges of the femoral neck to view the neck axis and center the guide wire on the AP view. The next step was to identify the entry point for the guide wire. This is one of the keys of success in this technique. Based on an experiment on a series of human dry femurs, the entry point was located on the lateral side of the femoral cortex, approximately 4 cm distally to the vastus lateralis ridge of the greater trochanter, at midpoint of the AP width of the lateral femoral cortex (**Figure 3**). To verify and adjust the entry point, a Kirshner wire was positioned anterior to the femoral neck, centered between the 2 Hohmann retractors, oriented according to the planned neck-shaft angle (CC'D), and had to fit the entry point identified. Slight proximal or distal adjustments of the entry point were made if needed to allow the wire to fit the center of femoral neck (on AP view) at the planed CC'D angle. The guide wire was then inserted with the correct angled guide and advanced towards the femoral head, with a 15˚ - 20˚ anteversion. This is another key point: The guide wire should not be inserted horizontally, and even less backward, because it could exit through the posterior aspect of the femoral neck without being noticed, having no visual control on its posterior aspect. The DHS triple reamer was slipped over the guide wire and the proximal femur was reamed to the planned depth. A blunt probe was introduced into the reamed hole to check that all its walls were bony and that we did not exit from the femoral neck or head. Tapping was done and the planed cervical lag screw was introduced and advanced into the neck-head segment. When screw insertion was complete, the T handle of the wrench was turned to be parallel to the femoral shaft, allowing proper sliding of the plate barrel over the laterally flattened shank of the DHS screw. Then, the side plate was fixed by cortical screws on femoral shaft (Figure 2). Additional antirotative screw was placed in case of unstable fractures. The guide wire and reduction wire were removed. Inter-fragmental compression was obtained using the barrel compression screw. The hip was mobilised (flexion-extension-rotation) to test the stability of the construct. The surgical site was irrigated properly and closed in layers with a suction draining system in place.

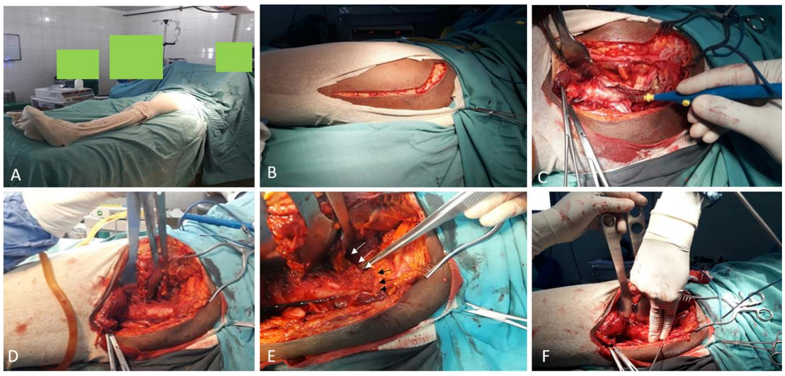

Figure 1. Watson-Jones approach for open reduction and internal fixation of proximal femoral fractures without traction table nor image intensifier. (A) Installation. (B) Inverted lazy 'j' skin incision. (C) Reverse 'L' release of the vastus lateralis. (D) Exposure of femoral neck. (E) Exposure of fracture site and fracture reduction. (F) Temporal fixation of reduced fracture with K-wire. White arrows, reduced fracture site; Black arrows, crest of insertion of the vastus lateralis on the greater trochanter.

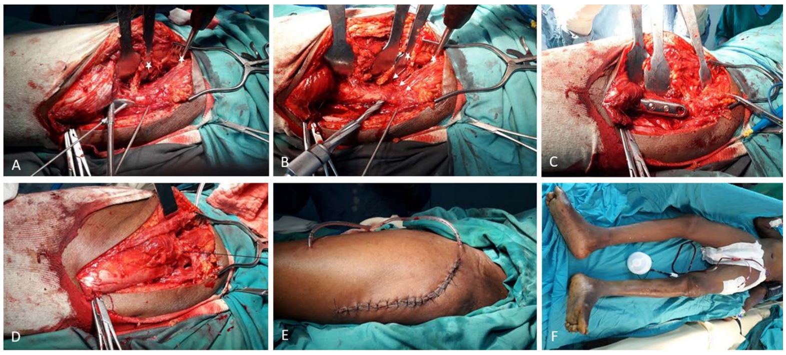

Figure 2. (A) Insertion of the cervical guide wire. (B) Insertion of DHS triple reamer. (C) DHS fixation. (D) Reinsertion of the vastus lateralis. (E) Closure. (F) Post-operative limb length and axis control. White stars, retractors on the superior and inferior borders of the femoral neck; White arrows, anatomical reduction of the fracture site.

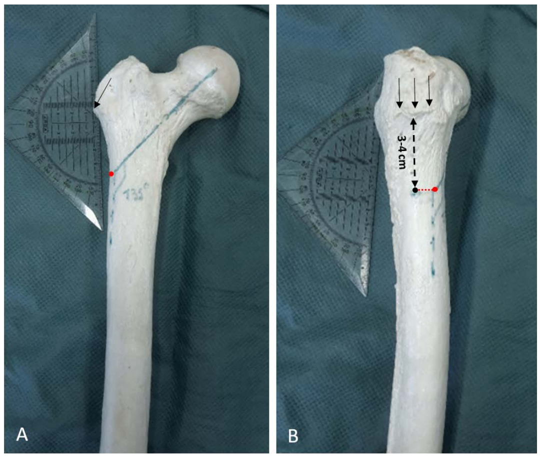

Figure 3. Illustration of the guide wire entry point on a dry human bone sample for 135˚ DHS. (A) AP view, A green line passing at middle 1/3 of femoral neck and forming a 135˚ angle with the lateral cortex has been drawn to identify the guide wire entry point. (B) Lateral view. Black arrows, crest of insertion of the vastus lateralis on greater trochanter; Black point, guide wire entry point at midpoint of the lateral width; Black dotted double arrow, distance between guide wire entry point and vastus lateralis crest.

Postoperative treatment comprised prophylactic antibiotics, pain medications, prophylactic anticoagulants and fluids. Post-operative control radiography was systematic. The rehabilitation program started immediately, with static exercises in bed. Walker assisted non-weight bearing on the operated side was started after 2 days. Active hip exercises were started after 5 days. Weight-bearing walking on the operated site was delayed for 6 weeks. After discharge, clinical and radiographic follow-up was performed at 1, 3, 6 and 12 months after surgery.

2.3. Outcome Measures

The outcome examined were the quality of reduction, positioning of the implants, length of postoperative hospitalization, rate of surgical site infection, the consolidation, implant failure, the functional outcome, and the overall mortality rate. Post-operative plain film were reviewed for evaluation of the fracture reduction and screw position by two orthopaedic surgeons who were not involved in the treatment of the patients (FG and MK). Lag screw position was considered “good” when the screw was inserted either over the inferior calcar, or in the middle third of the femoral head on the AP view, and in the middle third of the femoral neck on lateral view [9] [10]. It was judged “fair” when the lag screw were inside the femoral neck on AP and lateral views, but not in the “good” position described above. The position was considered “poor” if the lag screw was out of the femoral neck or head. The tip-apex distance (TAD) was used to assess the accuracy of lag screw placement as described by Baumgaertner et al. [10] [11]. Reduction was considered good when there was normal or slight valgus alignment on the AP radiograph, less than 20˚ of angulation on the lateral radiograph and no more than four millimeters of displacement of any fragments

[10]. The reduction was acceptable when either alignment or displacement was like in good reduction, but not both. Reduction was poor when none of the criteria was met. The cut-out was defined as projection of the screw from the femoral head by more than 1 mm [10]. Consolidation was defined as painless full weight bearing on the affected limb with bridging callus across the fracture site [9] [10].

At the time of the study, all patients were contacted via phone calls to return for a final radio-clinical evaluation (**Figures 4-5**). Their informed consent was obtained. Functional outcome was evaluated using Harris Hip Score (HHS), Postel Merle d'Aubigné (PMA) score, and Parker mobility score.

Figure 4. Case illustration 1. (A) Preoperative radiographs. (B) and (C): 1 year postoperative radiographs. (D), (E) and (F) Complete functional recovery.

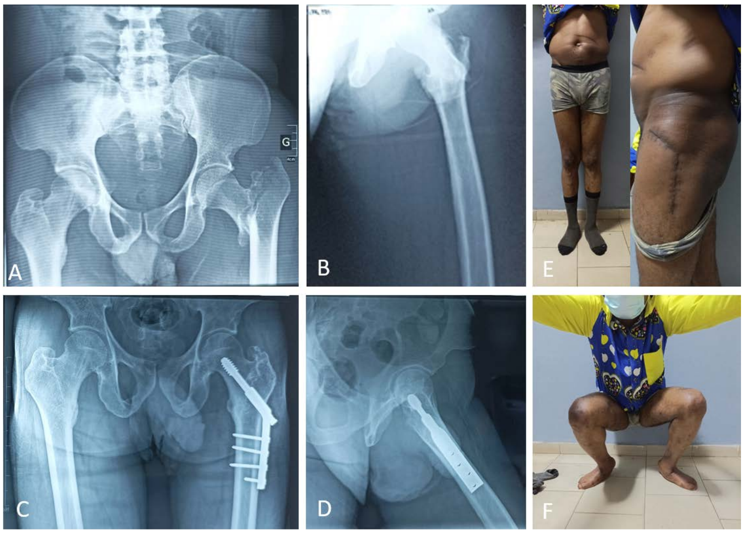

Figure 5. Case illustration 2. (A) Preoperative radiographs. (B) and (C): 1 year postoperative radiographs. (D), (E) and (F) Complete functional recovery.

2.4. Statistics

Data were analyzed using SPSS version 25.0 software (SPSS Inc., Chicago, Illinois). Descriptive statistics were summarized as mean, standard deviation and range or count and percentages. Quantitative variables were compared using Student's t-tests (parametric data), or Mann-Withney U (non-parametric data). Chi-squared test or Fischer exact test was used for the comparison of categorical variables. Multivariate logistic regression analysis was used to investigate factors associated with poor outcomes. A p-value <0.05 was considered statistically significant.

3. Results

The baseline data are presented in **Table 1**. Forty-nine patients met inclusion criteria. Eight patients were excluded (one refusal and 7 patients did not return for final evaluation). The mean age was 59.5 ± 21.6 years (range, 18 - 110), with a male preponderance (sex ratio 1.56). Half of our study population was below 60 years of age and dominated by males (81%). Osteoporosis was diagnosed in 15 (36.6%) patients. Seventy-two percent of hip fractures were due to high-energy trauma. According to OTA classification, most of the fractures were type A2 (36.6%) and A3 (31.7%). The median delay from injury to surgery was 3 days. The mean follow-up period was 33.8 ± 15.0 months (range, 12 - 59).

The mean duration of surgery was 128.7 ± 35.0 minutes. Good reduction was achieved in 31 (75.6%) cases (**Table 2**). Implant positioning was fair to good in 37 (90.2%) cases. The mean TAP was 26.1 ± 3.9 mm with 25 (61.0%) of patients having TAD < 25 mm. Consolidation was achieved in 38 (92.7%) patients, and the mean healing time was 5.3 ± 1.9 months. The mean delay of assisted weight-bearing walking was 56.8 ± 18.3 days.

Table 1. The preoperative data of the patients.

Characteristic	
Age (Years)	59.5 ± 21.6
Age group (n, %)	
Below 60 years	21 (51.2%)
Above 60 years	20 (48.8%)
Gender (M/F)	25/16
Body mass index (Kg/m^2)	29.7 ± 4.3
Confounding medical conditions	**(n, %)**
Hypertension	10 (24.4%)
Diabetes	4 (9.8%)
Osteoporosis	15 (36.6%)

Continued

Tobacco consumption	5 (12.2%)
Alcohol consumption	25 (61%)
HIV infection	2 (4.9%)
Injury mechanism (n, %)	
Motor vehicle accident	29 (70.7%)
Slipped and fell	11 (26.9%)
Falling from a height	1 (2.4%)
Parker mobility before injury	
High functional level	37 (90.2%)
Low functional level	4 (9.8%)
Type of fractures (n, %)	
Cervical fracture	5 (12.2 %)
Pertrochanteric fracture	18 (43.9%)
Intertrochanteric fracture	12 (29.3%)
Trochantero-diaphyseal or Bifocal fracture	6 (14.6%)
OTA classification (n, %)	
31A1	8 (19.5%)
31A2	15 (36.6%)
31A3	13 (31.7%)
31B1	0 (0%)
31B2	3 (7.3%)
31B3	2 (4.9%)
Evans' fracture stability	
Stable fracture	14 (31.1%)
Unstable fracture	27 (65.9%)
Days from injury to surgery (n, minimum-maximum)	3 [1 - 20]

Table 2. Perioperative data and outcome.

Variable	Value
Duration of surgery (min)	128.7 ± 35.0
Blood lost (ml)	524.2 ± 181.6
Postoperative hospital stay (days)	12.4 ± 5.0

Continued

Fracture reduction (n,%)	
Good reduction	31 (75.6%)
Acceptable reduction	8 (19.5%)
Poor reduction	1 (4.9%)
Lag screw position	
Good	30 (73.2%)
Fair	7 (17.1%)
Poor	4 (9.7%)
Early complications (n, %)	
Surgical site infection	3 (7.3%)
Deep venous thrombosis	1 (2.4%)
Pulmonary embolism	1 (2.4%)
Late complications	
Lag screw cut-out	3 (7.3%)
Aseptic non-union	1 (2.4%)
Mal union	3 (7.3%)
Aseptic necrosis of femoral head	2 (4.9%)
Chronic bone infection	1 (2.4%)
Deaths at last follow up (n, %)	3 (7.3%)
Tip Apex distance (mm)	26.1 (3.9)
Consolidation (n, %)	38 (92.7%)
Healing time (months)	5.3 ± 1.9
PMA hip score	
Poor	2 (4.9%)
Fair	3 (7.3%)
Medium	3 (7.3%)
Good	3 (7.3%)
Very good	26 (63.4%)
Excellent	4 (9.8%)
Patient regained autonomy	34 (82.9%)

Early postoperative complications included 3 cases of surgical site infection (SSI) and 1 case of pulmonary embolism. SSI was treated by early debridement, antibiotics and implant retention. Lag screw cut-out was the main late complication, observed in 3 (7.3%) cases. The overall mortality rate at the final follow-up was 7.3%. According to PMA score, functional outcome was good to excellent in 33 (80.5%) patients. At final follow-up, 34 (82.9 %) had regained their autonomy. The mean limb shortening was 2.3 ± 3.1 mm.

In univariate analysis, there was an association between mechanical failure and osteoporosis (p = 0.04), fracture reduction (p = 0.003), and TAD (p = 0.025) (Table 3). We did not find a statistically significant association between mechanical failure and screw position (p = 0.218). In multivariate logistic regression, no independent factors were predictive of mechanical failure.

4. Discussion

Management of proximal femoral fractures remains a challenge in the developing world. In the absence of image intensifier, open reduction and internal fixation is very often the only relevant therapeutic option. This study describes a technique using the Watson-Jones approach for ORIF of proximal femoral fractures with Dynamic hip screw (DHS) without an image intensifier nor traction table. We found that the technique allowed good reduction in 75.6% of cases, acceptable to good implant positioning in 90 % of the patients and implant failure in only 7% of the patients. Consolidation was achieved in 92.6% of patients at an average 4.2 months, with a good to excellent functional outcome in 80% of the patients.

Table 3. Univariate analysis of factors associated with mechanical failure (MF).

Factor	Category	Without MF	With MF	P value
Gender	Male	24	2	0.701
	Female	14	1	
Age group	≤60 years	21	0	0.107
	>60 years	17	3	
Osteoporosis	No	26	0	**0.043**
	Yes	12	3	
Fracture stability	Stable	14	0	0.539
	Unstable	24	3	
Fracture reduction	Good	31	0	**0.003**
	Acceptable	6	2	
	Poor	1	1	

Continued

Implant position	Good	29	1	0.218
	Fair	6	1	
	Poor	3	1	
Tip apex distance	≤25	25	0	**0.025**
	>25	13	3	

Closed reduction and internal fixation are the standard treatment of PFF. But, in the situation where the reduction cannot be obtained, direct visualization of the fracture is mandatory [6]. Open reduction provides the framework for successful manipulation of the fracture fragments, temporary stabilization, and ultimately fracture fixation. The most frequently used approaches are the anterolateral (or Watson-Jones) approach and the direct anterior (or Smith-Petersen) approach [6] [12] [13]. Although a recent sound anatomical study found that Smith-Petersen approach provides superior exposure of the femoral neck and articular surface as well as visualization and palpation of clinically relevant proximal femoral anatomic landmarks compared with the Watson-Jones approach [13], the latter appears to be more relevant because it allows direct fracture reduction and DHS placement through a single incision. Although anterior approach have been found to injure the ascending branch of the lateral femoral circumflex artery [14], these two approaches preserve the posterior vasculature to the femoral head, and capsulotomy is unnecessary in case of intertrochanteric fracture. In fact, femoral head avascular necrosis occurred in only two cases in the current study. Another major complication linked to open reduction is a higher rate of SSI [15]. In the current study, 3 patients developed deep wound infection which required early debridement and implant retention. Unfortunately, one of these patients (an 85 years old man) died 12 days after surgery. In the developed world, mortality associated with proximal femoral fractures has been reported to be as high as 30% during the first year post-injury [1] [16] [17]. In contrast, the mortality rate at a mean follow-up period of 33 months in this study was only 7%, in line with studies in the developing world [2]. This is probably due to a relatively younger study population, with a mean age of about 60 years.

The mechanical failure rate was comparable to that observed in studies conducted under standard conditions [18] [19] [20]. Overall, despite technological limitations, delayed time to surgery and longer postoperative hospital stay, we did not observe much more complications than those reported under standard conditions [21] [22]. A recent systematic review showed no difference between proximal femoral nail (PFN) and DHS for implant failure; and DHS needs less intraoperative fluoroscopy time [23]. This supports the use of DHS in limited-resources settings.

The success of the above described technique rely on few tips. Preoperative planning on real size radiographs of contralateral hip allow to determine the implant characteristics (neck-shaft angle, length of the cervical lag screw). However, this would not be useful in case of bilateral hip pathology or significant deformities. The 2 slim Hohmann retractors positioned on the upper and lower edges of the femoral neck allow to view neck axis and center the guide wire on anterior-posterior view. The combination of the previous landmark with an introduction point of the guide wire located about 4 cm below the vastus lateralis ridge on the greater trochanter for 135˚ DHS insures an acceptable positioning of the cervical screw on AP view. To successfully position the cervical screw in the lateral view, the entry point of the guide wire must be at the middle of the antero-posterior width of the lateral surface of the femoral shaft, and the guide wire must be oriented forwards for a 15˚ - 20˚ anteversion. Indeed, it is better for the cervical screw to be more anterior than posterior. Finally, since the fixation is not always rigid enough, we believe that the loading should be postponed on the operated limb for at least 45 days as we have done, with appreciable results.

The main limitations of this study are the small sample size and the monocentric character. In addition, longer-term outcomes, especially for young patients or those with intracapsular fracture, are crucial for evaluating joint preservation and arthritic changes. Furthermore, since the procedure described here is not the gold standard, it cannot be used in the developed world. Nevertheless, in the developing world, we believe that all the orthopedic surgeons should master this technique to be able to treat their patient in case of absence or failure of image intensifier.

5. Conclusion

This study shows that open reduction and internal fixation using dynamic hip screw for proximal femoral fractures via the Watson-jones approach without an image intensifier can give satisfactory anatomical and functional results in low resources settings. The study provides and validates a reliable and reproducible technique that could be very helpful for surgeons in austere areas all over the world.

Ethics Approval and Consent to Participate

This retrospective study was approved by the Institutional Review Board of The University of Yaounde I. Informed consent was obtained for each patient.

Acknowledgements

LF, OK, and DH conceived the study, participated in its design and coordination. LF and GF carried out the data collection, data analysis, statistical analysis, and drafted the manuscript. LF, ON, UT and MAGY performed the surgeries. All authors participated in the review of the manuscript. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare that they have no competing interests.

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