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Surgical management of proximal humeral fractures in a resource-limited setting: a retrospective cohort study

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ABSTRACT

Background: The management of proximal humerus fractures (PHF) remains controversial, particularly in resource-limited settings where access to modern implants is limited. This study aimed to evaluate the surgical outcomes of PHF in adults in Yaoundé and to identify factors influencing prognosis.
Methods: We conducted a retrospective cohort study of adult patients who underwent surgery for hip fractures between 2015 and 2020 at three specialist hospitals in Yaounde (the Yaoundé Central Hospital (YCH), the Yaoundé Emergency Centre (YEC) and the Yaoundé Military Hospital (YMH)). Data were collected on demographic characteristics, fracture characteristics, surgical techniques and outcomes. Functional outcomes were assessed using the disabilities of the arm, shoulder and hand (DASH) and Constant-Murley scores, and radiological outcomes were assessed at follow-up.
Results: A total of 47 patients were identified, of whom 28 were included in the final analysis. The mean age was 44±16 years, with a predominance of males (61%). Most fractures were two-part fractures according to the Neer classification (80.5%) and type A fractures according to the AO/OTA classification (78.1%). Plate fixation was used in 61% of cases, exclusively with non-locking implants. Anatomical reduction was achieved in 28.6% of patients. Bone union was observed in 85.7% of cases. Complications included malunion (35.7%), avascular necrosis (7.3%) and post-traumatic osteoarthritis (10.7%). The mean Constant and DASH scores were 63.3 and 33.2, respectively.
Conclusions: Despite limited technical resources and the use of non-locking implants, surgical treatment of hip fractures in this setting yields acceptable functional outcomes. However, complication rates remain high, highlighting the need to improve surgical facilities and the availability of implants.

Keywords: Fracture, Proximal humerus, Surgical treatment, Function, Resource-limited setting

INTRODUCTION

Proximal humerus fractures (PHFs) account for a significant proportion of fractures in adults and represent a growing challenge in orthopaedic trauma. Their incidence is rising worldwide, particularly among older people, where they are classified as fragility fractures, whilst in younger people they are more often associated with high-energy trauma and complex injury patterns.[1,2] Despite their frequency, the management of PHS remains controversial, as treatment decisions depend on multiple factors, including the pathological anatomy of the fracture, bone quality, the patient's age and functional expectations. The available treatment options range from conservative management to surgical interventions such as locked plate fixation, intramedullary nailing or shoulder arthroplasty.[3]

However, even with modern surgical techniques, outcomes remain variable and complication rates-particularly fixation failure, avascular necrosis and malunion-remain high.

Locked plate fixation has become the most commonly used surgical technique for displaced posterior trochanteric fractures, but its reliability is increasingly being called into question due to significant rates of mechanical failure and reoperation, particularly in osteoporotic bone.[4] Although technical improvements, such as cement augmentation and optimisation of screw configuration, have been introduced to enhance fixation stability, their clinical benefit remains controversial and recent meta-analyses suggest that these adjunctive strategies do not significantly reduce complication rates compared with the use of locked plates alone.[5,6]

Other techniques, notably intramedullary nailing, have shown comparable functional outcomes without any clear superiority over plates.[7] These uncertainties highlight the complexity of managing hip fractures and the importance of individualised, context-specific treatment strategies, particularly as most of the available data originate from high-income countries with access to state-of-the-art resources.

In low- and middle-income countries such as Cameroon, the management of PHF remains a clinical challenge due to systemic constraints, notably late presentation of patients, restricted access to imaging techniques and intraoperative fluoroscopy, as well as the limited availability of modern implants.[8] Consequently, surgeons often resort to conventional or improvised fixation methods, which can compromise outcomes. It has been demonstrated that global disparities in orthopaedic care significantly influence the outcomes of trauma treatment, with limited resources contributing to suboptimal surgical techniques, delayed rehabilitation and higher complication rates.[9] Furthermore, commonly used classification systems, such as the Neer and AO/OTA systems, have limited reproducibility, and key prognostic factors are not always properly assessed in these settings.[3] Given the scarcity of data from Sub-Saharan Africa, this study aims to provide data from local research. It therefore sought to assess the functional and radiological outcomes of surgically treated PHF in adults in Yaoundé, Cameroon, and to identify factors influencing prognosis in a resource-limited setting.

METHODS

Study design and setting

This was a retrospective cohort study conducted in three major referral hospitals in Yaoundé, Cameroon (the YCH, the YEC and the YMH). The study period ran from January 2015 to December 2020. These institutions are major tertiary care centres for the management of orthopaedic trauma in the region and receive a large number of emergency cases and referred patients. All data collected were anonymised and stored securely, with access restricted to the research team.

Patients

All adult patients aged 18 years and over who underwent surgery for a proximal humerus fracture during the study period were included. Patients were identified from operating theatre records and hospital records. Cases with incomplete medical records, insufficient clinical or radiological data, or patients lost to follow-up were excluded from the final analysis.

Ethical considerations

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the ethics committee of the Faculty of Medicine and Biomedical Sciences at Yaoundé I (No. 0029/UYI/FMSB/VDRS/DAASR/CSD). Given the retrospective nature of the study, the requirement to obtain written informed consent was waived. However, all patients contacted for the follow-up assessment gave their verbal informed consent prior to participating. The confidentiality and anonymity of patient data were strictly maintained throughout the study

Variables

Data were collected retrospectively from operating theatre records, hospital discharge summaries and outpatient follow-up records, using a standardised data collection form. The variables recorded included sociodemographic characteristics (age, sex), the mechanism and circumstances of the injury, and fracture characteristics according to the Neer and AO/OTA classification systems. Therapeutic data included the type of surgical approach, the fixation technique and the implant used. Information regarding postoperative management, including rehabilitation modalities, was also collected. Where necessary, patients were contacted by telephone and invited to attend a final clinical and radiological assessment to complete any missing follow-up data.

Outcome measures

The primary outcome measures were the functional and radiological results observed at the final follow-up. Functional outcomes were assessed using validated scoring systems, namely the DASH score and the Constant-Murley score. Radiological assessment focused on fracture union (bone healing), the quality of reduction and the presence of complications such as malunion, pseudarthrosis, avascular necrosis or implant failure. The radiographs obtained during follow-up were independently reviewed by an experienced orthopaedic surgeon and a radiologist to ensure consistency in interpretation.

Statistical analyses

The data were entered into Microsoft excel and analysed using IBM SPSS software (version 26.0, IBM Corp., Armonk, NY, USA). Continuous variables were presented as means with standard deviations (SD) and medians with interquartile ranges (IQR), whilst categorical variables were presented as numbers and percentages. Comparisons between groups were performed using Student's t-test or the Mann-Whitney U test for continuous variables, and the chi-square test or Fisher's exact test for categorical variables, as appropriate. A $p<0.05$ was considered statistically significant.

RESULTS

Sociodemographic characteristics

A total of 40 patients with 41 PHF were initially included in the study, of whom 28 were available for final assessment. The mean age of the study population was 44 years (±16.03 standard deviation), ranging from 18 to 80 years. When the data were stratified by sex, the mean age was higher among women, at 49.38 years (±16.11 standard deviation), than among men, at 40.54 years (±15.29 standard deviation). The cohort was predominantly male, comprising 25 patients (61%), resulting in a male-to-female ratio of 1.56. With regard to socio-economic characteristics, 17 patients (53.1%) were classified as having a medium socio-economic status.

In terms of occupation, 9 patients (25%) were entrepreneurs and 15 (46.5%) had completed higher education. Regarding lifestyle and medical history, 20 patients (48.8%) reported consuming alcohol. Comorbidities were relatively rare; one patient had a history of breast cancer, whilst two patients had a history of stroke, both presenting with motor deficits on the same side as the fracture (Table 1).

Clinical and radiological characteristics

The mean time to specialist consultation was 40.3 hours (±147.2 standard deviation), with a range of 0.5 to 840 hours. Road traffic accidents were the main cause of injury, accounting for 73.2% (n=30) of cases, primarily involving collisions between a vehicle and a motorcycle (33.3%) and collisions between vehicles (30.0%). The vast majority of fractures (92.7%) resulted from direct trauma. Most patients presented with isolated fractures, accounting for 60% (n=21) of cases, whilst 9 patients (25.7%) presented with multiple fractures and 5 (14.3%) were polytrauma patients. Associated injuries included head injuries and fractures of other limbs. Open fractures accounted for 14.6% (6/41) of cases, with Gustilo-Anderson type II being the most common subtype (50%). With regard to fracture types, two-part fractures were the most common, observed in 80.5% (n=33) of cases, and 65.9% (n=27) were classified as AO/OTA type 11A3 (Table 2).

Surgical treatment and outcomes

Initial management was predominantly conservative, with orthopaedic treatment involving immobilisation according to the Mayo Clinic method in 71.4% (n=25) of cases. The mean time to surgery was 170.9 hours (± 212.9 standard deviation), ranging from 5 to 1,076 hours. Surgical procedures were performed under fluoroscopic guidance in 22 cases (53.7%). The delto-pectoral approach was the most frequently used (80.5%, n=33), followed by the deltoid-transection and percutaneous approaches in 9.8% (n=4) of cases each. Plate and screw fixation was the main surgical technique (61.0%, n=25), with T-plates used in 88.0% (n=22) of these cases and spoon-shaped tibial plates in 12.0% (n=3). Pin fixation accounted for 24.4% (n=10) of procedures. Postoperative rehabilitation was undertaken by 73.2% (n=30) of patients in the form of physiotherapy, whilst 24.4% (n=10) opted for self-directed rehabilitation. The average number of physiotherapy sessions was 24.85 (±12.12 standard deviation), commencing after an average delay of 4.84 (±2.17 standard deviation) weeks. Average length of postoperative hospital stay was 8 days (±4.25 standard deviation). Fracture union was achieved in 85.7% (35/41) of cases. Early complications occurred in 14.6% (6/41) of patients, including one case of implant failure in a patient with bilateral fractures. A serious complication of wet gangrene was observed in one patient (2.4%) on the 15th postoperative day following plate fixation, requiring shoulder amputation (Figure 1). Consequently, the rate of early surgical revision 2.4% (1 case). Late complications (Figure 1) consisted mainly of shoulder stiffness (93%, n=38) and chronic pain (87.8%, n=36). Avascular necrosis, chronic infection and pseudarthrosis each occurred in 2 patients (4.9%). Other complications included one case of secondary valgus displacement and a fracture of the existing implant. The late revision rate was 7.3%.

Functional outcomes

Total of 23 patients (82.14%) resumed their previous activities, with a mean time to return of 3.67 months (±3.46 SD). Functional assessment revealed a mean DASH score of 33.18 (±23.8 standard deviation), ranging from 0 to 89.17; 44% of patients had minimal disability, whilst 8% had extreme disability (Table 3). Mean Constant score 63.28 (±23.44 standard deviation), with a mean range of motion of 26.16 (±9.6 standard deviation) (Table 4). Qualitatively, 24% of patients achieved very good results, whilst 36% achieved poor scores. Analysis of factors associated with functional outcomes revealed no statistically significant relationships. Use of fluoroscopy, the type of surgical reduction, the surgical technique and time to initiation of physiotherapy were not significantly associated with DASH or Constant-Murley scores. Similarly, although functional outcomes varied according to fracture type, these differences were not statistically significant; two-part fractures tended to have better outcomes, with disability being predominantly minimal and Constant scores ranging from fair to very good (Table 3). Further analyses using Fisher's exact test confirmed the

absence of significant associations between qualitative functional outcomes and the type of surgical reduction, as well as the use of fluoroscopy. Overall, despite variations in management and fracture characteristics, no independent factor demonstrated a statistically significant impact on functional recovery in this cohort. Figure 2 shows restoration of shoulder function following a fracture of the proximal humerus, fixed with a non-locking T-plate.

Table 1: Patients characteristics (n=41).

Variables	N	Percentage (%)
Gender		
Male	25	61
Female	16	39
Comorbidities		
Hypertension	5	14.3
Diabetes	2	5.7
Alcoholism	20	57.1
Neoplasm	1	2.9
Circumstances		
Falls	6	14.6
Road traffic accident (RTA)	30	73.2
Gunshot wound	5	12.2
RTA: collision (n=30)		
Vehicle-vehicle	9	30.0
Vehicle-motorcycle	10	33.3
Vehicle-rollover	3	10
Vehicle-pedestrian	6	20
Motorcycle-pedestrian	1	3.3
Motorcycle fall	1	3.3

Table 2: Clinical, radiological and surgical characteristics of fracture, (n=41).

Variables	N	Percentage (%)
Mecanism of injury		
Direct	38	92.7
Complex	3	7.3
Context of injury		
Isolated fracture	27	65.9
Poly-fracture	09	22.0
Poly-trauma	5	12.2
Side of injury		
Right	16	40.0
Left	23	57.5
Bilateral	1	2.5
Skin injury		
Closed fracture	35	85.4
Open fracture	6	14.6
Gustilo-Anderson's classification		
I	1	16.7
II	3	50.0
III A	2	33.3
III B	0	0
III C	0	0
Neer's classification		
2-part	33	80.5
3-part	3	7.3
4-part	4	12.2
Reduction		
Open reduction	37	90.2
Closed reduction	4	9.8

Continued.

Variables	N	Percentage (%)
Fluoroscopy		
Yes	22	53.7
No	19	46.3
Surgical approach		
Deltoid-splitting	4	9.8
Delto-pectoral	33	80.5
Percutaneous	4	9.8
Surgical technique		
Plate and screw	25	61.0
Pinning	10	24.4
Intramedullary nailing	1	2.4
Tension band fixation	1	2.4
External fixator	2	4.9
Other (lag screw)	2	4.9

Table 3: DASH and constant-Murley score rating, (n=25).

Scores	Score	N	Percentage (%)
***DASH score**	Minimal disability (0-25)	11	44.0
	Moderate disability (26-50)	10	40.0
	Severe disability (51-75)	2	8.0
	Extreme disability (76-100)	2	8.0
Constant-Murley score	Poor (<56)	9	36.0
	Fair (56-70)	8	32.0
	Good (71-85)	2	8.0
	Very good (86-100)	6	24.0

*DASH: Disabilities of Arm, Shoulder and Hand

Table 4: Constant-Murley score.

Score	Mean ±SD	Median	Minimum	Maximum
Pain (15)	10.92 ±3.57	10.00	6.00	15.00
ADLs (20)	14.52±5.29	15.00	4.00	20.00
ROM (40)	26.16±9.61	26.00	6.00	40.00
Strength (25)	11.80±7.20	10.00	0.00	20.00
Constant score	63.3±23.44	65.50	22.00	95.00

*ADLs: Activity Daily Living, ROM: Range of Motion.

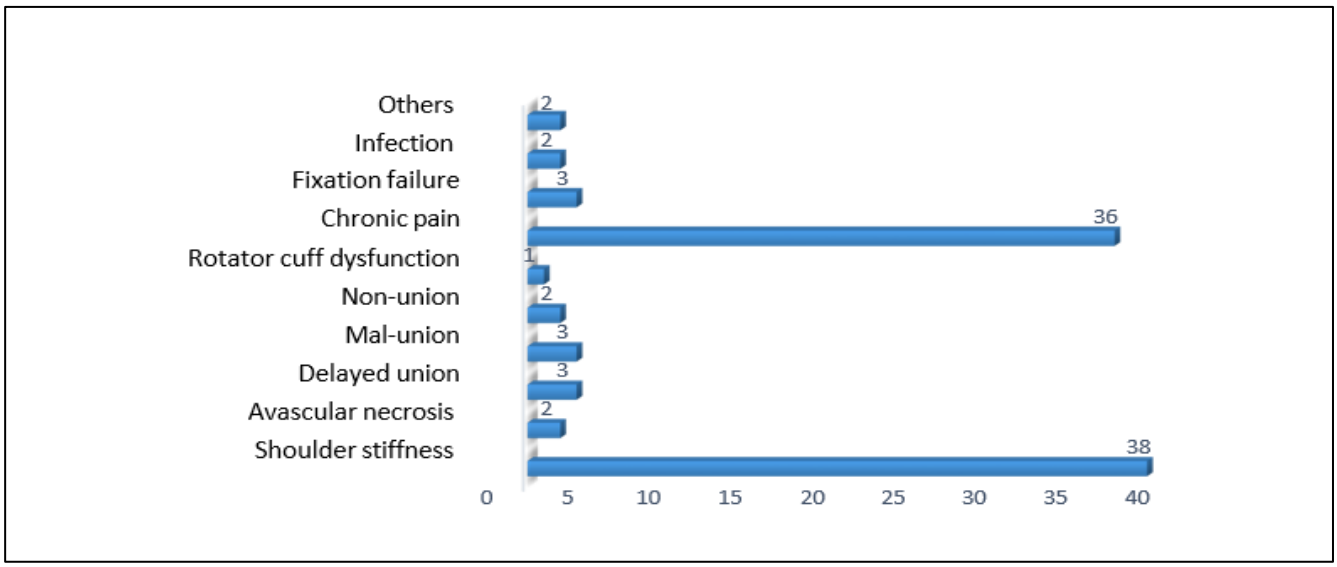

Figure 1: Late complications.

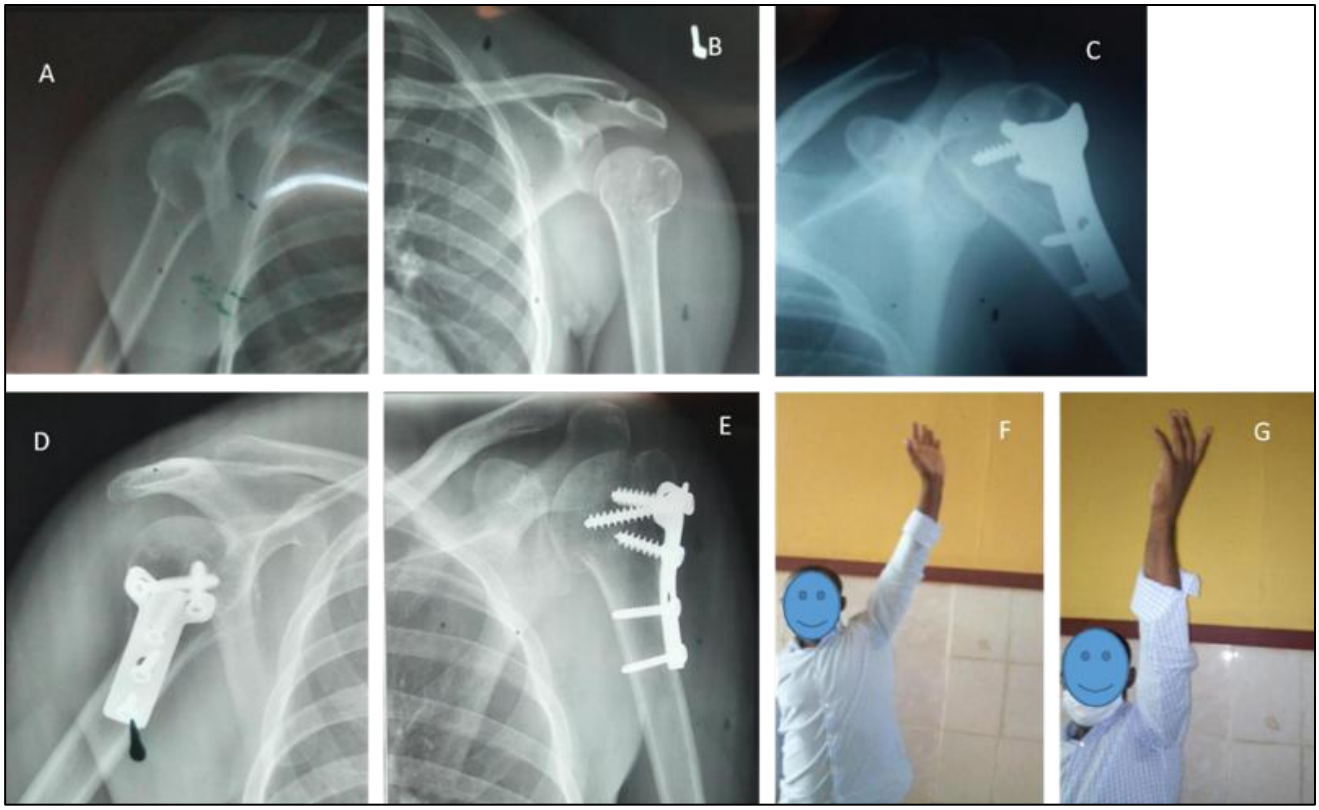

Figure 2: X-rays of a two-part fracture of the proximal left humerus (A and B); C=postoperative X-ray showing fixation with a T-plate; D and E=X-rays (lateral and anteroposterior) at 18 months' follow-up; F=abduction; G=forward flexion.

DISCUSSION

The aim of this study was to evaluate the functional and radiological outcomes of surgically treated PHF in three referral hospitals in Yaoundé. Although the study achieved most of its objectives, it was limited in its ability to identify independent predictors of poor outcomes. Several limitations must be acknowledged. Firstly, the retrospective design inherently exposed the study to selection and information biases. Secondly, a significant proportion of eligible patients were excluded due to missing records or loss to follow-up, resulting in a relatively small final sample size. Such limitations are commonly reported in trauma studies conducted in low- and middle-income countries, where medical record systems and patient follow-up remain suboptimal.[10,11] Furthermore, the lack of complete datasets limited the ability to perform robust multivariate analyses. This constraint has been highlighted in previous studies as a major obstacle to identifying prognostic factors in orthopaedic trauma research in resource-limited settings.[12]

Fractures due to osteoporosis are generally described as affecting mainly older women in high-income countries.[1,13,14] However, our findings differ markedly from this, with a younger mean age and a male predominance. This epidemiological profile has also been reported in several studies conducted in sub-Saharan Africa and other low- and middle-income countries, where high-energy trauma is the primary mechanism of injury.[9-11] he high prevalence of alcohol consumption observed in our cohort is consistent with previous studies identifying alcohol as a significant risk factor for trauma-related injuries.[12,13] Although comorbidities such as hypertension and diabetes were present, the size of our sample did not allow for a meaningful analysis of their impact on outcomes. The predominance of injuries on the left side, despite universal right-handedness, is likely coincidental and reflects the unpredictable nature of traumatic mechanisms. In our series, two-part fractures according to the Neer classification were the most common type, which is consistent with the existing literature.[13,15] Similarly, the predominance of type A fractures according to the AO/OTA classification corresponds to previously reported distributions. The preponderance of road traffic accidents highlights the role of high-energy trauma in our setting. This contrasts with Western populations, where low-energy falls predominate.[16] High-energy mechanisms are known to be associated with increased fracture complexity, soft tissue injuries and vascular damage, which can have a negative impact on outcomes.

The proportion of open fractures observed in this study is higher than that reported in most high-income settings, which likely reflects both the severity of the injuries and the specific epidemiological context, particularly gunshot wounds.[17] The management of PHFs in adults remains highly variable, with no universally accepted standard of

care.[18] Treatment decisions are influenced by multiple factors, including patient characteristics, fracture characteristics, the surgeon's experience and the availability of resources. In this study, fixation using non-locking plates was the most frequently used technique, in contrast to current international practice where locking plates are preferred for displaced fractures.[19-21] This divergence reflects the limited availability of modern implants in our setting. The use of improvised implants, such as adapted plates, further illustrates the constraints encountered in resource-limited settings. Similar findings have been reported in other low- and middle-income countries, where surgeons must adapt their techniques to the resources available.[33] Although fluoroscopic guidance and the delto-pectoral approach have been commonly used, the low rate of anatomical reduction is a cause for concern. It has been demonstrated that anatomical reduction and restoration of the neck-shaft angle are key determinants of treatment success and a reduction in mechanical failure.[23,24] Rehabilitation remains a major challenge, with a delayed start and limited access to physiotherapy due to financial constraints. Early, structured rehabilitation has been consistently associated with better functional outcomes.[25]

The union rate observed in this study is comparable to that reported in the literature.[26] However, the complication profile differs, with a high prevalence of abnormal union and shoulder stiffness. Complication rates following surgery for humeral head fractures remain high, even under optimal conditions, particularly with ORIF techniques.[27] However, the higher rates observed in this study are likely due to several factors, including suboptimal fixation, delayed surgery and limited rehabilitation. Avascular necrosis (AVN), osteoarthritis and non-union are well-known complications of humeral head fractures.[28] Their occurrence is closely linked to the severity of the fracture, vascular disruption and the quality of reduction. The delay before surgery observed in our series may have contributed to poorer outcomes, as early surgery has been associated with better results Shoulder stiffness, the most common long-term complication in this study, is multifactorial. It may result from prolonged immobilisation, inadequate rehabilitation and impaired joint biomechanics.[30,31]

Despite the limitations mentioned above, the functional outcomes were generally satisfactory. The mean DASH and constant scores were comparable to those reported in several international studies, although most of these focused on locking plate fixation.[30-32] It is interesting to note that no statistically significant association was observed between functional outcomes and variables such as age, sex, surgical technique or quality of reduction. This result may reflect the study's limited statistical power rather than the absence of genuine associations. It should be emphasised that acceptable functional outcomes were achieved despite the use of non-locking implants. This may be explained by the relatively young age of the study population and the predominance of less complex fracture types.

CONCLUSION

In our context, PHFs mainly affect a young, active population and are primarily associated with high-energy trauma, which contrasts with the profile of fragility fractures typically described in high-income countries. Despite these differences, surgical management remains challenging, particularly in resource-limited settings where delayed presentation, limited access to imaging and modern implants, as well as suboptimal rehabilitation conditions, influence treatment strategies and outcomes. In this study, surgical treatment, largely based on non-locking fixation techniques, resulted in acceptable fracture union rates and generally satisfactory functional outcomes, as evidenced by the DASH and Constant-Murley scores. However, these results were accompanied by a high prevalence of complications, notably shoulder stiffness and chronic pain, as well as relatively low rates of anatomical reduction. It is important to note that no significant association was observed between functional outcomes and surgical technique, the use of fluoroscopy, the type of reduction or delayed rehabilitation, which likely reflects both the heterogeneity of therapeutic approaches and the limited sample size. These findings highlight the adaptability of surgical practice in resource-constrained settings, but also underscore the need to improve technical platforms, promote early and structured rehabilitation, and optimise perioperative care.

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