



## Outcomes of plate-screw fixation of humeral shaft fractures in three hospitals of the city of Yaoundé

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### Abstract

**Background:** Surgical management of humeral fractures involves several methods including plate-screw fixation, intramedullary nailing, external fixation, and pinning. Nowadays, the most used surgical method is plate-screw fixation.

**Objective:** The aim of this study was to present the short-, medium- and long-terms outcomes of plate-screw fixation of humeral fractures in three hospitals in the city of Yaoundé.

**Material and Methods:** This was a descriptive and retrospective study with prospective evaluation carried out in the orthopedic and trauma surgery departments of three hospitals in the city of Yaoundé, over a period of 6 years and 4 months. We analyzed the medical records of the operated patients and did a physical reevaluation of the patients using a pre-conceived tested data sheet. The following variables were studied: socio-demographic characteristics, fracture profile, clinical and radiological profile, and the functional prognosis of the shoulder and elbow joints (using the Constant and Murley score, and the Mayo elbow performance score respectively). Data analysis was done using the software Statistical Package for Social Sciences (SPSS) version 23.0.

**Results:** Eighty-two cases of osteosynthesis were recorded. The mean age of the patients was  $37.9 \pm 11.5$  [16 – 71] years and there was a male predominance (sex ratio of 2.7). The dominant humerus was most involved (96.4%). Closed fractures were predominant (65.8%), and the majority (47%) of them were simple fractures. The diaphysis was the most affected bone part (69.5%). Road traffic accidents accounted for 70.7% of the fractures. Two patients had a polytrauma, 26 had multiple fractures, and 54 had an isolated humeral fracture. The mean operating time (for the osteosynthesis) was 122 min and the mean blood loss volume during surgery was 296 cc. There was a significant correlation between these two variables. Postoperative complications included 8 cases of postoperative radial palsies (who recovered within an average of 4 months), 06 cases of superficial skin infections, 05 cases of secondary displacements, 03 cases of implant damage and 02 cases of vicious callus. The bone reductions were sub-anatomical in 79% and cortical fixation was good in 72.6% of cases. Consolidation was achieved within an average of 18 weeks. The consolidation time significantly varied according to the type of fracture line and the type of reduction obtained. Functional recovery of the shoulder and elbow was nearly normal in all patients. The mean Constant and Murley score was 96.9 while the mean Mayo elbow performance score of 97.3.

**Conclusions:** Plate-screw fixation enables an adequate management of humeral fractures with acceptable clinical and radiological results, low complication rates, and good functional outcomes.

**Keywords:** osteosynthesis, humerus, plate-screw, fixation

### Introduction

Humeral fractures account for 3% of all fractures. They have an annual incidence ranging from 13 to 14.5 per 100,000 inhabitants <sup>[1]</sup>. As stated by Charnley, the humerus is the easiest bone, among long bones, that can be treated conservatively with good results <sup>[2]</sup>. This is partly related its good tolerance for sub-anatomic reductions. In fact, a shortening of 3 cm, and an angulation of up to 20 ° are acceptable in the humerus. However, non-operative treatment requires a long period of immobilization. This causes discomfort to the patient and can result in stiffness of the shoulder and elbow, and nonunion. All these factors motivate the resort to surgical treatment. The indications for surgery in cases of humeral fractures are open fractures, segmental fractures, pathological fractures, fractures associated with vascular or nerve damage, bilateral

fractures, fractures in multiple trauma patients, as well as failure of conservative treatment <sup>[3]</sup>.

The surgical therapeutic modalities include plate-screw or intramedullary nailing internal fixation, and external fixation. The reported results of the internal fixation methods have broadened the sphere of surgical techniques and implants now used to provide absolute or relative stability of the fracture site <sup>[4]</sup>. Numerous studies have compared the results obtained after plate-screw fixation with those of intramedullary nailing fixation. Plate-screw fixation is the most used method because it does not require a specific technical platform, and is therefore suitable in our work setting <sup>[5]</sup>. The aim of this study was therefore to present the results of plate-screw fixation in our setting (three hospitals in the city of Yaoundé).

## Methodology

Over a period of 6 years 4 months, from January 2010 to June 2016, we conducted a retrospective descriptive study in the orthopedic and trauma surgery departments of 03 hospitals in the city of Yaoundé (the Central Hospital, the General Hospital and the Fondation Rodolphe d'Orthopédie et Traumatologie). We consecutively recruited all patients who had undergone plate-screw fixation of a humeral fracture. We did a physical reassessment of the shoulder and elbow of these patients during scheduled interviews using a pre-conceived tested technical form. We Included records of adults aged 16 years and above, who were followed-up for at least 6 months post-surgery. We excluded patients with pathological fractures, floating shoulders, floating elbows, joint fractures, and incomplete records. We also excluded those lost-to-follow-up, and those who refused to give their consent. On the basis of these criteria, we recorded 82 osteosyntheses in 80 patients. The variables studied were the socio-demographic profile, fracture profile, clinical and radiological profile of the patients, and the functional prognosis of the shoulder and elbow (assessed by the Constant and Murley functional score, and the Mayo performance score respectively). This study was approved by the institutional ethics and research committee of the Faculty of Medicine and Biomedical Sciences, and we also obtained authorizations from the various health structures.

## Results

One hundred and twenty-four (124) screw and plate osteosynthesis were recorded in one hundred and twenty (120) patients, but 44 who did not meet our eligibility criteria were excluded. We therefore included a total of 82 internal fixation in 80 patients.

### Socio-demographic profile

Our series consisted of 60 men and 22 women for a sex ratio of 2.7. The mean age of these patients was  $37.9 \pm 11.5$  years with range from 16 to 71 years. The dominant side was predominantly affected (96.4%), and 02 patients had presented a bilateral fracture.

### Fracture profile

The most predominant bone lesions were closed fractures (65.8%), followed by pseudarthrosis (13.4%). Open fractures, classified according to the Gustillo-Anderson (GA) classification were found in 7 (8.5%) patients among whom 04 patients (4.8%) were G.A. type I fractures, and 03 patients (3.6%) GA type II fractures. According to the AO classification, simple fractures (type A) were predominant (47%), followed by wedge fractures (type B) in 22% of the fractures. Complex/comminuted fractures (type C) represented 13% of the fractures. Regarding the location of the fractures, the middle diaphyseal portion was the most affected (69.5%) followed by the distal diaphysis (25.6%). Five patients presented with a proximal diaphyseal line and 03 with a distal diaphyseal line. The most frequent displacements were superposition/shortening (68.2%) followed by medial displacements (23%). The main etiology of the fractures were road traffic accidents (70.7%), followed by work accidents (9.7%), then assaults and falls (7.3%). The initial lesions were single trauma in 54 patients, multiple fractures in 26 patients and polytrauma in 2 patients. The associated lesions were of two types: lesions of nerve fibers (which were present in 5 patients who

presented with preoperative radial palsy) and bone lesions (such as femoral, leg bones and pelvic fractures).

### Intraoperative data

The mean operation time was  $122 \pm 29.05$  [90-240] min for average blood loss of  $296 \pm 79$  [250-500] cc. There was a strong association between the two variables ( $r = 0.7$ ;  $p < 0.001$ ).

### Postoperative complications

The short- and medium-term clinical post-operative outcomes were favorable in more than half of the patients. Complications were present in 29.6% of patients. These included 8 cases (9.7%) of radial paralysis secondary to the surgical procedure (they all recovered within averagely 4 months post-surgery without any surgical revision), 06 cases (7.3%) of superficial skin infections (which increased the duration of hospitalization), 5 cases (6%) of secondary displacements (among which 3 were placed a cast), 03 cases (3.6%) of implant damage (for which the patients had to undergo a second surgical intervention), and 02 cases (2.4%) of vicious callus.

### Types of bone reduction

During the interviews, the quality of the reduction was assessed on the immediate postoperative plain X-ray films of the operated limb. The reductions obtained were mainly sub-anatomical (79%). The best reductions were anatomical in 17.8% of the cases and 3.2% had a functional reduction (Figure 1). The type of reduction also depended on the type of fracture line; the best reductions were obtained for simple fractures.

### Cortical fixation

In addition to the reduction, the quality of the bi-cortical screw fixation was appreciated. More than half of the patients had good cortical fixation (72.6%), 22% had an acceptable and 4.8% a poor cortical fixation (Figure 2)

### Time delays

Regarding the time spent before treatment, apart from cases of non-union, all the patients had been operated during the first week following their fracture (average delay time = 4 days). They were re-evaluated after an average follow-up of 28 [11-61] months. Bone consolidation was noted after an average of 18 [9-72] weeks post-surgery. The consolidation time significantly varied according to the type of fracture line and the type of reduction. It also varied according to the site of the fracture but the association was not significant. Thus, the more commutative the fracture line was, the longer the consolidation time (that is, 21 weeks for types B and C fractures). Anatomical-type reductions consolidated faster (13 weeks), and the distal diaphyseal fractures consolidated after an average of 21 weeks (Table I).

### Functional prognosis of the shoulder and elbow

Functional recovery was assessed in 57 patients using the Constant score for the shoulder, and the MEPI score for the elbow. The shoulder assessment was rated excellent and good in 56 patients (98.2%), and average in 1 patient (1.8%). The elbow assessment, on the other hand, was found to be excellent and good for all patients. Furthermore, the mean Constant score was  $96.9 \pm 7.3$  [51-100] and the mean MEPI score was  $97.3 \pm 4.5$  [65-100] (Figure 3).

## Discussion

Humeral fractures are the only long bone fractures for which a shortening of 3 cm and an angulation of up to 20 ° are acceptable [3]. In our study, 82 plate-screws fixation of humeral fractures were identified. The male sex was predominant (73.1%), and this could be explained by the fact that men are more active, and are more involved in road accidents (where the upper limb remains relatively exposed). The average age of the patients was 37.9 years, possibly due to the fact that our Cameroonian society is made up of a young and highly active population. We did not find a bimodal distribution as described in two studies in Europe and Asia [6, 7]. The dominant limb was affected in 96.4% and would be related to the fact that the involvement of the dominant limb is an indication for surgery. Our results are similar to those of Mir G *et al.* in India in 2014 [3]. Closed fractures were most frequent because of the good muscular coverage of the humeral shaft. According to the AO classification, simple fractures were predominant. The main etiology of the fractures was road accidents. This high frequency of accidents had already been reported in Cameroon by Ngaroua *et al.* in 2016 [8], and is believed to be due to the poor condition of roads and the advent of two-wheeled vehicles made available to people who have little concern for the material and bodily damage that these accidents can cause. The mean operating time for these osteosyntheses was 122 min with a mean blood loss of 296 cc. Mir G *et al.* in their study found an average time of 66.2 min (during plate-screw fixation) with an average blood loss of 310 cc [3]. In this same line, Chaudhary *et al.* [9] had a mean operation time of 90.2 min for a mean blood loss of 205 cc. Major postoperative complications were represented by 8 cases (9.7%) of postoperative radial palsies and 6 cases (7.3%) of superficial skin infections. Similar findings were reported by Changulani *et al.* in India, in 2007. [10] They reported an incidence of 5% of postoperative radial palsy and 4% of postoperative infection during plate-screw humeral fractures fixations. The risk of damage to the radial nerve is linked to the trajectory of the latter and the position of the plate. In addition, 05 patients had a secondary displacement (which was handle by the placement of a cast) and 03 patients had fractures of the initial implant (they benefited from a second intervention). On radiographic images, the reductions were mainly sub-anatomic (79%) and the cortical fixations were good (72.6%). In fact, surgically treated fractures of the humerus tolerate non-anatomical reduction. Patients consolidated within an average of 18 weeks. A similar time frame (16 weeks) was reported by Mir G *et al.* [3] and is due to the fact that the plate-screw fixations allow an absolute stability to be obtained, especially in events of anatomical reduction. This delay depends on the type of reduction and the type of fracture line. The best reductions obtained the fastest consolidation time (13 weeks for anatomical reductions), and the more the trait was comminuted, the longer the consolidation time (15 weeks for types A, 21 weeks for types B and C). Regarding the time delay between the fracture and the surgery, all the patients had been operated during the first week following the accident (mean delay = 4 days). These lesions mainly affected adults with high functional demands requiring early management and rapid recovery. Our results are similar with those of Huri *et al.* in Turkey in 2014, [11] and with those of Concha *et al.* in Colombia in 2010 [12]. They respectively found mean delays of 6.4 and 4.8 days. Functional recovery

was assessed by the Constant score for the shoulder, and MEPI for the elbow. It was almost normal in all patients, with a mean Constant score of  $96.9 \pm 7.3$ , and a mean MEPI score of  $97.3 \pm 4.5$ . Harish Kurup *et al.* [13, 14] in their meta-analysis found similar results with an almost normal functional recovery after plate-screws osteosynthesis.

## Conclusion

Plate-screw osteosynthesis enables an adequate management of humeral fractures with acceptable clinical and radiological results, a low rate of complications, and near-normal functional outcomes. However, this technique requires strict compliance with the principles of internal fixation, and regular monitoring of patients.

## Conflicts of interest

The authors declare no conflict of interest.

## What is known about this topic?

- The work carried out on the subjects informs us about the epidemiological aspects, namely the age, the profile of the patients and especially the mechanisms leading to this lesion.
- On the other hand, several treatment methods have been described and evaluated according to their results. Very few studies have been carried out in Africa and Cameroon, in particular concerning plate-screw osteosynthesis.

## What new information can be obtained from this study?

- Our study evaluates the technique of screw-plate osteosynthesis in an African context where the technical platform is not up to standard, and where qualified orthopedic surgeons are few.
- At the end of this study, we realize that this technique is appropriate in our work context because it does not require any special equipment. Complications were rare and so, this technique can be applied without fear.
- Considering the clinical and functional results, this technique could be taught as a gold standard in schools of surgery in Africa.

## Contributions from authors

We certify that the aforementioned authors have contributed to the designing, writing, analysis, reading, and approval of this manuscript, according to their rank.

**Table 1:** Consolidation time according to the fracture line, the quality of reduction, and the site of the fracture.

Variables	Mean consolidation time (weeks)	P-Value
Types of fracture line		0.037
Type A	15	
Type B	21	
Type C	21	
Types of reduction		0.04
Anatomical	13	
Sub-anatomical	20	
Functional	23	
Site of the fracture		0.8
Proximal diaphysis	18	
Middle diaphysis	18	
Distal diaphysis	21	

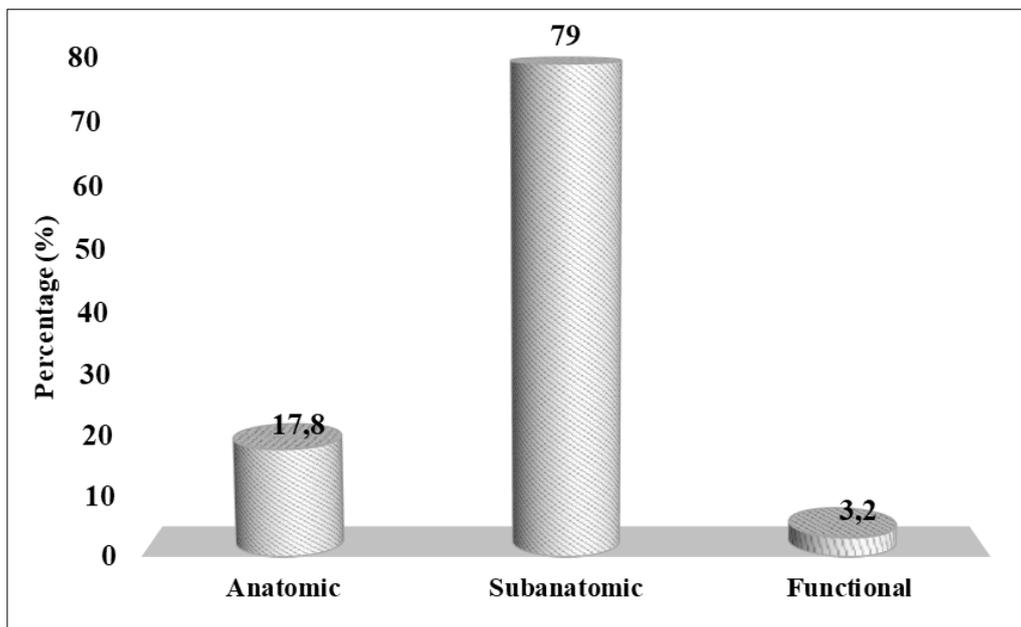


Fig 1: Types of reduction



Fig 2: Pre- and post-operative radiological images



**Fig 3:** Radiological and clinical images during the re-evaluation

### References

1. Matsunaga FT, Tamaoki MJS, Matsumoto MH, dos Santos JBG, Faloppa F, Belloti JC. Treatment of the humeral shaft fractures--minimally invasive osteosynthesis with bridge plate versus conservative treatment with functional brace. *BioMed Central*,2016;7:14(1):246.
2. Livani B, Belangero W, Medina G, Pimenta C, Zogaib R, Mongon M. Anterior plating as a surgical alternative in the treatment of humeral shaft non-union. *Int Orthop*, 2010;34(7):1025–31.
3. Wali MGR, Baba AN, Latoo IA. Internal fixation of shaft humerus fractures by dynamic compression plate or interlocking intramedullary nail: a prospective, randomised study. *Strat Traum Limb Recon*,2014;19(9):133–40.
4. Singiseti K, Ambedkar M. Nailing versus plating in humerus shaft fractures: A prospective comparative study. *Int Orthop*,2010;(34):571–6.
5. Superti MJ, Martynetz F, Falavinha RS, Fávoro RC, Boas LFV, Filho SM, *et al*. Evaluation of patients undergoing fixation of diaphyseal humeral fractures using minimally invasive bridge-plate technique. *Rev Bras Ortop*,2012;47(3):310–7.
6. Tytherleigh-Strong G, Walls N, McQueen MM. The epidemiology of humeral shaft fractures. *Bone Joint J*. 1998;80-2.
7. Tsai C-H, Fong Y-C, Chen Y-H, Hsu C-J, Chang C-H, Hsu H-C. The epidemiology of traumatic humeral shaft fractures in Taiwan. *Int Orthop*,2009 :15:33(2):463–7.
8. Jérémie MA, Natacha AAM, Yaouba D, Joseph EN. Les fractures dues aux accidents de la voie publique à l' Hôpital Régional de Ngaoundere (Cameroun). *Health Sci Dis*,2016;17(3):24-8.
9. Chaudhary P, Karn NK, Shrestha BP, Khanal GP, Rijal R, Maharjan R, *et al*. Randomized controlled trial comparing dynamic compression plate versus intramedullary interlocking nail for management of humeral shaft fractures. *Health Renaissance*, 2011;9(2):61-66.
10. Changulani M, Jain UK, Keswani T. Comparison of the use of the humerus intramedullary nail and dynamic compression plate for the management of diaphyseal fractures of the humerus. A randomised controlled study. *Int Orthop*,2006;31:391–5.
11. Huri G, Biçer ÖS, Öztürk H, Deveci MA, Tan I. Functional outcomes of minimal invasive percutaneous plate osteosynthesis (MIPPO) in humerus shaft fractures : a clinical study,2014;48(4):406–12.
12. Concha JM, Sandoval A, Streubel PN. Minimally invasive plate osteosynthesis for humeral shaft fractures: are results reproducible? *Int Orthop*,2010;34(8):1297–305.
13. Kurup H, Hossain M, Jg A. Dynamic compression plating versus locked intramedullary nailing for humeral shaft fractures in adults (Review). *Cochrane Bone, Joint and Muscle Trauma*,2011:(6):18-27.
14. Daniel Handy Eone<sup>a</sup> Prudence Christelle Danielle Ngon<sup>a</sup> Marie José Essi *et al*. Anterior approach in humeral plating osteosynthesis *Orthopaedics and Traumatology Surgery and Research*,2018;104(6):847-851