

# Surgical Treatment for Proximal Humerus Fractures Comparison between Plate Fixation and Kapandji's Pinning

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## Abstract

**Introduction:** Proximal humerus fractures are common, however, there is no consensus on a decision-making algorithm for the therapeutic management of these fractures, the aim of this study is to evaluate and compare functional results between two surgical techniques and to deduce the satisfactory results of the Kapandji's pinning which, compared to the screw plate, should keep its place in the therapeutic arsenal. **Patients and Methods:** It's a retrospective study, including two groups: The first of 18 patients treated with palm-tree pinning using kapandji's technique, the second of 16 patients treated with anatomical screw plate at the orthopedic trauma service of the Mohamed VI university hospital between July 2013 and July 2018. We compared the results of the two techniques by studying three parameters which are the healing time, the anatomical reduction, and the functional outcomes. The average age was 46 years, and the sex ratio (M/F) was 2.3. **Results:** The statistical analysis of functional and radiological results showed no significant difference between the two techniques, indeed the average healing time was 56.3 days in the group treated by screw plate and 55.2 days in the group treated by Kapandji's pinning ( $p = 0.46$ ), Constant's score was 73.18 and 79.05 respectively ( $p = 0.27$ ) and the average cephalodiaphyseal angle was  $49.03^\circ$  and  $52.07^\circ$ , respectively ( $p = 0.35$ ). **Discussion:** This study has clearly shown, as reported in the literature, that there is no conclusive evidence to suggest superiority of osteosynthesis by anatomical plate versus kapandji's pinning. However, the simple achievement of pinning according to kapandji's technique, the preservation of soft tissues and the low cost make us prefer this technique. Furthermore, despite the progress noted in the development of osteosynthesis means of the proximal humerus, percutaneous pinning should always keep its place.

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## Keywords

Fracture of Proximal Humerus, Osteosynthesis, Humeral Anatomical Plate, Kapandji's Pinning

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## 1. Introduction

Proximal humerus fractures are frequent and represent approximately 5% of all fractures, their frequency of occurrence increases to more than 10% after the age of 65 years and are in the third rank of osteoporotic fractures after proximal femur fractures and wrist fractures [1]. There are many varieties, with different prognoses and treatments. Numerous classifications have been proposed according to the location of the features in relation to the articular surface and the tuberosities, the number of fragments, the displacement, and the association or not with a glenohumeral joint dislocation [2]. Currently, there is no consensus for the therapeutic management of these fractures [3] which ranges from simple immobilization to humeral arthroplasty in addition to several osteosynthesis techniques.

The treatment must meet two main objectives: to ensure good fracture healing and to allow early mobility of the shoulder.

Despite the progress noted in the development of means for osteosynthesis of the upper extremity of the humerus, percutaneous pinning would have satisfactory results similar to those of the screw plate and should always keep its place in the therapeutic arsenal of this type of fracture.

In 1989, Kapandji described his technique of centro-medullary pinning for the treatment of displaced surgical neck fractures in young patients, with divergent K-wires introduced at the "V" deltoid level [4]. Few authors are experienced in this technique and have reported the results, including simple and complex fractures [5].

The aim of this retrospective study is to evaluate the functional results of proximal humerus fractures treated by palm-tree pinning using the kapandji's technique compared to those treated by the screw plate.

## 2. Material and Methods

### 2.1. Patients

All fractures of the proximal humerus (34 cases) managed surgically by osteosynthesis; whatever the pathological type of the fracture, the mechanism of the trauma, the terrain, the sex or the side affected; at the orthopedic trauma service of the Mohamed VI university hospital between July 2013 and July 2018 with an average follow-up of 24 months; were included retrospectively. The average age was 45, and the sex ratio (M/F) was 2.4.

The first group of 18 patients is treated by Kapandji's pinning, and the second of 16 patients treated by anatomical screw plate by deltopectoral approach.

Patients under the age of 15 were excluded from our study, fractures of the

proximal humerus treated orthopedically as well as all diaphyseal or distal extremity fractures of the humerus. Patients with fractures extending into the humeral shaft or into the articular surface (head split fractures) and patients treated with other methods of fixation or with shoulder replacement were excluded from the study.

## 2.2. Methods

All patients were summoned to the service to evaluate functional and anatomical results. For functional evaluation we used Constant score which is a score based on an age-and sex-matched, and we also used a qualitative assessment according to Constant, as a function of the differential between the Constant index on the operated side and that on the opposite healthy side. To appreciate radiological results, we considered the cases judged anatomical: a translation less than 0.5 cm, an overlap less than 0.5 cm, a great tuberosity displacement less than 5 mm and an alpha angle equal to  $45^{\circ} \pm 10^{\circ}$ . We compared the results of the two techniques by studying three parameters: healing time, anatomical reduction, and functional results. Data analysis was performed on SPSS.

### **Surgical procedure of Kapandji's pinning:**

Under general anaesthesia, patients were placed in a beach-chair position. The upper limb was prepped and draped in a sterile fashion, free of the table. C-arm fluoroscopy was positioned in order to obtain orthogonal imaging of the proximal part of the humerus during the procedure.

The first step consisted of pinning, whereby the deltoid "V" insertion was identified clinically and confirmed under fluoroscopy. Then, a short approach (4 cm) was performed directly toward the humeral shaft, dividing brachial muscle fibres, and a hole of 6 mm was created with drills of increasing diameter. During the exposure of the shaft, bent retractors are never placed at the back of the shaft to avoid radial nerve damage. Three or four non-threaded K-wires of 2-mm diameter were prepared in a "double bent fashion" (proximal 10 mm is bent by  $45^{\circ}$  followed by a smooth gentle curve in the same direction of the next 10 cm). Then, wires are inserted in the medullary canal and pushed up to the level of the fracture. The K-wires were placed in the subchondral bone in a divergent fashion [Figure 1].

### **Surgical procedure of Plate fixation:**

We used the beach chair position, pre-operative positioning of the image intensifier is important to secure good orthogonal images during surgery.

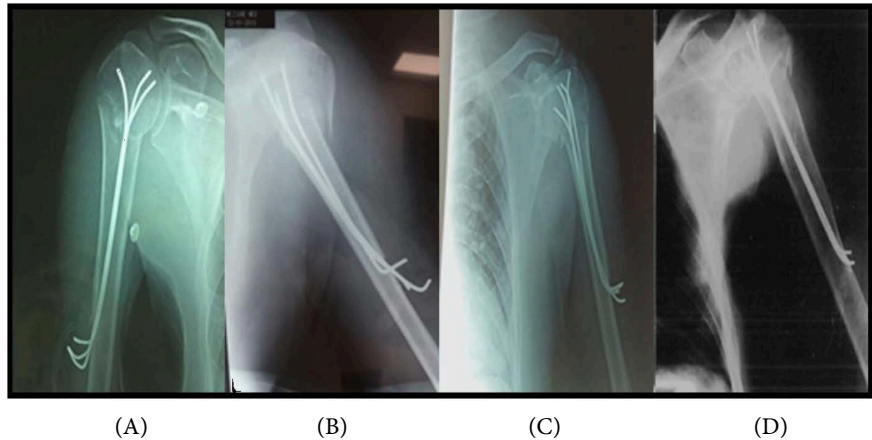
We used a deltopectoral approach, careful dissection is the key to identification of the fracture anatomy and preservation of blood supply to the fragments. The biceps tendon is a key landmark to fracture identification. In some cases, the humeral head collapses into varus and should be elevated back gently using X-ray control. This will usually leave behind a space in the metaphysis requiring a bone graft or substitute. The medial calcar must be reduced into an anatomical position without overreduction into varus. If there is poor bone stock or comminution in this area the surgeon must watch closely in the post-operative period



**Figure 1.** Shoulder radiograph showing sub-tuberosity fractures treated by Kapindji's pinnig.

for collapse and possible screw penetration. Once reduced, the fragments may be held with K-wires. The tuberosities and the rotator cuff edges are secured with non-absorbable sutures and reduced onto the head. The proximal humerus is then reduced onto the diaphysis and may be secured with a temporary K-wire.

The plate is placed just posterior to the bicipital groove and at least a centimetre distal to the top of the head. Most designs allow for a central reference guide wire in the humeral head around which the plate is orientated. Aiming devices available in a number of systems improve the accuracy of screw placement. When drilling, care must be taken to enter subchondral bone without penetrating the articular cartilage. This can be done by 'feel' and use of image intensification. All the head screws are now placed under image guidance. Most designs use locking, self-tapping screws; others use a combination of screws and smooth pegs which have smooth ends and reduce risks of articular penetration. Screw lengths must be carefully measured and it is better to under measure off the far cortex. The plate is now fixed to the diaphysis. A cortical screw is then advanced up a gliding hole in the shaft to appose the plate to the bone. This also allows the construct to be moved distally or proximally if required. The remaining diaphyseal screws are filled using either cortical screws or locking screws depending on the bone quality. Now the rotator cuff/Tuberosity sutures are passed through the suture eyelets in the plate and secured. The authors recommend the use of tough braided non-absorbable sutures which resists abrasion/rupture against sharp edges of bone or metal [Figure 2].



**Figure 2.** Shoulder radiograph osteosynthesis by screw plate. (A) cephalo-tuberosity Fracture-dislocation with 4 fragments treated by screw plate; (B) impacted sub-tuberosity fracture of the humerus treated by anatomical screw plate; (C) Non-impacted Fracture of surgical neck of humerus treated by anatomical screw plate. 2 years post-operative with good consolidation.

It is essential to screen the fixation carefully using the C arm image intensifier to check for quality and adequacy of reduction, position of metalwork and rule out any screw penetration into the joint.

### 3. Results

The ORIF group comprised 34 patients. Road accidents represent the main mechanism found in our series occurring in 17 cases. Most of our patients were right-handed (31 cases), the left side was the most affected with 64% of the cases. The reason for consultation in all our patients was severe shoulder pain with total functional impotence. We noted as associated bone lesions: fracture of homolateral distal radius in one case and a closed fracture of the contralateral tibia in one case. The associated traumas were: Head trauma (4 cases), dorsal spinal trauma (1 case), polytrauma (3 cases), and pelvic Trauma (one case). All our patients have benefited from a shoulder radiograph AP and Lamy profile, only 2 patients have benefited from a CT scan. We used Duparc classification [4] and Neer's classification [5] which are directly inspired from the concept of Codman [6].

The time between admission and intervention was less than 48 hours in 26 cases or 73.6%. The general anesthesia was used for all patients, the installation in supine was used in 21 patients or 61.7%, while the installation in beach-chair position was only adopted in 13 patients or 38.23%.

The Kapandji's punning is used in 18 cases or 52.94% while the screw plate is used in 16 cases or 47.05%. Post-operative immobilization was systematic in all our patients either by a Dujarier's bandage or by a simple scarf. The immobilization period was between one and three weeks depending on the type of osteosynthesis (one week for patients treated with a screw plate and three weeks for patients treated with Kapandji's punning). The rehabilitation was early and im-

mediate post-operative for the screw plate, postponed to the 3rd week in the case of punning.

Regarding the radiological results and according to the previous criteria, there were 29 results considered anatomical or 87.8%, versus 5 non-anatomical results or 14.7%. While the functional results, the mean follow-up was 24 months, the evaluation was based on the Constant score and the weighted Constant score, we obtained: an average Constant score of 76.44 on with extremes of 58 and 94 and an average weighted Constant score of 87.17% with extremes of 71% and 97%.

By analyzing the obtained results we've noted that younger people are more likely to obtain very good results (in the age group under 20 years (4 cases) we have 4 excellent results (100%) with an average Constant score of 93.75).

In our study, we noted a clear predominance of surgical neck fractures with 26 cases (76.4%), followed by cervical fractures with fracture of the great tuberosity or the trochin in 6 patients, then one case of cephalo-tuberosity fracture or (2.94 %) and cephalo-tuberosity fracture-dislocation (2.94%), Predominance of two fragment fractures which cover 76.4% of cases followed by three fragment fractures which affect 17.6% of studied population with 6 cases, and finally two cases of 4 fragment fractures(5.8%) [**Table 1**].

The distribution of different type of fractures according to the operating technique chosen is shown in [**Table 2**]. Surgical neck fractures had the best results, in fact 92.3% of patients with isolated surgical neck fractures had good to excellent results (or 77.4% of all good and excellent results).

Concerning the functional results according to the surgical technique, it was objectified that 18 patients treated with Kapandji's pinning had six cases of excellent results (33.33%), four cases of very good results (22.22%), six cases with good results (33.33%) and two with mean results (11.11%), the mean constant score was 79.05. The 16 patients treated with a screw plate had an excellent result (6.25%), nine of very good results (56.25%), five of good results (31.25%) and one case of moderate result (6.25%), the mean constant score was 73.18. the absolute mean constant score obtained was close between the two surgical techniques ( $p = 0.27$ ) [**Table 3**].

In addition, it was found that 16 patients treated by kapandji's pinning presented an anatomical reduction (the average cephalo-diaphyseal angle was  $52.07^\circ$ ), the average duration of healing was 55.2 days. Thirteen cases of the 16 patients treated with a screw plate presented an anatomical reduction while 3 cases (18.75%) presented a non-anatomical reduction (The average cephalo-diaphyseal angle was  $49.03^\circ$ ), the average healing time was 56.3 d (the p value was respectively 0.35 and 0.46) [**Table 4**].

We noted as complication in subjects treated with Kapindji's pinning: a common superficial infection, 1 case of delayed healing, 1 case of stiff shoulder; whereas in the subjects treated with a screw plate we noted: 1 case of superficial infection, 1 case of delayed healing, 2 cases of vicious callus and finally 1 case of stiffness of the shoulder.

**Table 1.** Types of fractures studied in our series with their frequency.

DUPARC	NEER	Fracture of two fragments	Fracture of three fragments	Fracture of four fragments	pourcentage
Fractures of the surgical neck		26	0	0	76.40%
Fractures of the surgical neck + great tuberosity		0	4	0	11.76%
Fractures of the surgical neck + trochin		0	2	0	5.88%
Cephalo-tuberosity fracture		0	0	1	2.94%
Cephalo-tuberosity fracture + luxation		0	0	1	2.94%
Pourcentage		76.40%	17.60%	5.80%	100%

**Table 2.** Operating techniques of fracture types according to the classification of Neer and Duparc.

Technique chirurgicale	Neer	Fracture a 2 fragments	Fracture a 3 fragments	Fracture a 4 fragments	
Embroschage de kapandji		18	0	0	
Plaque vissee		8	6	2	
Technique chirurgicale	Duparc	Fr sous tuberositaire	Fr sous tuberositaire + une des tuberosites	Fracture cephalo tuberositaire	Fr sous tuberositaire + Luxation
Embroschage de kapandji		18	0	0	0
Plaque vissee		8	6	1	1

**Table 3.** Functional results depending on the surgical technique (Constant score).

Surgical results	Technique		
	Kapandji's pinning	Plate	P value
Excellent	6 (33.33%)	-6.25%	0.0513
Very Good	4 (22.22%)	-56.25%	0.0416
Good	6 (33.33%)	-31.25%	0.89
Average	2 (11.11%)	-6.25%	0.61
Bad	0	0	
Average score	79.05	73.18	0.277

**Table 4.** Comparison of functional results between the two surgical techniques.

	Embroschage de kapandji	Plaque vissee
score de constant moyen	79.05	73.18
Pourcentage d'excellents et de bons resultants	88.88%	93.75%
Angle cephalodiaphysaire moyen	52.07°	49.03°
Delais de consolidation moyen	55.2j	56.3j
Reduction anatomique	88.88%	87.50%
Complications	17.01%	27.60%

No statistically significant effect was therefore observed between the two techniques, making it possible to conclude the superiority of one technique over the other.



## 4. Discussion

Several methods of osteosynthesis are applicable to the proximal humerus fractures, which explains the absence of a consensus on the therapeutic management of these fractures. Kapandji's pinning has the advantage of its simplicity and its harmlessness, the approach is simple, not very decaying, the only report is the radial nerve, which approaches the anterior compartment 4 to 6 cm below the deltoid. The use of screw plate provides better stability, especially with locked plates whose biomechanical qualities are superior to standard plate ones. CT scan appears to be an essential examination for analysis and classification of these fractures, in order to choose an adequate therapeutic management [7]. Many classifications have been proposed, in our study, we've adopted two classifications: Duparc [4] and Neer [8] which are directly inspired from Codman's classification [6].

Based on the fracture site, the fracture of surgical neck was dominant in our study with a rate of 76.4%. These results are consistent with those of literature (61% in the Lebellec series [9] and 66% for Savornin [10]). Indeed, it's the fracture type where we had good and excellent results (77.4% of all the good and excellent results).

Radiological outcomes were satisfactory with an average cephalodiaphyseal angle of  $50.63^\circ$ , the result obtained by Dheenadhayalan J [11] was close to our result with an anatomical reduction rate of 89% and an average Alpha F angle of  $39.6^\circ$ .

We obtained an average Constant score of 76.44 with extremes of 58 and 94, and an average weighted Constant score of 87.17% with extremes of 71% and 97%, which agree with other studies in literature, notably those of Alexa o [12], M. Elidrissi [13] and R. Chassat [14]...

The analysis of results concerning the influence of age has clearly shown that whatever the treatment used, most authors agree that outcomes are better in young patients, the mean constant score was 93.75 before the age of 20 years, 85.5 between 20 and 40 years, 73.07 between 40 and 60 years and 62 after 60 years. Frequent bone fragility in the elderly is a significant cause of complex fractures, secondary displacements, and vicious calluses due to the poor performance of the osteosynthesis material. Moreover, elderly age can also interfere in functional results through a lack of cooperation in rehabilitation process and preexisting lesions of the joint.

The pinning technique according to Kapandji is fast and minimally invasive, it offers an original approach which many advantages compared to other techniques of intra medullary pinning without neurovascular risk or extensor tendon rupture. The excellent and good results that we had, with an average constant score of 79.05 in our patients, agree with those of Le Bel lec [15], Barakat [16] and Monin [17].

Osteosynthesis of proximal humerus fractures by screw plate has been widely used, and this technique has the advantage of offering a more stable mounting



compared to pinning techniques, allowing thereby early mobilization with better functional results. 47.05% of our patients had benefited from this type of osteosynthesis, with 93.75% of excellent and good results and an average constant score of 73.18. However, the functional prognosis is correlated, as was shown in the study by Hardeman *et al.* [18] published in 2011, with the degree of preoperative displacement, vascularization of the humeral head, and the bone quality.

The parallelism between the final orientation of humeral head and functional result is not clear in literature; Kapandji [19] considered the reduction as “anatomical” in 57.9% of cases, “acceptable” in 26.3% and “mediocre” in 15.8%, without specific criteria. Although in mediocre reductions, some results remain good. In our series, when an anatomical reduction was obtained (angle  $\alpha = 45 \pm 10$ ), the results were all excellent and good. In our series, when an anatomical reduction was obtained (angle  $\alpha = 45 \pm 10$ ), the results were all excellent and good, except the cases with non anatomical reduction which they were less satisfying.

None of the two osteosynthesis techniques was free from complications, although screw plate may be considered superior in terms of reduction control. No case of osteonecrosis of the humeral head was reported in our series unlike the other series, this is probably due to the short follow up period.

This study had clearly showed that there is no statistically significant difference between the kapandji’s pinning and anatomical screw plate, which comes to join the study made in the orthopedic trauma service of Hassan II university hospital in 2013 [20] who showed that there is no superiority of one technique over the other, with a healing time of 6.1 weeks in the group treated with a screw plate, and 6 weeks in the pinning group, the mean absolute constant score was 86 and 90.92 respectively, and the mean cephalo-diaphyseal angle was 46.91 and 55.71 respectively.

## 5. Conclusion

The results found in our study, like those of literature, do not favor a technique compared to the other, but the simplicity of realization, preservation of the soft tissues, essential for vascularization of the humeral head, and the less cost of kapandji’s pinning, make us prefer this technique rather than osteosynthesis by plate. Furthermore, despite the progress noted in the development of means for osteosynthesis of proximal humerus, percutaneous pinning should always keep its place.

## State of Current Knowledge on the Subject

- Fractures of proximal humerus are common
- Many varieties, prognosis, and very different treatments
- Until now, there is no consensus or algorithm for the therapeutic management of these fractures.

## Contribution of Our Study to Knowledge

- The simplicity of making kapandji’s pinning.

- The preservation of soft tissues is essential for vascularization of the humeral head.
- The cost seems less important.
- There is no statistically significant difference between kapandji's pinning and anatomical screw plate
- All these criteria are the basis of Kapandji's pinning, a technique which must always keep its place in the therapeutic arsenal of proximal humerus fractures.

### Author Contributions

All the authors contributed to the conduct of this work, and all the authors read and approved the final version of the manuscript.

### Conflicts of Interest

The authors do not declare any conflict of interest.

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