PROXIMAL HUMERUS FRACTURES: COMPARATIVE STUDY OF TWO DIFFERENT FIXATION METHODS

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ABSTRACT

Objectives: The present study compares results of the treatment of patients with proximal humerus fractures using two different fixation methods: The T plate (Group A) for small segments that provides a relative stabilization is compared to the locking screw plate that promotes a rigid fixation. Methods: Eighteen patients were randomly divided into two groups and evaluated prospectively according to clinical aspect, functional score and radiographic parameters of displacement after fixation. Results: Using the Visual Analogue Scale – VAS, the mean pain at six months of follow-up was 2.1 for Group A and 2.2 for Group B. The mean range of forward elevation was 140º in Group A and 143º in group B. The mean UCLA functional scale scores were 30 and 31, respectively.

On the radiographic evaluation, the fractures of three patients in Group A had between 0 and 10 degrees of displacement after stabilization and six patients had displacement between 11 and 40 degrees; for Group B, seven patients had displacement between 0 and 10 degrees and three between 11 and 40 degrees. Conclusion: No early or late differences were found between groups in clinical and functional evaluations. In both groups, the prevalence of good results was observed. The reduction of the anatomical neck angles of the proximal humerus was closer to normal in the blocking screw group.

Keywords: Humerus fractures. Osteoporosis. Fracture fixation, Internal. Prospective studies. Comparative study.

INTRODUCTION

The shoulder joint allows considerable range of movements. The harmonious arrangement of the joints, muscles and ligaments of the shoulder girdle is essential for the positioning of the hand in space. Disarrangements caused by traumatism of the proximal extremity of the humerus and adjacent soft parts may lead to important functional limitation, generating dependence and loss of quality of life.[1] If not treated adequately, its fractures can result in defective consolidation, alteration in the mechanical axes and lever arms with consequent functional insufficiency not only of the shoulder, but of the entire limb.

These fractures correspond to between two and three percent of all upper limb fractures,[2] are more common in female patients over 60 years of age and are closely related to low bone density.[3] Those that occur in younger patients have distinct epidemiological and clinical characteristics with more frequency and are determined by high-energy trauma.[4]

Several factors determine the prognosis of these lesions, whereas the choice of adequate treatment for the patient is one of those with the greatest influence. Publications on this topic show that the treatment is controversial.[5,6] In patients with low bone density their fixation with the necessary stability continues a major challenge.[7] In the choice of the material and ideal fixation technique, two fundaments should be contemplated: adequate stability and implants of low volume. The need to respect tissue biology, the subacromial space and at the same time the obtainment of mechanical stability of the system can be conflicting objectives. A repercussion of this dilemma is the diversity of techniques and the different kinds of osteosynthesis materials advocated, a result of the dissatisfaction over the considerable incidence of complications, such as loss of the reduction, non-consolidation, osteonecrosis, reduction of the arc of movement and residual pain.[1]

While the discussion of which would be the best surgical implant option for these fractures persists, there is consensus that deviated fractures in healthy patients, or with comorbidities under clinical control and with preserved motor and cognitive function, should be treated with reduction, stabilization and early rehabilitation.[5]

This prospective study is aimed at comparing the result of two internal fixation techniques in a specific group of patients: individuals with two- and three-part fractures of the proximal end of the humerus according to Neer,[8] over 50 years of age, resulting from low kinetic energy traumatism. There is an evaluation of the early

All the authors declare that there is no potential conflict of interest referring to this article.

clinical and functional results and of the objective radiographic analysis of the maintenance or non-maintenance of the reduction obtained in the immediate postoperative stage.

METHODS

Between February 2006 and October 2007, 18 patients with proximal humerus fractures in two and three parts according to Neer's classification were preselected according to the inclusion criteria. The rules of the Institutional Review Board were complied with and followed.

These patients were allocated consecutively in a random manner by means of a draw in two groups: (Group A) nine patients, who had their fractures fixed with the use of T plates and small fragment screws and (Group B), another nine patients in which these were stabilized by plates specifically designed for this anatomical region, fixed by screws locked on the actual plate.

The inclusion criteria were: 1) two-part fracture (surgical neck) or three-part fracture (surgical neck and greater tubercle); 2) low energy of the traumatism; 3) sound patients or patients with comorbidities; 4) patients that were functionally independent before the trauma. The trauma mechanism in all the cases was the fall to the ground. No patient exhibited associated lesions. The cases were operated at an average time of one week after the fracture date (varying between five and nine days). The surgeries in both groups were conducted with a similar technique, only varying in terms of the type of implant used. Surgical access was performed by deltopectoral route, with minimum tissue aggression. Two suture sites were positioned previously in the supraspinous and subscapular tendons, close to the bone attachment. These were used to assist in the reduction and as adjuvants to the fixation of the fragment proximal to the plate.

The reduction is obtained by indirect methods, without the use of bone forceps or direct manipulation of the focal point of fracture and under radioscopy. Temporary fixation was performed when necessary with crossed Steinman wires. From this moment on, the plate is set on the fracture, sometimes using it to optimize the reduction. The greater tubercle is the key fragment for obtainment of system stability, and the exact reduction of this component of the fracture is essential.[7]

Two different principles are henceforth applied. The patients from group A have their fractures fixed with the principle of relative stability. T plates are used with the screws positioned far from the focal point of the fracture. (Figure 1) Those from group B are stabilized with a stiffer fixation, through a configuration in the implant-bone system that allows the neutralization of the acting forces, with little dependence on bone quality, on account of the use of screws that are locked on the plate. (Figure 2)
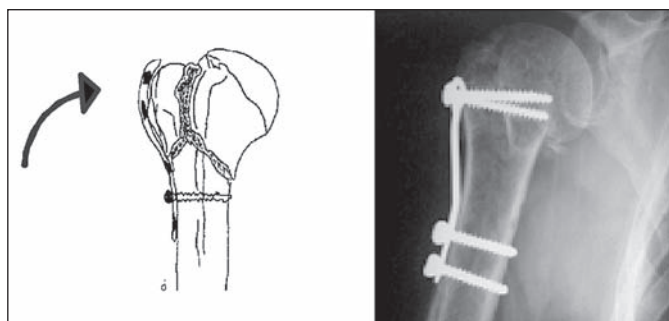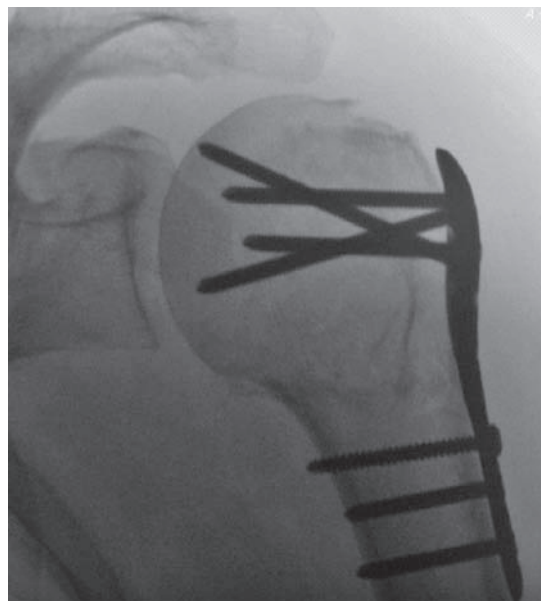

Figure 2 – *Plate and locking screws.*

Postoperative rehabilitation was the same for both groups. The use of a splint for seven to ten days was recommended for comfort and pain relief. Passive and active exercises for the elbow and hand were carried out according to the pain tolerance of the patient, who is encouraged to start them as early as possible. Formal physiotherapy is started on the 10th day, with an emphasis on the gain of amplitude of movement, by means of assisted passive exercises, respecting pain. Active exercises for the deltoid and rotator cuff muscles are introduced after the sixth week with the use of elastics and the passive exercises are maintained.

The patients were examined at regular intervals after one and six postoperative months. The clinical parameters were based on the subjective scaling of pain, by means of the visual analog scale (VAS), (self-evaluated scale from 0 to 10, where zero corresponds to no pain and 10 to extreme pain) and on the amplitude of elevation, lateral rotation and medial rotation movements following the standardization of AAOS.[9]

The functional evaluation was carried out in the sixth month by the criteria of UCLA (University of California at Los Angeles).[10] The results were distributed in four groups, considered excellent when between 34 and 35 points, good between 28 and 33, fair between 21 and 27 and poor between zero and 20.[11]

The radiological evaluation was documented in the true anteroposterior incidence, paying attention to the consolidation parameters and quality of the reduction obtained in the immediate postoperative stage. These were compared with those of the sixth postoperative month. Transparencies of the contralateral side were obtained to facilitate and to improve the precision of measurements in the frontal plane of the epiphyseal-diaphyseal angle. (Figure 3) The radiographic results observed were distributed in four groups: in the first of them when no deviation was observed or with deviation between 0° and 10°, in the second when deviation between 11° and 20° was observed, in the third with deviation between 21° and 40° and in the fourth deviations over 40°. In the case of deviation they described the deformity observed (varus or valgus).

Figure 1 – *T plate.*
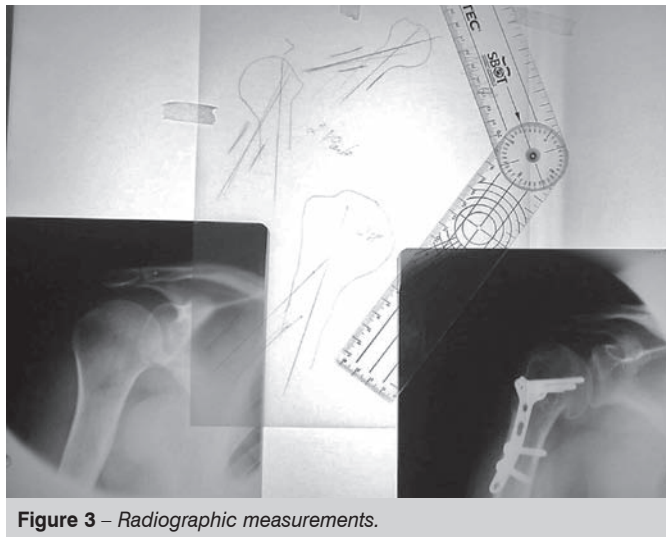
Figure 3 – Radiographic measurements.

Figure 4 – Mean value of the visual analog scale of pain.

STATISTICAL METHOD

We adopted the significance level of 5% (0.05) for the application of the statistical tests. It was considered a significant difference when p < 0.05.

We applied the Mann-Whitney test to verify possible differences between both the groups considered, in the various variables of interest.
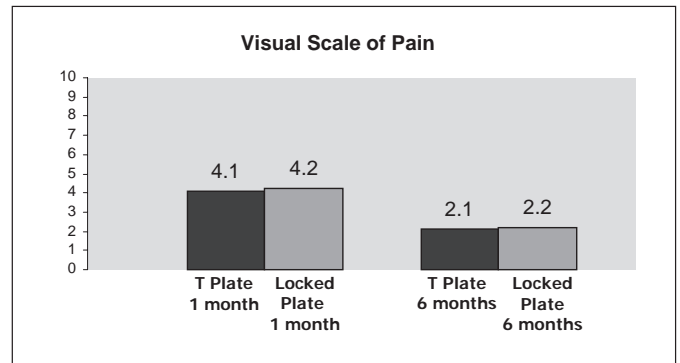
RESULTS

Nine patients (eight women and one man) were evaluated in group A (T plate), aged 66 years on average (minimum of 50 and maximum of 80 years), with four two-part fractures and five three-part fractures. Nine patients (eight women and one man) were assessed in group B (locked plate), aged 68 years on average (minimum of 50 and maximum of 80 years), with three two-part fractures and six three-part fractures (Table 1).

Table 1 – Characteristics of the groups.

	T Plate	Locked Plate
Gender	1M 8F	1M 8F
Average Age	66 (50 to 80)	68 (50 to 80)
2-part fracture	4	3
3-part fracture	5	6

In group A, the mean value obtained on the visual analog pain scale was 4.1 in the first postoperative month (with a maximum of six and minimum of one) and 2.1 in the sixth month (with a maximum of five and minimum of zero). In group B the mean value was 4.2 in the first postoperative month (with maximum of seven and minimum of two) and 2.2 in the sixth month (with a maximum of four and minimum of zero). In the evaluations in the first and sixth month the differences did not show statistical significance (p=0.99 and 0.42 respectively). (Figure 4)

In relation to the arc of movement, in Group A, the mean elevation in the first month was 95° (with maximum of 130° and minimum of 45°) and in the sixth month it was 140° (with maximum of 160° and minimum of 80°). The mean lateral rotation in the first month

was 19° (with maximum of 40° and minimum of zero degrees) and in the sixth month it was 40° (with maximum of 70° and minimum of 20°). As for medial rotation in the first month, seven patients reached between the sacroiliac joint and L3 and two arrived at L3 and in the sixth month one of them reached L4 and the other eight surpassed T12.

In group B, the mean elevation in the first month was 90° (with maximum of 110° and minimum of 60°) and in the sixth month it was 143° (with maximum of 170° and minimum of 110°). The mean lateral rotation in the first month was 27° (with maximum of 45° and minimum of 10°) and in the sixth month it was 43° (with maximum of 60° and minimum of 20°). As for medial rotation in the first month, seven patients reached between the sacroiliac joint and L3 and two arrived at L3; in the sixth month one patient reached L4, two between L4 and L1 and five above T12. (Table 2)

Table 2 – Mean Value of the Arc of Movement Amplitude.

	Elevation	Lateral rotation
Group A - 1 month	95°	19°
Group B - 1 month	90°	27°
Group A - 6 month	140°	40°
Group B - 6 month	143°	43°

The differences were not significant in the first and sixth month for elevation (p = 0.44 and 0.93), for lateral rotation (p = 0.22 and 0.68) and for medial rotation (p= 0.19 and 0.40).

At six months, in Group A, four patients managed to actively raise their arms above 150°, three between 120° and 150°, and two below 120°. In Group B, four patients raised their arms above 150°, three others between 120° and 150° and the other two reached less than 120°. (Figure 5)

The radiographic evaluation of the immediate postoperative period showed that in Group A, three patients maintained a difference in the epiphyseal –diaphyseal angle between 0 and 10° in relation to the opposite side, four between 11 and 20° and two between 21 and 40°. In group B in seven the difference was between 0 and 10°, one between 11 and 20° and one between 21 and 40°. (Figure 6) The angles of reduction obtained when using the plates with locked screws were significantly closer to the normal anatomical parameters than those using the T plates (p = 0.02).
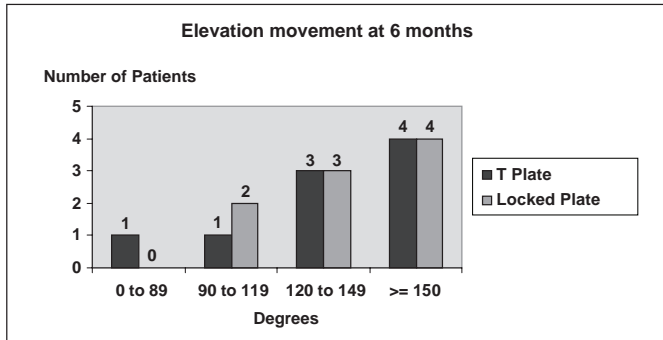
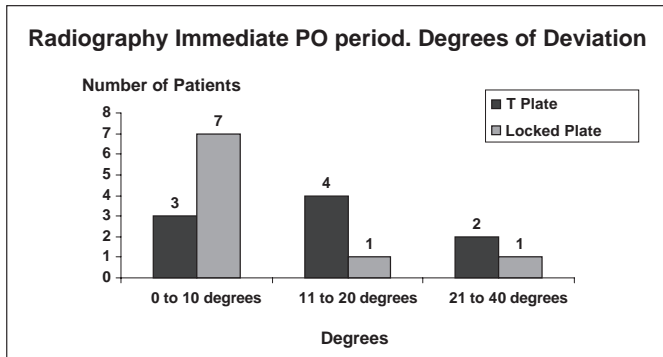**Figure 5** – *Amplitude of Elevation Movement at six months.*

Figure 6 – *Radiographies from the immediate PO period. Degrees of deviation.*

In the evaluation performed at six months, all the patients had their fractures consolidated and none of them exhibited defective consolidation of the greater tubercle. In group A five patients continued with the same reduction as in the immediate postoperative stage, in one there was increase of deviation between 1º and 5º, in one between 6º and 10º and in another two between 11º and 20º. In Group B, six patients did not have modification in the reduction angle, while in two there was increase of the deviation between 1º and 5º and in one between 11º and 20º. (Figure 7) The differences among the groups were not significant (p = 0.45).
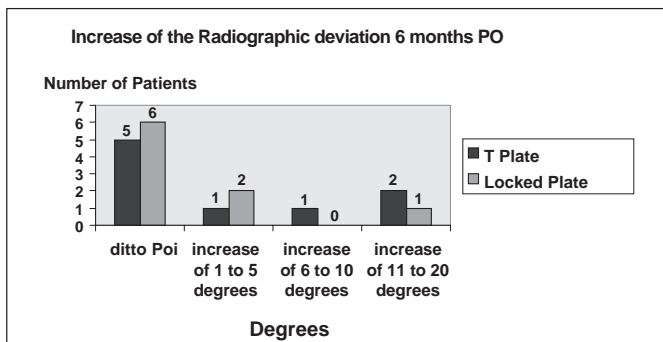

Figure 7 – *Increase of the radiographic deviation in relation to the immediate PO period.*

In the functional evaluation by the UCLA scale Group A had an average of 30 points (minimum of 21 and maximum of 35) and Group B, an average 31 points (minimum of 24 and maximum of 34), without significant difference (p = 0.85). In Group A there was

one patient with an excellent outcome, six good and two regular, in Group B one patient with an excellent result, six good and two regular. (Figure 8)
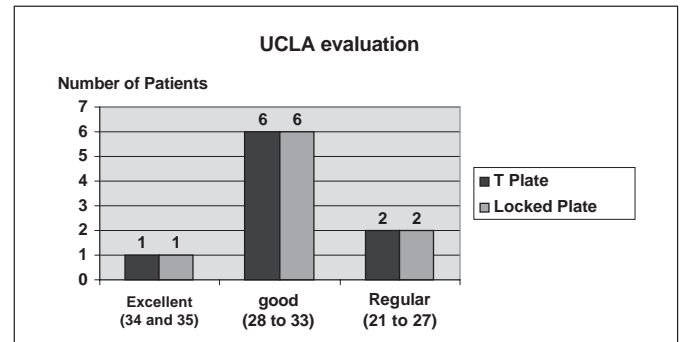

Figure 8 – *Functional evaluation UCLA scale.*

In neither of the groups were there complications such as: infections, delayed consolidation or, taking into account the short follow-up period, signs of avascular necrosis. In the fixations performed with the T plate (Group A) we observed on two opportunities a slight retreat of proximal screws (Figure 9) and in the locked plate group (Group B) in one case this plate was poorly positioned initially, at a distance and with two screws overreaching the epiphyseal joint surface. (Figure 10)

Figure 9 – *T plate backward travel of the plate and proximal screws.*

DISCUSSION

Proximal humerus fractures are mostly minimally deviated and stable, allowing conservative treatment.[6,12] However, between 15 and 20% of these fractures appear with significant deviations.[4] In unstable fractures, closed reduction methods, if not accompanied by fixation, are ineffective and have unsatisfactory functional results.[5,13] There is a prevalence of these fractures in female patients, particularly after menopause, where the reduction of bone mass is frequent.[14-16] The inclusion criteria of this study aimed to contemplate precisely this specific group of individuals, where the fixation

Figure 10 – *Locked plate, screws perforating the epiphysis.*

of the implant in the bone is often precarious, hindering the obtainment of adequate stability that guarantees the consolidation of the fragments in a good position, as a condition for the reestablishment of good function in the affected limb.

The decision for the best treatment method starts to become controversial as soon as these fractures are classified. The two classifications used the most often, those of Neer[8] and AO[17],have a low interobserver concordance[18] and do not highlight relevant aspects of these lesions, like the size of the posteromedial metaphyseal component united to the epiphysis, the integrity of the soft parts in the posteromedial region of the humerus neck and the bone quality. It is known that these factors influence the evolution and the stability of these fractures and should be attentively identified in decision making when choosing the best treatment method.[7]

Among the various osteosynthesis options we can cite tension bands,[19,20] percutaneous fixation,[21,22] bone suture,[23] in our milieu PFS80,[24] T plates,[25,26] intramedullary fixation,[27,28] fixation with fixed angle blade plate,[29] semitubular plate,[30] locked plate for proximal humerus[31,32] and other methods. This study compares two of these implants with different principles. The relative stability provided by the T plate with 3.5 mm screws in contrast to the neutralization of the deforming forces obtained by fixation with plate and locked screws. T plates with 4.5 mm screws were used a lot by the AO school in the treatment of these fractures.[25,33] But the results with this kind of implant have not always proved satisfactory, particularly in dealing with patients with osteoporosis.[26] There are few published mechanical assays that make a reference to their behavior. These implants are characterized by promoting a stiff assembly, which when used in dense bones allow considerable tolerance of initial deforming loads, yet do not maintain the same behavior as of when they are cyclically solicited.[34,35]

We emphasize, however, that the above mentioned T plate and the manner in which it is employed is very different from that used in this study. The plate thus described is that of large fragments, robust and thick, using 4.5 mm screws and acting with a neutralization plate. The one reported in this study, however, corresponds to the plate of small fragments, designed for the treatment of distal radius fractures. With its thin profile, it occupies a small area, does not

obliterate the subacromial space, is more elastic and for this reason adapts well to the anatomical and mechanical characteristics and to the most adequate principles for stabilization of a porotic bone.

The other implant of this study, the plate with locked screws, behaved adequately in biomechanical assays. In locking the screw on the plate and with these arranged in a divergent manner, one achieves a larger fixation area, which favors greater stability of the system, decreasing its chances of failure.[35-38] Although there are reports in clinical practice of some difficulties in its placement and complications,[39] good results were reported with its use.[31,40,41]

Uniform principles were followed in the treatment of the patients from both groups. In the surgical act there was the same concern with the preservation of the soft tissue envelope and the incentive for early rehabilitation dictated the same physiotherapy protocol. We sought to minimize any other technical difference that was not the implanted material. The reduction of the number of variables involved made a comparison of two different mechanical principles of fixation in these fractures possible under equal conditions.

The T plate with its thin profile and arrangement of the screws further from the focal point of the fracture allows a better distribution of the cyclic solicitations over all the components involved in the fracture stabilization, thus avoiding overload in a critical area, the screw interface in the mechanically insufficient bone.[7,34]

In turn, the plate with locked screws used in this study also merits special emphasis as it is a delicate material, not obstructing the subacromial space. The screws anchored on the actual plate permit a firm assembly, which neutralizes the forces that act on the focal point of the fracture, without depending on bone quality.[35-38]

Compared clinically, the two groups did not show any difference in the mean postoperative pain determined and in the parameters of amplitude of elevation and rotation movements, both in the evaluations performed 1 month and 6 months after surgery.

The fact that a significant number of patients in both groups achieve an arc of functional movement is related to some factors. One of the most important is the possibility of accomplishing and of maintaining the fracture reduction, reestablishing the anatomical parameters close to normal and thus the preservation of the biomechanical conditions of the joint. The slight aggression to the periarticular tissues and the thin profile of the implants facilitate the sliding of the plate in the subacromial space. And the degree of stability obtained, which allows early rehabilitation with exercises for gain of amplitude without the fear of losing the reduction.

Complications are relatively frequent in the treatment of these fractures, and include humeral head osteonecrosis,[5,19,21] with percentages reported from 0 to 45% of the cases. This outcome was not observed in any of the cases of this study. It should be considered, however, that the follow-up time is short, (it is not uncommon for epiphyseal necroses to manifest only a year after the trauma)[1] and that the fractures included in the study, type two and three of Neer, are less prone to this outcome. The avoidance of excessive dissection to obtain the reduction and the non-use of voluminous implants might also have contributed to the consolidation of all the fractures without vascular affliction.

The complication observed the most in this study was defective consolidation. It was more frequent in Group A, and its main determinant was an insufficient initial reduction. However in just two cases the deviation was greater than 20° (26° and 30°). We attributed these deviations to the concern of not using direct reductions or greater detachment of tissue to better expose the focal point of fracture. There

was preference for less aggression to the fracture environment to the detriment of a more exact reduction. In Group B it was less frequent, only exceeding 20º (24º) in one case. The previous obtainment of epiphyseal-diaphyseal angles close to normal is a technical prerequisite for the adequate application of the plate with locked screws.

There was also partial loss of the reduction initially obtained in the immediate postoperative stage, in four patients (increase of 6º, 10º 16º and 16º in relation to the initial reduction) in group A, in some cases accompanied by the backward travel of the plate and of the proximal screws. The lack of integrity of the medial cortical and the accommodation of the fixation system must have contributed to this. In Group B there were also minor losses of the reduction initially obtained, in three patients, but to a lesser degree (4º, 4º and 16º). In both groups, the correlation between flawed consolidation and worst functional results was not possible, which can be explained by the small magnitude of the deviations.

In group B, in one case the placement position of the plate was inadequate, located far from the bone and with screws perforating the epiphysis. In this case the functional result was not satisfactory, with UCLA at six months of 24.

Although it was not a prior analysis parameter, it was noticed that the technique for placement of the plate with locked screws calls for greater surgical detailing, which is a difficulty already described by other authors,[42] who reported 13.7% of complications due to faults in the adequate positioning of the implant.

CONCLUSION

The clinical and functional results, adopting as parameters: the analog scale of pain, the arc of movement and the UCLA scale were similar in the two groups studied.

The radiographic parameters showed that the relation between humeral epiphysis and diaphysis obtained with the plates and locked screws was closer to normal anatomical angles. With the T plates there was partial loss of the position achieved in the immediate postoperative period in some cases. However, the small magnitude of these deviations did not compromise the clinical and functional results.

The epidemiological characteristics, type of fracture, surgical and rehabilitation techniques were similar in these two groups. With the number of patients studied neither implant proved superior to the other.

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