



## Is Early Mobilization a Viable Option after Intramedullary Nailing of 4-Parts Proximal Humerus Fractures?

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Received: September 12, 2022

Published: November 07, 2022

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### Abstract

**Introduction:** After Centro medullary nailing (ECM) of 4-fragment (4P) cephalo-tuberositary fractures of the upper end of the humerus (ESH), the implementation of shoulder immobilization is usual, although no scientific justification does not support this attitude, nor the duration of immobilization.

The objective of this study was to assess the impact of immobilization time after ECM of ESH 4P fractures on clinical, radiological outcomes and complication rates. The hypothesis was that early mobilization would not be accompanied by a deterioration in results or an increase in the complication rate.

**Materials and Methods:** All patients operated on for a 4P fracture of ESH by ECM in our center between 2010 and 2018 were included retrospectively. 2 groups were formed according to the duration of post-operative immobilization of the shoulder: 0 to 2 weeks (group A) and 3 to 6 weeks (group B). All had a clinical examination (amplitudes and Constant score) and x-rays of the shoulder at least 24 months of hindsight. 58 patients of average age 66 years (39-98) were included, including 25 in group A and 33 in group B.

**Results:** The average decline was 38.5 (24-73) months. The active joint amplitudes at the last setback were: active anterior elevation 149° (80-180°) in group A versus 134 (60- 180°) in group B ( $p = 0.099$ ); active external rotation elbow to the body 45° (15-70°) in group A versus 42° (15-70°) in group B ( $p = 0.6$ ). The Absolute Mean Constant score was 78.29 for Group A (45-100) versus 68.59 points (45-96) for Group B ( $p = 0.0065$ ). Regarding complications, in group A, we found 2 retractile capsulitis, 2 pseudarthrosis and 2 osteonecrosis of the humeral head. In the group B, we found 5 retractile capsulitis, 1 infection of the surgical site, 3 osteonecrosis of the humeral head and 1 pseudarthrosis.

**Conclusions:** Early shoulder mobilization after ECM of ESH 4P fractures had no impact on clinical or radiological outcomes, complication or displacement rates secondary.

**Evidence Level:** IV, retrospective study.

**Keywords:** Humerus Fracture; Cephalo-Tuberositary; Centromedullary Nailing; Immobilization

### Introduction

Fractures of the upper end of the humerus (ESH) account for 5% of all fractures [1], with complex fractures (cephalotuberositarian fractures with 3 and 4 fragments) accounting for 15-20% of fractures of ESH [2]. Their management is orthopedic in the majority of cases [3]. Depending on different factors, the realization of osteosynthesis may be indicated. Different surgical options are available, including anterograde centromedullary nails (ECM) and

blocked screw plates that are the most common, with indications and similar clinical outcomes [4].

After ECM of ESH fractures, the placement of a shoulder immobilization splint is usual [5] in order to avoid a loss of reduction of the fracture and osteosynthesis, the time of bone consolidation, especially in the case of 4-part fractures (4P) that are by definition more unstable.

The duration and modalities of this immobilization are left to the discretion of the surgeon. But the extension in time of the immobilization exposes to a joint stiffening, with articular amplitudes sometimes difficult to recover and often at the cost of long months of rehabilitation, which goes against the current general attitude in orthopedics favoring a rapid joint mobilization and a limitation of minimum immobilization [6]. This problem concerns in the first-place elderly patients in order to avoid the occurrence of complications and a loss of autonomy [7] but also young patients in order to allow a faster professional and sporting return [8].

After ECM of ESH 4P fractures, few data are available on the value of post-operative immobilization, as well as the duration of immobilization.

The objective of this study was to assess the impact of immobilization time after ECM of ESH 4P fractures on clinical, radiological outcomes and complication rates. The hypothesis was that early mobilization would not be accompanied by a deterioration in results or an increase in the complication rate.

**Materials and Method**

**Study population and design**

This is a retrospective comparative study, monocentric (University Hospital of Strasbourg). Patients operated on for 4P fracture of ESH by ECM were included. The inclusion criteria were: (1) displaced 4P fracture of ESH confirmed by a preoperative CT scan; (2) recent non-pathological traumatic fracture (< 4 weeks); (3) antero-grade ECM; (4) clinical and radiological evaluation at a minimum of 24 months. Patients who did not meet all of these criteria were excluded.

Of the 66 patients operated on for a 4P fracture of ESH by ECM over the inclusion period, 8 (12%) were lost to follow-up or died. In the end, 58 patients (34 women and 24 men), with an average age of 66 years (39-98) at the time of surgery were included for statistical analysis. 2 groups were formed according to the duration of immobilization: group A (no immobilization or immobilization less than or equal to 2 weeks) including 25 patients and group B (immobilization of 3 to 6 weeks) including 33 patients.

Patient demographics were identified in the files (gender, age, medical-surgical history, dominant side, occupation).

The 2 groups were comparable for the different demographic characteristics studied, except for the age of the patients which was significantly higher in group B (Table 1).

	Groupe A	Groupe B	P-value of the difference
Sex ratio H/F	1,27	0,87	0,45
Age (year)	61,92 (39-88)	69,18 (46 -98)	0,004
Smoking (%)	32 (8)	27 (9)	0,69
Diabetes (%)	24 (6)	39 (13)	0,21
Forced labourers (%)	20 (5)	25 (8)	0,09
Dominant side reached (%)	44 (11)	43 (14)	0,35

**Table 1:** Demographic characteristics comparing early mobilization group (group A) VS late mobilization group (group B).

**Surgical intervention**

The surgery was performed under general anesthesia and interscalenic block. The patient was seated in a semi-seated position. The first pathway was a trans-deltoid superolateral pathway extending from the antero-lateral part of the acromion over 3 cm in distal, discizing the deltoid in the direction of muscle fibers. The gutter of the biceps was located in order to locate the tuberosities. A tenotomy of the long portion of the biceps was performed and a thread tenodesis with adjacent soft parts was performed at the end of the procedure. One wire had passed at the bone-tendon junction at the infraspinatus and another at the subscapular in order to mobilize the tuberosities. The cephalic cap was raised and reduced by passing through the fracture focus using a graft-chase or a rugine and temporarily fixed to the glene using one or 2 pins of arthrorise. The threads were tied together to reduce tuberosities. The supraepine tendon was open in the direction of the fibers for 1 centimeter. After trepanation of the humeral head at the square point at its apex and introduction of the bore guide, the nail inlet hole was widened using the dedicated wick and a short Aequalis nail (Tornier-Wright, Montbonnot-France) was set up. The distal lock was carried out in percutaneous using aiming guns, with 2 screws. Proximal locking was carried out using aiming guns with 4 screws (2 in the major tuber, 1 in the minor tuber and 1 in the calcar). The arthrorise pins were removed. The supraepine was closed, as was the deltoid and the various skin incisions. A classic elbow splint to the body with

a counter-scarf was put in place at the end of the intervention, in internal rotation. The decision to place a splint and the duration of immobilization were left to the discretion of the surgeon. Patients were asked to keep their splints at all times, except when grooming and dressing. Rehabilitation (active and passive) was started after the immobilization period.

**Clinical and radiographic evaluation at the last setback**

At the last setback, the patients all had a clinical examination (measurements of shoulder joint amplitudes and calculation of the Constant score [9] and x-rays of the shoulder according to a standardized protocol (face and axillary profile). Complications inherent in surgery and iterative procedures were identified in the files. The 2 groups were compared with regard to joint amplitudes, Constant score and the occurrence of complications such as capsulitis, avascular osteonecrosis and pseudarthrosis.

**Statistical analysis**

The descriptive study of the two groups was carried out with tests of independence by adjusting the influential variables: age and professional activities. The comparison of the results between the two groups was carried out using the calculation of the Student or Mann-Whitney Wilcoxon t-test. For the crossing between two qualitative variables, the test parametric chi2, as well as the exact Fisher test. A p-value < 0.05 was interpreted as statistically significant between variables. The statistical analysis was performed using R software version 3.1.

**Results**

Demographic data are provided in table 2.

The average decline was 38.5 months (24-73 months). There was no difference between the 2 groups regarding the average decline (41 vs. 36 months).

**Clinical outcomes**

Table 3 presents the clinical results, compared between the two groups. There was a trend towards a better Constant score in group A (p = 0.06), but there was no significant difference between the 2 groups in clinical outcomes at the last decline.

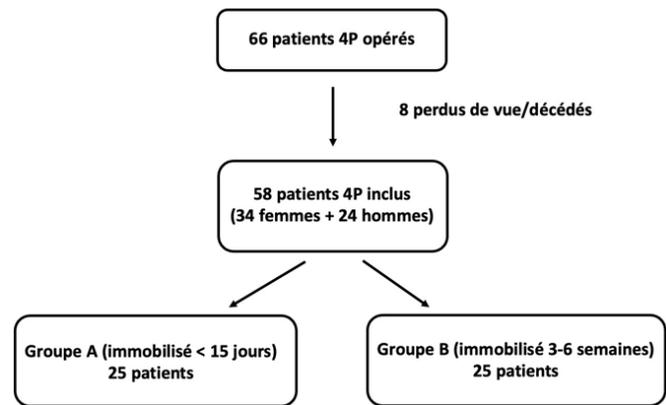


Table 2

	Groupe A	Groupe B	p
Average decline (months)	41 mois	36 mois	0,47
Active anterior elevation (°)	149° [80-180°]	134° [60-180°]	0,29
Active external rotation (°)	45° [15-70°]	42° [0-80°]	0,42
Active internal rotation (points)	5,8 [4-10]	4,9 [4-8]	0,19
Mean constant (/100)	78,29 [45-100]	68,59 [42-96]	0,06

Table 3: Clinical outcomes compared between the two groups.

**Complications**

Table 4 shows the different complications in the two groups. There were 6 complications in group A, compared to 10 in group B.

**Discussion**

Our working hypothesis was validated, there was no significant difference in the clinical outcomes and complication rate after ECM of ESH 4P fractures, only patients were immobilized or mobilized early. In particular, there was no secondary displacement of osteosynthesis.

In our cohort, there were 6 patients out of 58 patients whose age was over 75 years. Current data from the literature suggest in

	Groupe A	Groupe B
Complications	6 (24%)	10 (30%)
Disassembly	0	0
Infections	0	1 (3%)
Pseudarthrose	2 (8%)	1 (3%)
Osteonecrosis	2 (8%)	3 (9%)
Retractile capsulitis	2 (8%)	5 (15%)

**Table 4:** Postoperative complications in both groups.

these patients treatment with an inverted total shoulder prosthesis [10,11] will yield better results. We justify this choice of osteosynthesis because these patients were all operated between 2011 and 2013.

After fractures of the ESH, the risk of avascular osteonecrosis has been well studied by Hertel, *et al.* [12] who identified the risk factors associated with the characteristics of the fracture. The displacement of the latter and in particular the loss of the medial hinge at the level of the calcar increased the risk of osteonecrosis. After osteosynthesis of ESH fractures, the risk of secondary displacement is one of the main complications, occurring in about 10% of cases [13] and related to loss impaction of the spongy bone in the surgical cervix area. Since the forces on the proximal screws are high while the vis-os interface is fragile, secondary displacement is possible [14]. This complication is a possible risk factor for poor clinical outcomes and remains more common in elderly patients [15]. This suggests that osteopenia is a risk factor for vicious callus and poor outcomes after nail osteosynthesis.

The immobilization of the shoulder must therefore preserve the osteosynthesis by avoiding moving it and thus the fracture.

Conversely, the disadvantages of prolonged immobilization are widely published [16] in the shoulder as in other joints, including an increased risk of stiffness, contractures and muscle atrophy, leading to a more difficult or prolonged functional recovery. ESH fractures cause excess mortality in elderly patients [17], to a lesser extent but in the same way as fractures of the proximal femur. In younger and active patients, they lead to prolonged work stoppages, highlighting the interest of early mobilization in order to re-empower patients more quickly.

From an economic point of view, humerus fractures represent a significant cost to health systems, comparable to that of fractures of the pelvis or spine [18], these expenses increase with the loss of autonomy, in particular caused by the immobilization of the operated member.

No publication to our knowledge has evaluated the possibilities of early shoulder mobilization after ECM of ESH 4P fractures. In the case of more unstable fractures, caution is usually recommended post-operatively in order to avoid secondary displacement whether in elderly osteoporotic patients or young patients for whom the functional consequences of a displacement of the fracture can be significant.

The duration of immobilization has been studied for non-surgical treatments of proximal humerus fractures [19], in the direction of mobilization before the fourth week.

The recommendations are usually to immobilize the shoulder by a splint, for a period of 3 to 6 weeks depending on the team. But there are no published recommendations or studies investigating this aspect of management.

The current trend is to move towards a reduction in the duration of immobilization to the strict minimum, or even to eliminate it altogether by allowing at least one immediate passive mobilization. Thus, Laedermann, *et al.* [20] showed that immediate mobilization was possible after osteosynthesis of collarbone fractures, with similar results, without increasing the rate of Complications. Similarly, after repair of the rotator cuff, the placement of a splint post-operatively can be limited or even eliminated, under certain precautions [21]. After fractures of the proximal humerus treated non-surgically, Koval, *et al.* [22] found significantly improved functional outcomes in patients immobilized for less than 2 weeks, compared to those immobilized for more than 2 weeks. A mobilization of the shoulder early, as early as the second week after the fracture also improved short-term pain. The authors recommended starting rehabilitation within the first 2 weeks after the fracture. Maniscalco, *et al.* [23], in a prospective randomised study comparing no immobilization (with immediate mobilization) and immobilization for 3 weeks after nailing 3P fractures, found a mean Constant score significantly higher in the group without immobilization, without increase in the complication rate.

Regarding the complication rate: we observed 24% of complications in group A, and 30% in group B, consistent with the results of the literature [13,24]. Only the rate of retractile capsulitis appeared to be higher in group B, but given the limited size of the cohort, this difference was difficult to analyze.

### Bounds

However, these results should be interpreted cautiously, in light of the limitations of our study. First, there was no randomization, which limits the strength of our findings due to biases associated with retrospective design. Regarding the decision to immobilize the patient's shoulder, it was taken by the surgeon based on subjective decision-making criteria such as the stability of osteosynthesis at the end of the intervention, surgical habits or probably also the age of the patient. It is therefore not possible to generalize our conclusions to the entire population by affirming that early mobilization is possible for all. Finally, it was not possible to assess the influence of risk factors for osteosynthesis displacement due to the limited numbers in our series.

### Conclusion

Early mobilization after ECM of ESH 4P fractures was not accompanied by an increase in the rate of complications and in particular secondary displacements or osteonecrosis. There was a trend towards improved clinical outcomes with early mobilization, although this trend was not statistically significant. The lack of randomisation and the limitations of the studies require us to be cautious in interpreting these results. It can nevertheless be concluded that early mobilization is a justified option after ECM of 4P fractures of ESH, provided that osteosynthesis is stable intraoperatively, in elderly people at risk of loss of autonomy as well as in young patients wishing to resume their activities more quickly.

### Conflict of Interest

Source of funding and contribution of authors.

### COI

Maxime ANTONI: Consultant fees from FX Solutions  
Philippe CLAVERT: Consultant fees + Royalties from Tornier Stryker, Deputy Editor-in-Chief - Orthopaedics and Traumatology: Surgery and Research, Associate Editor - Surgical and Radiologic Anatomy

### Funding

None.

### Authors' Contribution

Florent BALDAIRON, Maxime ANTONI, Vinh LE THAI: development of the study protocol, analysis of the files, patient review and writing of the manuscript.

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