

# Aseptic Pseudoarthrosis of the Humeral Diaphysis. Epidemiological Features—Therapeutic Assessment

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## Abstract

**Objective:** The aim of this work was to assess the epidemiological factors of the pseudoarthroses of diaphyseal humeral fractures in order to prevent them and also to assess the results of their treatment by screwed plate associated with an auto-graft. **Material and method:** This was a retrospective series of 36 aseptic pseudoarthroses of the humeral diaphysis treated by screwed plate, associated or not with a bone autograft between January 1997 and December 2016 at the Treichville University Hospital. The criteria of inclusion refer to the existence of an aseptic pseudoarthrosis of the humeral diaphysis treated by screwed plate. The approach was antero-external. Two thirds of pseudoarthroses were between the middle 1/3. 23 atrophic pseudoarthroses (65%) and 13 hypertrophic pseudoarthroses. Functional results were assessed using the Steward and Hundley criteria. **Results:** Mortality was zero, and postoperative complications were dominated by 4 hematomas and 2 transient iatrogenic paresthesias of the radial nerve. The sequelae were minor and the consolidation was acquired in 97.25% of patients. **Conclusion:** The treatment of aseptic pseudoarthroses of the humerus by screwed plate associated with an auto-graft is a reliable technique, inexpensive with a satisfactory functional outcome.

## Keywords

Arms, Fracture, Humerus, Pseudoarthrosis, Screwed Plate, Bone Graft

## 1. Introduction

Pseudoarthrosis is a dreadful complication of diaphyseal fractures of the humerus. The methods of treatment are numerous [1] [2] [3] [4] but the most usual are inspired by the techniques of surgical stabilization of the recent diaphyseal

fractures of the humerus [1] [3]. This surgical stabilization requires compression of the focus as proposed by Rosen [5] and/or stimulation of osteogenesis by de-cortication or a graft according to Judet [6]. This treatment usually requires 3 methods: the screwed plate, the locked centro medullary nailing and the method of external fixation. The locked centro medullary nailing and external fixation have advantage to non open the lesion. So the risk of infection is reduced. But these techniques are problematic when an autograft is to be performed; Moreover with the external fixator, there is a risk of damaging the radial nerve [7] [8] [9]. In screw-plate osteosynthesis, the risk of devascularization is high, as is the risk of infection. This technique allows to monitor the radial nerve and to apply a bone graft if necessary [1] [4]. Each method has then its advantages and disadvantages. In the treatment of these pseudarthroses, our choices have always been towards the technique of screwed plates. These plates among other advantages require an inexpensive technical platform.

In this study of a relatively large series, we assess the results of this method and then compare its results with those of the other methods through a review of the literature.

## 2. Material and Method

This was a retrospective study that collected all patients received and treated with aseptic pseudoarthrosis of the humeral diaphysis between January 1997 and December 2016 at the Department of Orthopedics and Traumatology at the Treichville University Hospital. The criterion of inclusion refers to the existence of an aseptic pseudoarthrosis of the humeral diaphysis treated by screwed plate associated or not with a bone graft. Aseptic pseudoarthroses treated by another technique, septic pseudoarthroses and pseudoarthrosis due to a significant loss of bone matter from other surgical techniques were excluded. Our operating procedure did not change over time. This treatment consisted of an external approach to the focus, resection of the fibrosis of the focus of pseudoarthrosis, an assessment of the degree of osteoporosis, articular mobilization of the elbow, then permeabilization of the medullary canal and avulsion of the bone ends. A cortico cancellous graft was systematically performed in all patients. The restraints were ensured by a synthetic material. An immobilization by Brachio antebrachial plaster was performed in all patients for 8 weeks followed by a plastered armband of Sarmiento for 4 to 6 weeks. This release of the elbow allowed its functional rehabilitation.

The epidemiological analysis of our results focused on the type of fracture according to the seat and the type of fracture, the existence of associated lesions, the type of treatment of the recent fracture and its postoperative follow-up.

The analysis of the treatment of pseudoarthrosis concerned the nature of the osteosynthesis, the different operative times and the technique of placing the cortico cancellous graft and the postoperative outcome.

Our healing criteria were the absence of pain when using the arm, radiological consolidation of the pseudoarthrosis focus.

The functional results were assessed according to the criteria of Steward and Hundley quoted by Martinez [7] and which take into account the existence of pain, the degree of mobility of the elbow and bone consolidation (Table 1).

### 3. Result

#### 3.1. Epidemiological Data

- Patients: there were 27 men and 9 women with an average age of 43 years with extremes of 18 years and 75 years. The dominant limb was concerned in 21 cases; it was the right limb. Road accidents were responsible in 30 (85%) cases followed by field accidents in 2 patients, domestic accidents in 2 patients and 2 cases of assault with a firearm and a weapon with ablade.
- Types of lesions: the fractures were in 25 cases in the middle 1/3, in 7 cases in the upper 1/3 and in 4 cases in the lower 1/3. These fractures were initially complicated by 4 skin openings and 3 radial paralyses (1 blunt section and 2 bruises), the nerve section was sutured and evolved towards a limitation of incomplete extension. Nervous contusions had evolved without sequelae.
- Associated lesions: there were 3 cases of homolateral fracture of the forearm, 2 cases of fracture of the leg, 1 case of fracture of the contralateral femur.
- The initial treatment of these fractures was orthopedic in 15 patients, surgical in 7 patients and in 14 patients a “traditional” treatment had been carried out. This is a local technique with bamboo stalks that does not comply with any orthopedic immobilization rule. This method was often used among the last patients in our series.

#### 3.2. Clinical Data

Pseudoarthrosis dated from a minimum of 6 months and a maximum of 15 months with an average of 7 months. Our patients consulted for elbow pain (40%), relative functional impairment or abnormal mobility (35%) and for aesthetic reasons (25%). The elbow was limited in all cases; there was no case of ankylosis of the elbow. The passive and active mobility was on average 0/10/110°. Radiographic assessment showed 23 atrophic pseudoarthroses (65%) and 13 hypertrophic pseudoarthroses (Figure 1).

#### 3.3. Therapeutic Data

A tourniquet had been placed at the root of the arm in 7 corpulent patients with

**Table 1.** Our functional results according modified Stewart and Hundley Criteria.

Scores	Criteria	Number
<b>Good</b>	No pain, limitation of adjacent joint mobility < 20° and angulation < 10°.	34
<b>Fair</b>	Pain after efforts of fatigue, limitation of mobility ranging between 20° and 40° and angulation > 10°.	1
<b>Poor</b>	Permanent pain, limitation of mobility > 40° and nonunion.	1



**Figure 1.** Radiography of an atrophic pseudoarthrosis of the humeral diaphysis following imperfect osteosynthesis: poor compression, insufficient number of screws, dismantling of equipment.

a fracture of the lower 1/3 of the humerus. This tourniquet was removed on approaching the entrance of the pseudoarthrosis focus. In 2 cases of atrophic pseudoarthrosis, the avulsion of the bone ends resulted in a shortening of 1 cm and 1.5 cm necessary to face the bone surfaces; this shortening had no functional or aesthetic consequences. The cortico cancellousbone graft was removed at the anterior iliac crest in 35 patients and at the posterior iliac crest in one patient. The screwed plate was installed taking into account the principles of AO of osteosynthesis [10]. Before fixing or affixing the graft, we often punctured it with 4 to 5 holes to facilitate its rehabilitation. 30 plates of Müller and 6 narrow plates of Shermann were used. The cortico-cancellousgraft was screwed in 31 patients and affixed in 5 cases of hypertrophic pseudoarthrosis. An immobilization by brachio antebrachial plaster was performed in all patients for 8 weeks followed by a plastered armband of Sarmiento for 4 to 6 weeks. This release of the elbow allowed its functional rehabilitation.

### 3.4. Postoperative Evolution

The surgical follow-up was marked by:

- 4 hematomas due to inadequate drainage; Local care has allowed them to dry up.
- 2 iatrogenic paresthesias of the radial nerve regressed completely in the 3<sup>rd</sup> month.
- The 2 radial involvements due to neurometosis also regressed; On the other hand, that linked to the section left after-stitch sequelae.
- A disassembly of osteosynthesis occurred in a 75-year-old woman. This patient had an important decalcification. The immobilization was reinforced by a thoracobrachial plaster. Consolidation was obtained at the price of a vicious callous in varus of 15°. This callus was functionally suitable.
- Another vicious callus was observed with a varus of 8°. It was also functionally acceptable.
- 5 patients had limitation of elbow mobility but no major repercussions on flexion-extension movements.
- Four patients presented atrophy of the arm and deltoid without functional impairment

At the level of donor site of the bone graft, we noted that 4 patients had minimal intermittent pain that declined by the end of the first year of operation.

Consolidation was right away acquired in 45 patients in an average time of 4 months with extremes of 3 months and 5 months (**Figure 2**). 1 patient has not consolidated and is currently awaiting resumption of treatment.

### 3.5. Functional Results

The mean follow-up was 24 months with extremes of 7 months and 8 years.

The functional results according to the score of Steward and Hundley were: 23 (65%) excellent results, 9 (25%) good results, and 4 (10%) mean results (**Table 1**).

## 4. Comment

Pseudoarthroses are serious complications of diaphyseal fractures of the humerus. This lesion has been the subject of numerous studies [1] [2] [3]. Our study allows to assess a certain number of aspects of this lesion. The series are generally limited, and rarely exceed 40 patients (**Table 2**). Epidemiologically, they occur at any age. From the etiological point of view, the various series of the literature place their rate between 1% and 10% according to the methods of treatment of fractures [7] [8]. In our series, this complication has been found in all treatment methods. Initial fracture treatment was orthopedic in 15 patients, surgical in 7 patients and “traditional” in 14 patients. The so-called traditional methods were non-negligible and related to cultural and socio-economic factors. For Babin [11], this rate is 5% for orthopedic treatment and it is between 0% and 0.9% after nailing for Kempf [12]. The therapeutic choice of the fracture is therefore an



**Figure 2.** Radiography of a plate osteosynthesis with bone graft screwed- good consolidation.

**Table 2.** Comparative post operative results with screw plate in literature.

	Cases	Rate consolidation	Consolidation deadline	Sepsis	Paralysis
Rosen (1990)	32	97%	6 months	0	0
Osman (1998)	15	100%	4, 2 months	0	0
Segonds (2000)	30	100%	4 months	1	2 résolutes
Kumar(2002)	40	91%	4, 5 months	1	2 résolutes

important factor in the etiologies of pseudoarthrosis. Inadequate stabilization is the predominant etiological factor. Pathologically, atrophic pseudoarthrosis was more common than hypertrophic pseudoarthrosis; it accounted for 65% of lesions in our study. This predominance was also found in most authors: [1] [2] [5].

## Therapeutically

Bone consolidation was right away obtained in 35 patients (97.23%). One patient has not consolidated and is waiting to have his treatment resumed. Infection was not observed and the involvement of the radial nerve, of iatrogenic origin was transient in both patients. In addition, our functional results were satisfactory in 90% of the patients (**Table 1**). The 2 (5.5%) mean results occurred in patients with disassembly of synthetic material and nerve damage. Segonds [9], in a study involving 30 pseudoarthroses treated by the same method observed 1 resumption of treatment after absence of consolidation. The average consolidation time in his series was 4 months. He recorded 1 infection and 2 regressive postoperative paresis after 6 weeks. **Table 2** confirms the rarity of infection in this technique. Radial nerve involvement was transient in all series and the rate of consolidation was between 90% and 100% [1] [3] [9]. Our results are thus superimposable to those of these different authors: a minimal septic risk, no death, a satisfactory consolidation rate.

Some authors have been tempted by locked centromedullary nailing in the treatment of diaphyseal pseudoarthroses of the humerus [2] [12] [13] [14]. This technique allows a closed-focus synthesis, which has the advantage to avoid devascularization, periosteum detachment. It has also the advantage to reduce the risk of infection. In this technique, the rate of consolidation varied between 53% and 100% according to most authors [12] [13] [14]. Infection was not exceptional because out of 27 pseudoarthroses, Kesemenli [2] has observed 3 infections. But a certain number of reproaches are made to the centromedullary nailing: the obligation to open the focus if one wants to introduce a bone graft; locking can be laborious in case of large bone demineralization; the risk of injuring the rotators in antegrade nailings. Dujardin [15] and Svend-Hansen [16] who were fervent advocates of this method at first, have abandoned it. As for the external fixation method which most often uses the Ilizarov external fixator, its promoters think contain the septic risks, the periosteal devitalization of the screwed plates, and the difficulties of blocking the rotation of the intramedullary nailings. The external fixator also allows a gradual reduction of the focus. But the rate of consolidation seems to be identical with that of the other methods and the radial nerve is not controllable. This method is not suitable to the patient [8] [16] [17] [18]. Thus the screwed plate with bone graft retains its importance in the treatment of aseptic pseudoarthroses of the humerus because the different complications of the screwed plates are also found in the other methods. In addition, the screwed plate has the advantage of visualizing the radial nerve and better explore it in case of involvement, and of always bringing a graft. This method remains therefore from our point of view an excellent technique of treatment of pseudoarthroses of the humerus. To these advantages we must add the flexibility of the technical platform, the absence of exposure to X-rays. To obtain this good result, Osman [1] emphasizes the need for bone contact in healthy areas and bone stabilization with a minimum of 8 screws including 4 on each side of the focus.

## 5. Conclusion

Pseudoarthrosis of the humerus is a dreadful complication mainly related to inadequate stabilization of fractures. The method of its treatment that we used is that of the screwed plate associated with a cortico cancellous graft. This method gives excellent results on bone consolidation. The involvement of the radial nerve, and the main iatrogenic complication feared in this technique are most often related to its hypersensitivity and are usually transient. Among the various therapeutic methods, the screw plate associated with an autograft remains a reliable and safe technique in the treatment of aseptic pseudoarthroses of the humeral diaphysis.

## Conflict

This work has no conflict of interest either with anyone or with any structure.

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