

ORIGINAL PAPERS

Scaphoid fractures treated by means of volar percutaneous fixation

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KEYWORDS

Scaphoid fracture;
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Abstract

Purpose: To analyze the functional and radiological results as well as the complications of carpal scaphoid fractures treated by means of volar percutaneous fixation.

Materials and Methods: A retrospective study was carried out of 41 patients with a mean follow-up of 15 months (range: 12-54). Fractures included in the study correspond to those classified as types B1 and B2 on Herbert's scale further to a detailed radiographic study for the carpal scaphoid. Fractures of the tubercle and the proximal pole were excluded from the study. Demographic data were collected on the mechanism of injury, postoperative complications and any associated lesions. Clinical and radiological evaluations were performed. The adapted DASH questionnaire was used for the functional assessment.

Results: Fracture healing occurred at 7-and-a-half weeks. All patients started using their hand in the first 2 weeks. Mean wrist range of motion one year into follow-up was 70° of extension and 65° of flexion. The final score on the adapted DASH scale was 44 points when there were no associated lesions and 80 when the fracture was associated with other injuries. The complications rate was 5.8% intraoperatively (2 instances of guide wire breakage) and 5.8% during follow-up. All cases went on to heal, except for one which developed pseudoarthrosis. OR time was of 20 min on average.

Conclusions: Volar percutaneous fixation is a simple, rapid technique characterized by low morbidity rates and scarce significant complications, which accelerates the patients' functional recovery.

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PALABRAS CLAVE

Fractura escafoides;
Osteosíntesis
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Cirugía

Fracturas del escafoides tratadas mediante osteosíntesis percutánea volar**Resumen**

Objetivo: Analizar los resultados funcionales y radiológicos, así como las complicaciones de las fracturas del escafoides carpiano tratadas mediante la técnica de osteosíntesis percutánea volar.

Material y métodos: Se realizó un estudio retrospectivo de 41 pacientes con un seguimiento medio de 15 meses (12 a 54). Las fracturas incluidas correspondían a los tipos B1 y B2 de la clasificación de Herbert, tras el estudio radiográfico específico para el escafoides carpiano. Se excluyeron del estudio las fracturas del tubérculo y del polo proximal. Se recogieron datos demográficos y sobre el mecanismo causal, complicaciones postoperatorias y lesiones asociadas. Se realizaron evaluaciones clínicas y radiográficas. En la evaluación funcional se utilizó el DASH adaptado.

Resultados: La consolidación de la fractura se evidenció en una media de 7 semanas. Todos los pacientes comenzaron a utilizar la mano en las 2 primeras semanas. La movilidad media de la muñeca al año de seguimiento fue de 70° de extensión y de 65° de flexión. La puntuación final según la escala DASH adaptada fue de 44 puntos cuando no hubo lesiones asociadas y de 80 cuando la fractura se asociaba a otras lesiones. Hubo un 5,8% de complicaciones intraoperatorias (2 casos de rotura de aguja guía) y un 5,8% durante el seguimiento. Todos los casos consolidaron, salvo uno que evolucionó a pseudoartrosis. La media del tiempo quirúrgico empleado fue de 20 min.

Conclusiones: La osteosíntesis percutánea por vía volar es una técnica sencilla, rápida, con mínima morbilidad, escasas complicaciones importantes y que acelera la recuperación funcional del paciente.

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Introduction

Treatment of undisplaced or minimally displaced fractures of the carpal scaphoid is a controversial issue. Treatment by means of cast immobilization is long and involves considerable discomfort associated to the plaster cast, whereas surgical treatment requires an acceptance of the risks inherent in any kind of surgical and anesthetic intervention¹⁻⁵.

In the last few years, the development of osteosynthesis methods and of reliable surgical techniques has made it possible for many of these fractures, which were traditionally treated conservatively, to be addressed surgically in a standardized way with good results²⁻⁸.

Percutaneous osteosynthesis is a minimally invasive technique that affords a more rigid kind of internal fixation than that afforded by cast immobilization; it also considerably decreases the levels of morbidity characteristic of open reduction and consistently offers good results with faster recovery periods, to the extent that most patients can go back to their previous activity levels²⁻¹³.

The purpose of this study is to assess the functional and radiologic results, as well as the complications, of fractures of the carpal scaphoid treated through a volar approach by means of percutaneous osteosynthesis.

Materials and Methods

A retrospective study was carried out of 48 cases. Fractures were classified following Herbert's Trading system¹⁴, all of them being within subgroups B1 and B2, i.e. they were all

either undisplaced or minimally displaced transverse or oblique fractures of the middle third of the scaphoid. If a fracture presented with gross displacement it was immediately excluded since such cases required open reduction. Fractures of the proximal pole were excluded from the study since they were considered amenable to fixation through a dorsal approach; multiple-trauma patients with a scaphoid fracture were also excluded. Patients with associated injuries were only included in the study if the injuries were present in the same limb. There were 4 patients with associated fractures that required surgery; 2 of them with a fractured metacarpal on the same hand and another with a proximal humeral fracture. There was another patient that sustained an elbow dislocation, which was treated conservatively. Exclusions comprised 8 patients with multiple trauma, 4 cases that were lost to follow-up and 2 patients who experienced a surgical delay of over 10 days. Therefore, the total number of patients reviewed in the present study was 34. Additional exclusions included patients with concomitant fractures of the distal radius since radius and scaphoid surgeries were both performed as open procedures; patients with follow-ups under one year were also excluded.

Mean follow-up was 15 months (range: 12-54). Mean age was 28 years (range: 16-54). There were 30 males and 4 females. As regards laterality, the right hand predominated in 17 cases (it was dominant in 15). Wrist joint motion was assessed with a conventional goniometer and the final outcome by means of the adapted DASH questionnaire¹⁵. This is a standardized measure that captures the patients' own perspective of their upper extremity status; it contains

30 questions that are scored from 1 (no difficulty) to 5 (unable to perform the activity). The mechanism of injury was a fortuitous fall in 15 cases, a sports accident in 7, a road accident in 9 and a fall in 3. Diagnosis of the fracture was made within the first 48 h. In 4 cases diagnosis was made between 2 and 6 weeks later because of an erroneous initial diagnosis (wrist contusion or sprain) or because the patient took that long to seek consultation; these cases were not included in the study.

All patients were studied radiographically by means of anteroposterior and lateral wrist views; in cases where these views were not conclusive specific scaphoid views were used. Surgery was performed at 3 days on average.

The osteosynthesis system used was a cannulated compression screw. Devices from different manufacturers

were used depending on surgeon preference but these variations were not part of the study.

Surgical technique

Patients were placed in the supine position with upper limb ischemia on a radiolucent hand table with the arm in abduction. Anesthesia was regional in all cases. Surgery was performed through a palmar approach (fig. 1). The wrist was placed in extension and supination and moved to ulnar deviation on the free edge of the table. This maneuver assists in decreasing fragment displacement, making the trapezium move dorsally thus facilitating guide wire insertion. In all cases, cannulated screws were used that

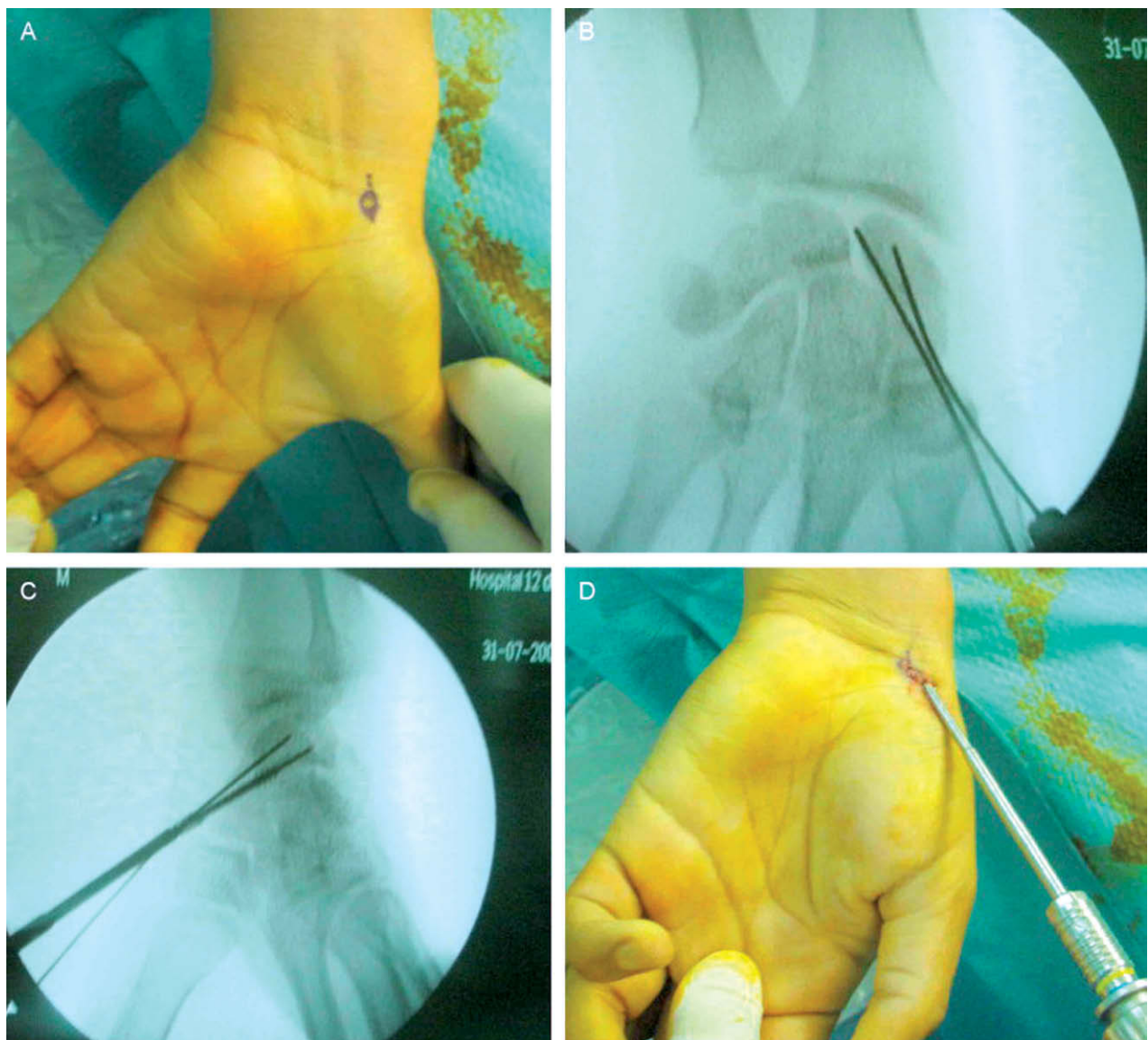


Figure 1 A) Placement of the wrist and point of entry. B) Placement of the 2 wires prior to drilling. One of the wires prevents fragment rotation during drilling. Radioscopic control. C) Screw insertion. Radioscopic control. D) Screw introduction. It is important to «feel» that there is good interfragmentary compression.

had been designed for scaphoid osteosynthesis. Under radiographic control, a needle was placed on the skin to mark the direction of the scaphoid on the anteroposterior view as well as the entry point. Insertion was carried out through an incision of less than 5 mm. It is advisable to use a guide wire or, alternatively, the metal portion of a venipuncture cannula to ease the tension exerted on the guidewire and protect the soft tissues. An important technical requirement is to avoid an excessively palmar introduction of the screw since the drill may injure the distal fragment of the scaphoid and prevent a stable fixation. It is advisable to use a second wire that may prevent fragment rotation during reaming. This stabilizing wire is often the first of 2 wires that must be introduced if it is impossible to gain an optimal position for inserting the screw; it also serves as a reference to place the second wire in the right position. After the position of the wires has been verified radiographically, low speed burring is performed avoiding a possible conflict between the drill bit and the other wire, whereby the wire may break and an

open approach be needed to remove the broken wire fragment. After the right length has been measured, the screw is driven into place with the screwdriver. The screw should be about 4 mm shorter than the measured length to prevent it from protruding. Furthermore, it should be ascertained that the distal threads of the screw cross the fracture site completely to achieve good interfragmentary compression. In this series, the length of the screws ranged from 18 to 26 mm. The skin does not normally require a suture but a single stitch may, on occasion, be useful. The patient was mobilized with a splint for one week, not because the osteosynthesis required it as the osteosynthesis must be stable in itself, but because in order to provoke an antialgic effect and to enhance the patients' comfort; this one-week delay does not interfere with adequate rehabilitation. When the splint is removed, patients are advised to restrict their physical activities and contact sports for 4-6 weeks, although they are allowed to perform all kinds of everyday activities that do not require the use of force.

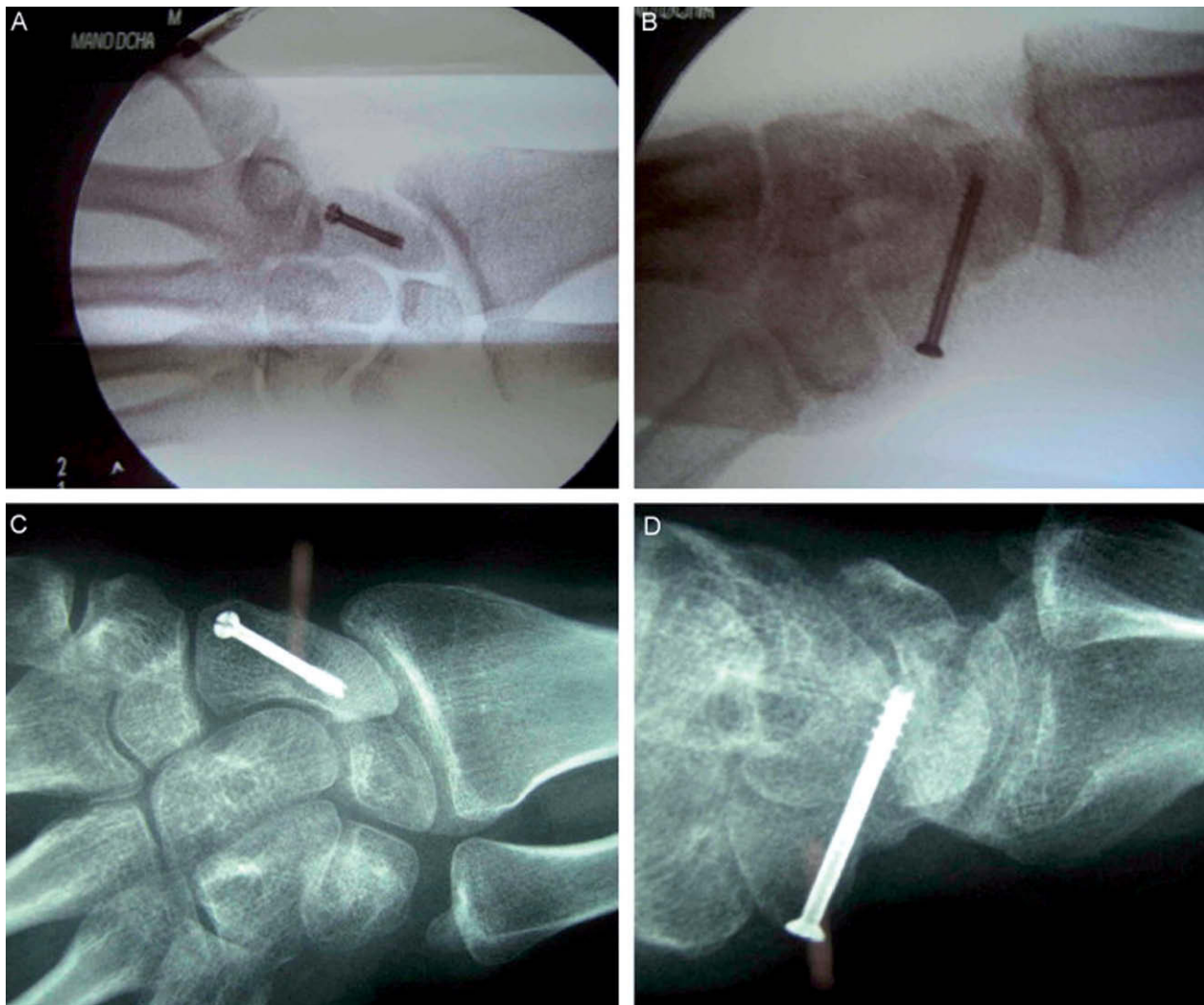


Figure 2 Fracture healing. Standard case. A) Intraoperative control. B) Intraoperative control. C) X-ray view at one year showing healing of the fracture. D) X-ray view at one year showing healing of the fracture.

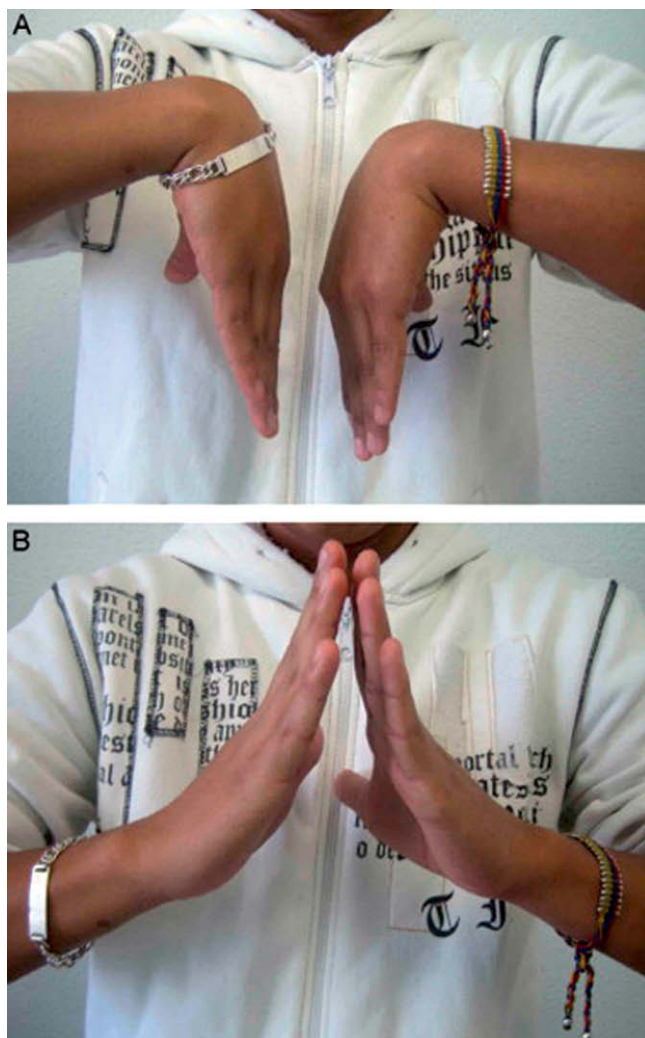


Figure 3 Final range of motion. A) Flexion. B) Extension.

Results

Fracture healing was assessed from the passage of bone trabeculae through the fracture site as seen in the patients' follow-up x-rays (fig. 2). The fracture healed in all cases after a mean follow-up of 7 weeks (range: 5-9), except for the case that progressed to pseudoarthrosis. In this case, erroneous initial screw placement was a determining factor. All patients started performing their activities of daily living during the first 2 weeks and avoided forceful activities and unlimited hand use until the fifth week.

Mean final range of motion was 70° extension and 65° flexion as measured with a goniometer (fig. 3). Patients were not referred to rehabilitation following any specific protocol. Standard practice was to begin active non-weightbearing motion at the second week.

Complications were divided into intraoperative and postoperative. As regards the former, there were 2 instances (5.8%) of guidewire breakage. In one of these cases, the wire was removed without difficulty, with a tiny fragment remaining in the soft tissues; in the second the broken wire

fragment was left inside the scaphoid. In both cases the fracture healed uneventfully. In the course of the follow-up there were 2 complications (5.8%), one instance of transient dysesthesia at the screw insertion site that resolved spontaneously at 6 months and one case that went on to develop pseudoarthrosis, which required surgery with grafting and a new osteosynthesis. The pseudoarthrosis was due to suboptimal placement of the screw in the index surgery.

Discussion

The main complication of scaphoid fractures is their evolution to pseudoarthrosis. This complication is caused, above all, by fragment displacement; this occurrence is more common when the fracture line is located in the proximal half of the scaphoid bone since the radio-scapho-capitate and radio-scapho-lunate ligaments exert conflicting actions from the biomechanical point of view^{11,16,17}. The said displacement is a risk factor for pseudoarthrosis, which means that assessing its magnitude or the extent of fracture healing with conventional radiographs can be challenging. Some authors suggest performing a computerized tomography to determine the magnitude of the displacement and the degree of fracture healing, especially when conservative treatment is envisaged¹⁸. This study only considers conventional radiographs, which could constitute one of its shortcomings.

Undisplaced B1 and B2 fractures on Herbert's classification (oblique and complete transverse fractures) healed with conservative treatment at 8-12 weeks in 95% of cases^{2-4,11,19}, but functional recovery is achieved sooner with surgical treatment^{3,11,20}. In an attempt to shorten recovery time, these fractures started being treated with open reduction and osteosynthesis, but open reduction is not exempt from



Figure 4 Final appearance of the volar aspect of the wrist at the screw insertion site.

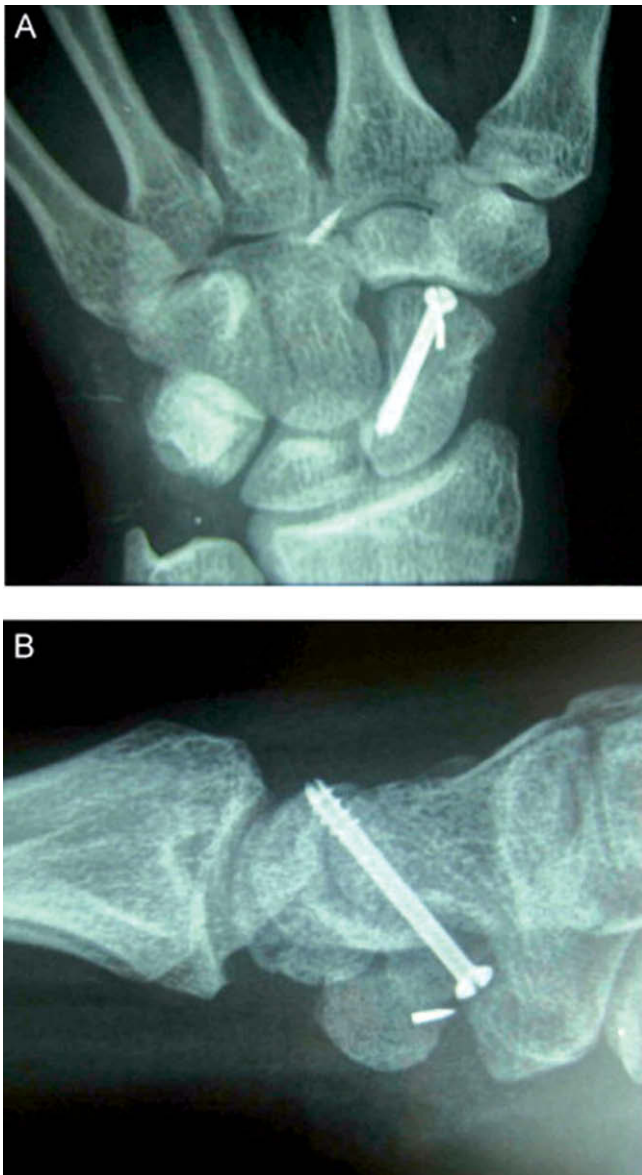


Figure 5 Breakage of the guidewire.

associated morbidity since the surgeon could create a iatrogenic carpal instability, secondary to the existing injury to the volar radiocarpal ligaments, notably the radio-scapho-capitate and the radio-scapho-lunate ligaments

The aim of percutaneous osteosynthesis is to achieve fracture healing in less time than conservative treatment and avoid the potential mortality risk inherent in open reduction as it causes a minute wound at the screw insertion site (fig. 4). Osteosynthesis must be compressive to prevent such complications as delayed healing and pseudoarthrosis. More important that the type of screw employed is its correct placement at the central axis of the scaphoid^{11,21}, which can be achieved by using cannulated screws.

The main indication of percutaneous osteosynthesis is undisplaced or minimally displaced fractures. In cases with displacement the technique can be employed in conjunction with arthroscopy to achieve accurate fragment reduction,

although some surgeons use arthroscopy systematically in scaphoid fractures. One of the advantages of this technique is that it is possible to make sure that the fracture has been properly reduced, contributing to diagnosing other ligament lesions including those in the triangular fibrocartilage complex^{19,22-26}.

The healing rate of scaphoid fractures obtained with this technique is high: some studies report rates of nearly 100%^{3,9,11,19,22} (fig. 5). The type of screw used is not a fundamental aspect of this technique. What is important is that it should be cannulated, that it should provide interfragmentary compression and that it is correctly placed^{11,12}.

From the point of view of evidence-based medicine, surgical treatment has not been shown to be more effective than standard conservative treatment as regards healing time and complications. Studies carried out in the last few years indicate that surgical treatment does have its benefits since it shortens healing time. As regards complications, even if their number is higher with surgical treatment, they are less serious and tend to decrease as the surgeon advances through his learning curve¹⁻⁶. At any rate, new studies are needed to delve more deeply into these issues.

Indication of this technique in subacute or late diagnosed fractures has been rather controversial, but the technique is nowadays recommended even for fractures with 4-6 weeks' evolution^{11,27}. The 2 patients in our series operated 10 days post-fracture went on to heal uneventfully, but were excluded from the analysis. Range of motion and prehensile strength experienced an initial improvement with surgical treatment, but there are studies that do not show significant differences between the groups^{2,4}.

Apart from the purely healthcare-related considerations, from a financial point of view treatment of these fractures by means of percutaneous fixation is considered cost-effective since its global costs, including those associated with patients' sick leave, are lower than those of conservative treatment; length of sick leave is also shorter in patients undergoing percutaneous treatment than in those undergoing conservative treatment^{5,11,20,28}. However, some studies indicate that, for non-manual workers, there are no differences in terms of length of sick leave with respect to manual workers²⁹.

A dorsal percutaneous approach can also be used for treating these fractures. In general, it is carried out through a small incision that allows the surgeon to control the dorsal structures at risk (especially the extensor pollicis longus). In this approach, introduction of the guidewire is performed by following the scaphoid axis in a more anatomic way than with the palmar approach, where the wire is introduced in a more oblique orientation with respect to this axis. However, it must be remembered that for introduction from the dorsum it is necessary to hyperflex the wrist, which could shift the fragments aside. Indication of a dorsal approach must be confined to proximal pole fractures. For that reason, those types of fractures, as well as any other fracture addressed by a dorsal approach, have been excluded from this study.

Percutaneous osteosynthesis through a volar approach of undisplaced or minimally displaced scaphoid fractures is a simple technique characterized by high healing rates, low

morbidity, few significant complications, which significantly speeds up the patient's functional recovery (fig. 5). Nevertheless, the authors of this study consider that in order to obtain good results the technique must be performed by experienced surgeons who are familiar with this condition.

Conflict of interests

The authors have not received any economic help whatsoever to carry out this research. Nor have we signed any agreement with a commercial interest related to this study. Furthermore, no commercial entity has paid or will pay any moneys to foundations, educational institutions or other non-profit making organizations the authors may be affiliated to.

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