Triquetral Fractures: Bibliographical Review about Four Clinical Cases

Fracturas de Hueso Piramidal: Revisión Bibliográfica a Propósito de Cuatro Casos Clínicos

Yulia Perova[1] Ángel Castro Sauras[2] Justo Manuel Villalba Garcia[3] Sandra Rodríguez Martínez[4] Miguel Ranera García[5] María Royo Agustín[5]

[1] Family and Community Medicine Department, Centro de Salud Teruel Centro, Teruel, Aragon, Spain
[2] Head of Department of Orthopedic Surgery and Traumatology, Hospital Obispo Polanco, Teruel, Aragon, Spain
[3] Department of Emergency Service, Hospital Obispo Polanco, Teruel, Aragon, Spain
[4] Family and Community Medicine Department, Centro de Salud Ensanche, Teruel, Aragon, Spain
[5] Department of Orthopedic Surgery and Traumatology, Hospital Obispo Polanco, Teruel, Aragon, Spain

Address for correspondence Yulia Perova, Residente, Centro de Salud Teruel Centro, Teruel (e-mail: yuliaperova@hotmail.com).

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Abstract

Triquetral, or pyramidal, bone fractures are the second most common carpal fracture after scaphoid fractures. They usually result from bone impaction after extension trauma and ulnar deviation of the wrist. These fractures are classified into three groups: triquetral dorsal cortical, body, and volar cortical fractures. The late diagnosis of these injuries is not uncommon since they may go unnoticed during care at the Emergency Services. The early performance of additional radiological tests, such as computed tomography (CT), may avoid late diagnoses. Classically, these fractures have a good prognosis, and their treatment is immobilization. However, magnetic resonance imaging (MRI) can help the diagnosis of associated lesions in cases of poor evolution. The recent literature discusses the different types of surgical procedures available depending on the presence of carpal instability, fibrous pseudoarthrosis, triangular fibrocartilage complex injuries, pisotriquetral arthrosis, etc. The objectives of this study are to compare clinical cases in two distinct profiles of patients presenting the same injury but different evolution and to carry out a complete review on the subject, providing additional information on some triquetral fracture complications.

Keywords

- triquetral fractures
- carpal instability
- wrist

Resumen

Las fracturas del hueso piramidal, o triquetral, son las segundas fracturas más frecuentes de carpo después de las fracturas de escafoides. Normalmente, se producen

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por impactación ósea tras traumatismos en extensión y desviación cubital de la muñeca. Estas fracturas se clasifican en tres grupos: corticales dorsales, fracturas del cuerpo del piramidal y corticales volares. No es infrecuente que estas lesiones se diagnostiquen de forma tardía, ya que en muchas ocasiones pueden pasar desapercibidas en la atención en los Servicios de Urgencias. Esto se puede evitar mediante la realización de pruebas adicionales radiológicas como la tomografía computarizada (TC) de inicio. Clásicamente, se ha considerado que estas fracturas tienen buen pronóstico y se tratan mediante inmovilización. Sin embargo, la resonancia magnética (RNM) puede ser útil para el diagnóstico de lesiones asociadas en los casos de mala evolución. Recientemente, se ha discutido en la bibliografía los distintos tipos de gestos quirúrgicos a realizar según encontremos una inestabilidad carpiana, pseudoartrosis fibrosa, lesiones de complejo de fibrocartílago triangular, artrosis pisopiramidal, etc. Los objetivos de esta revisión son comparar casos clínicos en dos perfiles diferentes de pacientes que tienen evolución distinta de la misma entidad patológica, así como el de realizar una revisión completa sobre el tema aportando información adicional sobre algunas complicaciones de este tipo de fracturas.

Palabras clave
- ► Fractura del piramidal
- ► inestabilidad carpiana
- ► muñeca

Introduction

Triquetral, or pyramidal, bone fractures are the second most common carpal fracture after scaphoid fractures.[1] These fractures are classified into three groups: triquetral dorsal cortical, body, and volar cortical fractures.[2,3]

The detection of triquetral with plain radiography can be difficult, challenging their initial diagnosis in Emergency Services. As such, they may go unnoticed and identified later, delaying treatment. In addition, depending on the fracture type, there may be associated complications, including painful pseudoarthrosis, persistent carpal instabilities, and pisotriquetral joint arthritis.[3] Several papers report age as a poor prognostic factor regarding general bone healing in fractures, which can take longer in older adults. However, information in the scientific literature to explain the consolidation delay in triquetral bone fractures remains scarce.[3] In contrast, carpal instability is the first suspicion in young people with poor evolution. In other words, the patient profile based on age and trauma context may condition the type of fracture, potential complications, and its management.

Triquetral fractures are usually treated satisfactorily with immobilization, except in very complex cases, those with associated complications, or both.[4] The few reported cases and the low evidence level in the literature result in little updated evidence on diagnostic-therapeutic algorithms. This is especially true regarding imaging tests with higher input resolution, identification of associated lesions, and the adaptation of the type of conservative treatment according to the patient to optimize the outcomes of this rare condition.

Objectives

Our objective is to present four clinical cases and perform a subsequent exhaustive review of the existing literature on the most controversial points we have observed when treating these patients.

Material and Methods

We performed a quasi-systematic bibliographic review, not including all cases published on the subject but rather those of higher relevance for discussion. We queried databases such as PubMed, Google Scholar, Medline, and Embase for papers published within the last 10 years, along with manuals and academic textbooks. Profile search strategies combined the controlled vocabulary based on keywords (thesaurus, like Medical Subject Headings [MESH]) and manual searches on bibliographic cross-references. ►**Table 1** shows the inclusion and exclusion criteria adopted for our review.

Next, we present our series of clinical cases, including four patients.

Case 1

A 25-year-old male patient went to the Emergency Services due to pain and functional impotence at the level of the right wrist after trauma with the affected hand in dorsal hyperextension. He presented local edema on the back of the wrist with decreased range of motion. The radiographic study revealed a dorsal fracture of the triquetral bone and the "pooping duck" sign (►**Fig. 1a**, ►**Fig. 1b**). We opted for conservative treatment with an intrinsic plus forearm

Table 1 Inclusion and exclusion criteria for selecting the papers for our bibliographic review

Inclusion criteria	Exclusion criteria
1. Original papers based on descriptive (such as case series) and analytical studies (such as case-control studies and clinical trials) 2. Studies performed in humans 3. Studies in Spanish and/or English 4. Studies published within the last 10 years.	1. Non-original papers or published in non-academic journals 2. Studies performed in animals

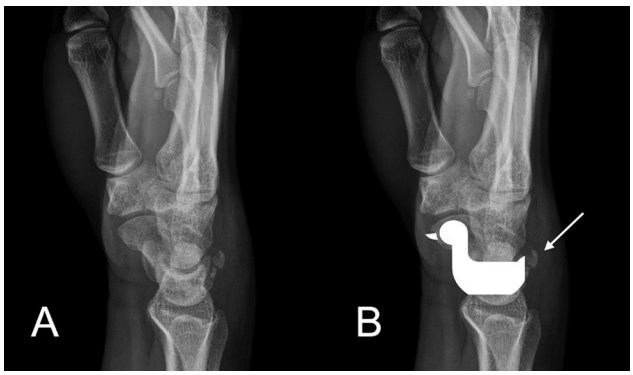

Fig. 1. Lateral radiograph of the right wrist showing a bony avulsion of the dorsal triquetral bone (A). The "pooping duck" sign is created by the confluence of the bone images of the proximal carpal row of the carpus: the scaphoid (head and neck), lunate (body and wings), and the dorsal cortex of the triquetrum (tail). The dorsal fracture fragment represents duck droppings (arrow) (B).

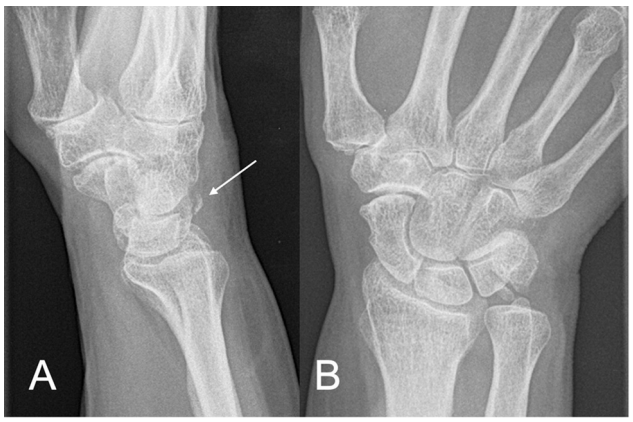

Fig. 2. Lateral (A) and anteroposterior (B) radiographs of the right wrist showing a triquetral fracture and the "pooping duck" sign (arrow). Patchy-looking signs of osteopenia.

plaster splint for 1 month. After splint removal, at 4 weeks, we placed an intermittent rigid wrist orthosis for 2 more weeks, and rehabilitation began. Three months later, the patient presented good functional evolution with no complications or functional alterations.

Case 2

A 62-year-old woman went to the Emergency Services with the same clinical picture shown before but fewer inflammatory signs. Once again, we identified a triquetral bone fracture in a plain radiography with the "pooping duck" sign, characteristic of dorsal fractures, and patchy osteopenia signs (►**Fig. 2**). We performed immobilization with a forearm splint and removed it after 4 weeks due to the absence of pain on palpation at the level of the fracture focus and to avoid secondary stiffness. At 5 months, there was an increase in local pain on triquetral palpation. This led to the request for an MRI, which revealed radioulnar joint effusion, synovitis at the ulnar styloid, rhizarthrosis signs, initial pisotriquetral osteoarthritis, triangular fibrocartilage complex (TFCC) lesion, and partial lesion of the scapholunate ligament (SL). At that time, we suspected the presence of mild signs of complex regional pain syndrome (CRPS) and delayed consolidation. In subsequent follow-up visits, the patient presented pain in the ulnar region of the wrist with subtle signs of midcarpal dynamic instability but negative Watson and Reagan maneuvers. We decided to continue the effective rehabilitation treatment for muscle strengthening and proprioception work. At the end of the follow-up (18 months after the fracture), the patient still had slight pain on palpation at the injury site level and a positive ulnar impingement maneuver. Diagnostic suspicion correlated with previous imaging findings, and we believed the patient could benefit from additional surgical procedures. However, the patient refused to perform any further diagnostic or therapeutic procedure up to that point since she was satisfied with the final functional outcome. We offered the possibility of another referral for salvage surgery in case of pain exacerbation concerning these conditions.

Case 3

A 63-year-old woman with a history of spondyloarthritis, post-traumatic fracture of the right ankle talus, and right femoral avascular necrosis treated with a total hip replacement went to the Emergency Department due to pain in the left wrist after a casual fall on her left hand in hyperextension. Once again, the clinical picture was similar to the previous ones, but the axial compression maneuver of the first finger was positive. A plain

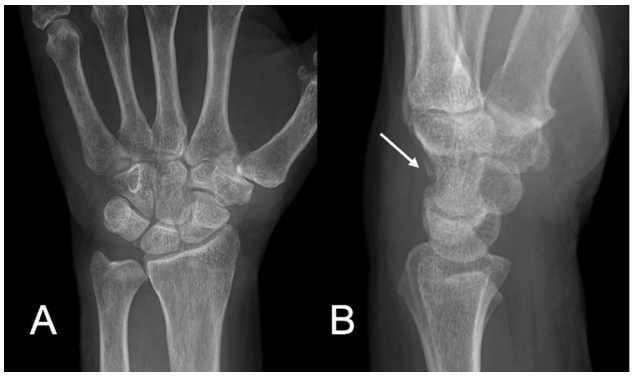

Fig. 3. Anteroposterior (A) and lateral (B) radiographs showing a dorsal fracture of the triquetral bone at the left wrist (arrow).

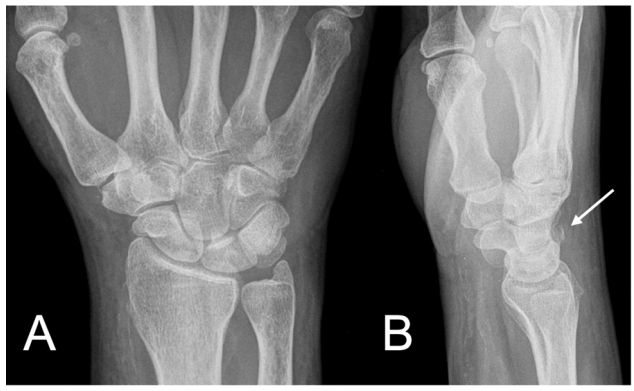

Fig. 4. Anteroposterior (A) and lateral (B) radiographs showing a triquetral bone fracture at the right wrist (arrow).

radiography ruled out a scaphoid fracture and revealed a left carpal triquetral bone fracture with a dorsal fragment (►**Fig. 3**). The treatment was the same as in the previous cases. After a month of rehabilitation treatment, the pain persisted on palpation at the triquetral bone level with no signs of carpal instability and negative Watson and Reagan maneuvers. There were slight signs of midcarpal instability due to muscle decompensation and mild pain in the thenar region of the hand at support. Radiography revealed carpal alignment and a very subtle volar deviation of the lunate, suggesting volar intercalated segment instability (VISI). Given the persistence of pain and some stiffness, negative carpal instability maneuvers, and lack of TFCC lesions, we decided to continue with rehabilitation treatment. Post-therapeutic improvement was remarkable. Despite the potential existence of intrinsic carpal ligament injuries (volar fracture and subtle VISI), age, negative tests, and functional outcome, we consensually decided that the patient should temporarily dismiss associated procedures. We will refer her again in case of clinical worsening to settle if a salvage surgical treatment is required.

Case 4

A 75-year-old man suffered a fall from his own height. He went to the Emergency Services due to pain and functional impotence in his right hand. A plain wrist radiography diagnosed a dorsal triquetral fracture (►**Fig. 4**). We immobilized the patient with a forearm plaster splint for 4 weeks. Subsequently, we replaced the splint for a semi-rigid orthosis to make efforts for 3 more weeks. The patient underwent self-assisted rehabilitation at home as indicated by the traumatologist and recovered with no complications. He was discharged 3 months after the fracture.

Discussion

Biomechanics and classification:

As mentioned, there are three types of triquetral fractures, and we can infer the potential diagnostic and therapeutic adaptations according to the suspected associated lesions. The dorsal cortical fractures are the most common type, as in our case, and result from an avulsion or shear mechanism. This mechanism may be against the ulnar styloid in extension trauma and ulnar deviation of the wrist; the positive length of the ulnar styloid process is a risk factor (cubitus plus).[5] Another mechanism is against the hamate after trauma with the wrist in forced dorsal extension and a pronated forearm. Bece et al. used MRI images to analyze 21 with dorsal triquetrum cortical fractures.[6] Their case series employed a more accurate diagnostic technique (i.e., MRI), and fractures caused by impaction were the most common. This finding contrasts the fact that, classically, the most frequent cause is ligament avulsion (dorsal radiotriquetral or navicular-triquetral ligaments).[6]

Triquetral body fractures (sagittal, transverse, or comminuted) represent the second most common type.[2] Their diagnosis often occurs in complex carpal fracture-dislocations due to high-energy trauma, such as lunate fractures, present in 12% to 25% of these injuries.[3] Because of the usual request for a complete imaging study (i.e., CT), they seldom go unnoticed. Both situations show how supplementary tests with a highest diagnostic power are one of the reasons why these lesions are more often diagnosed and considered the most frequent.

The third group consists of volar cortical fractures, the least frequent of these injuries. They can be caused by the avulsion of the volar lunotriquetral or scaphoid-triquetral ligaments, which is much less powerful than their dorsal counterparts.[2,3] As such, an associate carpal instability may be present.

Clinical and radiological diagnosis:

The clinical picture for suspicion is pain at the ulnar surface of the wrist characterized as the "pyramidal point" worsening with wrist flexion and extension, inflammation, and limited mobility. However, this picture is not pathognomonic.[3,7] The differential diagnosis is very broad, including TFCC and lunotriquetral ligament lesions and hamate and lunate fractures, which frequently have a higher acute level of symptoms.[8]

In patients with pain from a previous chronic process, one must consider extensor carpi or flexor carpi ulnaris tendinitis, Guyon canal syndrome, impaction syndromes (ulnocarpal and ulnar styloid), and hamate proximal pole chondromalacia.[8] This may justify the slower evolution in older patients, as in the third case presented here. A slower rehabilitation process is common in this patient profile. We wonder if limiting immobilization times in these patients would be indicated to avoid secondary complications due to rigidity or CRPS risk. On the other hand, there is a risk of increasing the consolidation delay of osteoporotic bone in patients with expected poor bone quality, such as postmenopausal women. We have not found scientific evidence regarding whether we should adjust the immobilization times according to the patient profile.

Regarding radiological diagnosis in the emergency room, there is no gold standard view for these lesions. As such, always request the three classic views of the wrist (anteroposterior, lateral, and pronated oblique).[9] The 45-degree pronated oblique and the lateral views are the best views for dorsal cortical fractures.[2] One of the characteristic radiological signs of dorsal fractures is the "pooping duck" sign, in which the fractured and avulsed fragment of the dorsal triquetrum cortex projects itself along the dorsal border of the carpus.[10] We observed this sign in all our cases.

CT and MRI gained significance to diagnose these lesions. It is critical to know the clinical picture and have a high diagnostic suspicion; even so, plain radiography is not powerful enough in some cases. CT is helpful and widely available to detect occult triquetral fractures when clinical suspicion is high.3 MRI, not as widely available in emergency rooms, is reserved for the study of associated injuries in cases with poor evolution, including carpal instability, extrinsic carpal ligament injuries, and occult triquetral fractures that were not evident in a CT scan.[11] They also help to rule out chronic injuries that worsen after trauma and potentially justify a slow evolution. In fact, in our second case, we can precisely appreciate how supplementary tests confirmed some associated lesions that may justify a more torpid evolution. In conclusion, when faced with a case of post-traumatic ulnar pain, one must always maintain a high suspicion for associated lesions, requesting other tests if necessary, such as CT, MRI, dynamic radiology, ultrasound, or arthroscopy.[4,7] Likewise, contextualize the condition, age, type of associated lesion, and patient profile to propose definitive treatments in line not only with the findings of supplementary tests but also with the clinical status of the subject.

Treatment and complications:

Up to the generalization of CT availability, there has been some limitation in classifying these fractures in the emergency room. Conservative management is universally recommended for most triquetral bone fractures, especially for dorsal cortical lesions (as in our case), non-displaced fractures with no associated lesions, or both.[2] William et al. recommend splint immobilization for approximately 4 to 6 weeks as the first-line treatment.[2] Surgery must be the initial treatment for fractures with significant displacement or carpal fracture-dislocation.[1]

Here, we have described how each subtype can be associated with different complications requiring specific management.[2] However, the publications we found do not have sufficient power since outcomes based on the fracture type and potential associated injuries are not usually presented, except for large carpal fracture-dislocations.[12] This limits us when establishing a diagnostic-therapeutic algorithm for emergencies and complications. We believe that even though this initial classification did not change treatment because of the good outcomes reported by previous studies, it can help us to individualize management, predict potential complications, refer for associated surgical procedures, and explore new paradigms as to which cases could benefit from early surgical treatment.

In this context, our study is especially interesting for several reasons. First, it is one of the few works with a case series with an $N > 1$.[3,5,13,14] In fact, we have found only one paper in which this is also true.[15] This allows us to begin to establish some hypotheses regarding treatment individualization. Second, we collected aspects omitted in many studies, including age, sex, occupation, patient profile, associated injuries, and fracture subtype. Moreover, we insist on a consensus with the patient when establishing a surgical salvage or with subjects who are not realistic concerning outcome expectations.

On the other hand, there is scientific literature to establish recommendations in cases with poor evolution and residual pain; as such, we need to expand the study and treat existing associated injuries.[4] For instance, a period of about 6 or 8 weeks of symptom persistence was established to recommend an MRI scan to investigate a potential ligament injury or TFCC rupture.[2,3]

In addition to expanding radiological studies, a torpid evolution led us to reconsider conservative management resorting to a salvage surgical intervention. In our humble opinion, the difficulty lies in establishing the exact reason justifying this poor evolution, how to study it, when to perform new procedures, and which ones to consider since they may have significant clinical relevance.

For example, a fact with some consensus is that the reference treatment for persistent pain at the fracture site is open resection of the painful fragment.[4]

However, as shown in this brief case series, clinical persistence cannot always be attributed to the fracture itself. In this case, it is necessary to emphasize the importance of a good-regulated clinical examination and the adequate use and application of supplementary tests. For instance, we can see very flowery radiological outcomes in the second and third cases that reflect associated, probably chronic, injuries in patients over 55 years old who recover a high functional profile after a proper rehabilitation time. These older patients are similar to those with shoulder trauma resulting in rotator cuff injuries.[16] The much larger experience and literature in rotator cuff injuries allow the establishment of a

more valid recommendation,[17,18] i.e., that these lesions are casual findings in which initial rehabilitation treatment and subsequent surgical salvage are increasingly advocated if necessary.[19]

As reflected in our case series, we propose to consider the type of patient we are dealing when managing this condition as clinicians. In fact, after reviewing the literature, we can assert that it is foreseeable that this type of fracture heals more adequately and faster in young people only using plaster immobilization.[3,5,13,14] The patient in the last case was also a man and, even though he was 75 years old, the resolution was early and satisfactory. However, as in the second case, delays in triquetral fracture healing can occur in the presence of osteoporotic bone and we do not have sufficient information on this hypothesis in the reviewed literature. Previous chronic injuries may also justify a slower evolution. This may suggest that we must consider the age and gender of the patient when anticipating a worse bone quality resulting in consolidation delay.[20] Moreover, we must consider extending immobilization times to the upper limit and contrast them with the risk of stiffness depending on the patient profile. All these factors require comparison in studies of high scientific quality, with a larger sample size (which was very limited in our work) to allow testing these hypotheses.

In conclusion, the early diagnosis and treatment of these lesions based on a sufficient study of them seems relevant, a fact that does not usually occur in emergency settings.[21] In case of poor evolution, it is critical to propose other diagnoses and therapeutic procedures if necessary. The growing role of arthroscopy in diagnosing and treating associated complications is very relevant and helpful in carpal instability lesions, as comprehensively described by García-Elias et al.[7]

The literature reports that complications seem infrequent or have minor relevance.[4] Most triquetral bone fractures are benign lesions with good clinical outcomes.[4] This may explain why it is often said, in a very superficial way, that treatment must be conservative without considering early potential complications, as occurs with other conditions, such as scaphoid fracture, on which there is an immense and very diverse literature regarding management. Still, these complications do occur. Fibrous nonunion can happen but is usually asymptomatic. Although symptomatic pseudoarthrosis is rare, Durbin reports conservative management as inadequate due to the persistent pain related to this complication.[22] It has been previously described that its treatment is the excision of the residual fragment, as in hamate fractures.[22] A review by Niemann et al.[25] reports eight cases published since 1950 in which triquetral fractures were surgically treated (except for the Durbin case from 1950).[22] In five cases from this study, fracture treatment used internal fixation with or without bone graft. In the last two cases, treatment was the excision of small, distally located fragments. Conservative treatment resulted in the only case with unfavorable evolution. In addition, this review presents fractures with medial or distal involvement of the triquetral body that does not correspond to the fracture pattern shown here. In the case of persistent ulnar pain, we must remember that dorsal cortical fractures can be associated with TFCC lesions.[8] In other words, the fracture pattern can guide which complication justifies this persistent pain and how to address it. As such, we should not limit ourselves to simply excising the fragment since an excision does not always assure a satisfactory resolution in all cases of persistent ulnar pain after a triquetrum fracture.

The management of TFCC injuries is widely described and detailed in the literature, highlighting the review article by Dr. Esplugas.[26] If these lesions have a chronic profile or low repair viability (joint degeneration, signs of ulnocarpal impingement, non-repairable fibrocartilage lesion, etc.), as in the second case, the initial management is conservative. If symptoms persist, the salvage treatment is surgical. We need to inform the patient about the expectations related to this type of injury since we will surely face a chronic exacerbated condition, considering palliative measures in a previously injured tissue, joint, or both. Several types of repair have been proposed to alleviate symptoms, including synovectomy, debridement, arthroscopic ulnar shortening techniques (which allow a more precise evaluation and complete management), or open procedures in case of symptom persistence.[27] If they present characteristics of being a repairable lesion (for example, absence of chondral lesion, presence of viable tissue) we should be inclined towards surgical rescue, especially in young patients and in symptomatic lesions, with multiple options depending on the lesion and good outcomes.[26,28] Another condition to consider is pisotriquetral osteoarthritis, which could be previous or de novo resulting from a fracture extending into this joint. Depending on the type and symptoms, pisotriquetral osteoarthritis treatment may involve debridement, fragment excision, or even arthrodesis.[29] The arthroscopic technique has good outcomes in treating this condition.[30]

Conclusions

Although triquetral fractures are the second most frequent carpal fracture, the quantity and quality of the available literature are far from scaphoid fractures, for which there are multiple reviews and management algorithms. Therefore, knowledge of this condition requires strengthening, highlighting the growing significance of early testing with greater diagnostic power for ulnar pain and carpal trauma. This approach can avoid complications that, despite infrequent, can cause severe limitations. Similarly, we must begin to review the criteria to start individualizing the initial and salvage treatment of complications based on different types of patients, fractures, and associated injuries. Lastly, we must note that the power of the available literature is insufficient to achieve this. Therefore, we believe further studies are required, reformulating the variables considered to establish treatments and outcomes. Also, it would be interesting to create databases with records from conditions with no

extensive case series, which may allow future research of greater relevance.

Authorization Letter

All authors declare this paper was not published in other communication media.

Conflict of interests

None.

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