



English Version



Versión en español

## Proprioceptive rehabilitation strategies in posttraumatic wrist injuries. Scoping review

### Estrategias de rehabilitación propioceptiva en lesiones postraumáticas de muñeca. Revisión de alcance

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## Abstract

### Background:

The proprioceptive approach can effectively improve strength, mobility, edema reduction, and pain reduction, which in turn has a positive impact on functionality.

### Objective:

To identify proprioceptive rehabilitation strategies reported in the literature in adults with traumatic wrist injuries.

### Methods:

A scoping review was performed following the parameters of the Prisma ScR strategy. We included research with adult patients diagnosed with posttraumatic wrist injuries who used proprioceptive rehabilitation. Pain, functionality, strength, joint mobility ranges, and edema were evaluated.

### Results:

After removing duplicates and applying the exclusion criteria, a total of 123 articles were found, which left six articles, including 125 patients. Rehabilitation protocols based on proprioceptive neuromuscular facilitation and using sensorimotor tools that promote wrist recovery have been generated. In addition, other approaches have been established, such as motor imagery, which generates a work of identification and organization of movement, improving pain and manual function. However, longer follow-ups, standardization of the instruments used during proprioceptive intervention, and increasing the observed population are needed to generate a recommendation for early intervention and cost-benefit estimates.

### Conclusions:

Proprioceptive rehabilitation has demonstrated benefits in the recovery of the lower limb and hip or back. However, for the rehabilitation of traumatic wrist injuries, it is a research pending. Well-described data and good quality designs are needed to routinely propose this strategy in the clinic.



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### Keywords:

Hand injuries; wrist injuries; proprioception; physical therapy modalities; rehabilitation

### Palabras clave:

Lesiones en las manos; lesiones en la muñeca; propiocepción; modalidades de fisioterapia; rehabilitación

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#### **Conflict of interest:**

The authors declare no conflict of interest

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## **Resumen**

### **Antecedentes:**

El enfoque propioceptivo puede mejorar de manera efectiva la fuerza, la movilidad, la reducción del edema y la disminución del dolor; lo que a su vez tiene un impacto positivo en la funcionalidad.

### **Objetivo:**

Identificar las estrategias de rehabilitación propioceptiva reportadas en la literatura, en adultos con lesiones traumáticas de muñeca.

### **Métodos:**

Se efectuó una revisión de alcance siguiendo los parámetros de la estrategia Prisma ScR. Se incluyeron investigaciones con pacientes adultos, diagnóstico de lesión postraumática de muñeca, que utilizaron rehabilitación propioceptiva. Se evaluó el dolor, la funcionalidad, la fuerza, los rangos de movilidad articular y el edema.

### **Resultados:**

Se incluyeron seis artículos, que involucraron 125 pacientes al aplicar los criterios de exclusión. Se han generado protocolos de rehabilitación basados en facilitación neuromuscular propioceptiva y el uso de herramientas sensoriomotoras que promueven la recuperación de la muñeca. Además, se han establecido otros abordajes como la imaginería motora, que genera un trabajo de identificación y organización del movimiento, mejorando el dolor y la función manual. Faltan seguimientos de mayor tiempo, estandarización de los instrumentos utilizados durante la intervención propioceptiva y aumentar la población observada para generar una recomendación de intervención temprana y estimaciones entre el costo y el beneficio.

### **Conclusiones:**

La rehabilitación propioceptiva ha demostrado beneficios en la recuperación del miembro inferior y la cadera o espalda. Para la rehabilitación de las lesiones traumáticas de muñeca, es un pendiente de la investigación. La información bien descrita y los diseños de buena calidad son necesarios para proponer rutinariamente esta estrategia en la clínica.

## Remark

### 1) Why was this study conducted?

Traumatic wrist injuries have a high frequency of consultation, the structural damage, together with the immobilization time generates sequelae associated with pain, edema and functional limitation of the wrist and alteration of proprioception in the wrist joint. The evidence of its practice is not clear, there are multiple approaches, techniques, population sizes and follow-ups, which makes it difficult to establish which intervention should be used in rehabilitation, for how long it should be started and how often. This research aims to identify the evidence of proprioceptive interventions implemented in traumatic wrist injuries in adults.

### 2) What were the most relevant results of the study?

Wrist proprioception rehabilitation is a topic that has received little attention in the scientific literature. Through the search conducted, few studies were found on the rehabilitation of proprioception of the wrist, however in the studies found that mention its clinical relevance in different pathologies not only traumatic but also degenerative of the hand and wrist, this lack of evidence is more pronounced when looking for the effectiveness of proprioceptive procedures. The results of the search indicate that the use of protocols based on motor imagery, sensory rehabilitation and proprioceptive neuromuscular facilitation can generate favorable clinical and statistically significant results in patients with traumatic wrist injuries, specifically with fractures of the distal third of the radius and triangular fibrocartilage injury. However, these results are not conclusive due to small sample sizes and the lack of unification of evaluation and follow-up criteria during treatment.

### 3) What do these results contribute?

The findings of this research highlight the importance of exploring new avenues of study in the field of proprioception, especially in relation to the wrist. The lack of sufficient studies on the efficacy of proprioceptive techniques in this area underscores the need to undertake additional research with appropriate evaluation and follow-up protocols. To advance in this field, it is recommended that studies be conducted that consider the essential criteria of proprioception, such as the neuromuscular system, the sensory system, and the musculoskeletal system. These investigations must have a significant population sample in order to conclusively demonstrate the effectiveness and clinical relevance of proprioceptive techniques applied to the wrist.

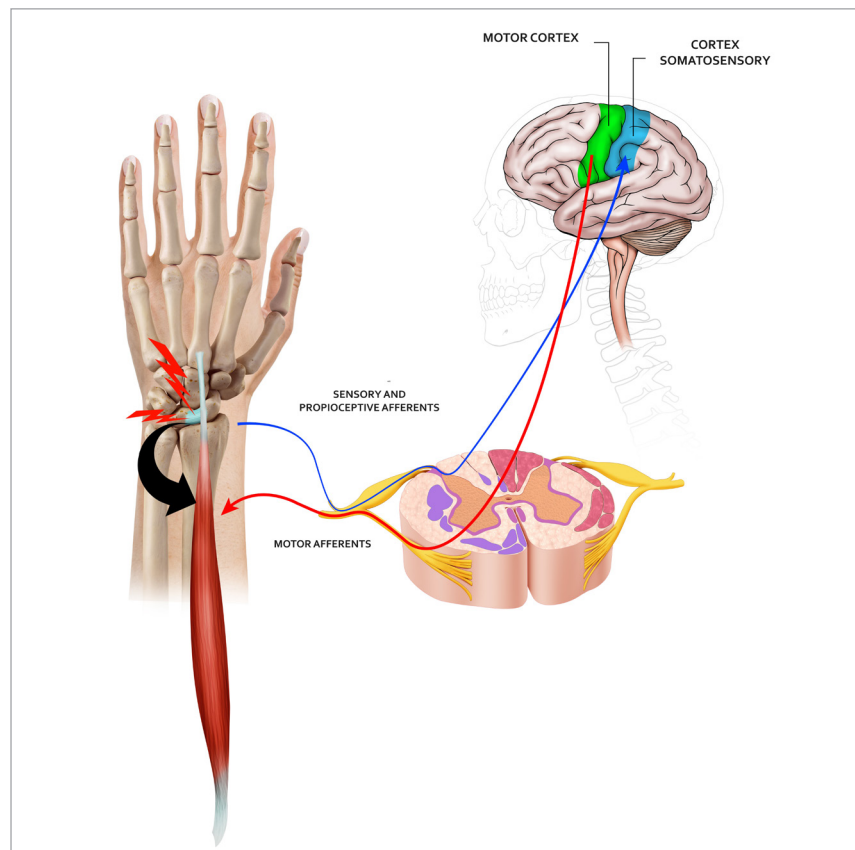
## Introduction

Traumatic injuries of the wrist are frequent; out of 436 traumatic injuries of the upper extremity, 77.0 % are of the wrist, and of these, 38.6 % are fractures of the distal third of the radius, which can generate functional, proprioceptive, and occupational limitations<sup>1,2</sup>. Proprioceptive impairment has gained importance in recent years, and proprioceptive re-education practices have been postulated as the primary strategy to improve function in this type of injury<sup>3</sup>, which makes it necessary to initiate medical and therapeutic treatment<sup>4</sup> to reduce associated complications such as pain, edema, limitation of joint mobility, and loss of strength<sup>5-7</sup>.

Proprioception is a sensory function with receptors in the skin, muscles, tendons, and joints that carry information to the central nervous system for conscious and unconscious control of position sense, joint movement, muscle strength, and balance<sup>3,8,9</sup> (Figure 1).

Proprioceptive rehabilitation has been studied in lower limbs since the last century with positive results, and these have been extrapolated to upper limb rehabilitation. Only since 2009 has proprioceptive rehabilitation been investigated in the treatment of hand and wrist injuries of traumatic origin<sup>9,10</sup>.

This review aims to identify proprioceptive rehabilitation strategies for recovering traumatic wrist injuries without neurological injury and their effects on pain, functionality, strength, joint mobility ranges, and edema.



**Figure 1.** Principles of the wrist proprioceptive pathway. Certain anatomical and physiological criteria must be met for a joint to have a proprioceptive function. In the joints there are mechanoreceptors, which respond to stimuli (pressure, movement, and speed), sending afferent information through the dorsal horn of the spinal cord, information that will be processed in the somatosensory cortex and derived to the motor cortex to finally send the motor response that travels along the efferent pathway, reaching the anterior horn of the spinal cord, and from there the motor neurons will synapse at the neuromuscular junction to cause motor action.

## Materials and Methods

A scoping review was carried out following the Prisma ScR <sup>11</sup> methodology for scoping review and the Joanna Briggs Institute Manual <sup>12</sup>.

### Inclusion and exclusion criteria

A search was conducted for scientific articles describing the use and outcomes of proprioceptive rehabilitation in adults with traumatic wrist injuries. Articles of clinical trials, cohort studies, and case studies were considered, and published in English, Spanish and Portuguese, with no restriction on publication date. The filters of title, abstract and content were applied, and the date of collection or search for information was made with a cut-off date of November 2023. The following research question (PICO) was established:

Participants: adult patients over 18 years of age with a diagnosis of posttraumatic wrist injury.

Interventions: proprioceptive rehabilitation in posttraumatic wrist injury.

Comparison: none, other intervention, or conventional management.

Results: pain, function, strength, joint mobility ranges and wrist edema.

Narrative articles, cross-sectional studies, editorials, and letters to the editor were excluded. Investigations with patients with neurological and adjacent joint lesions were excluded to better appreciate the effect of proprioceptive rehabilitation.

### Search methods for study identification

The search process and identification of studies were performed using the following terms: Rehabilitation, Hand Injuries, Wrist Injuries, Proprioception, Physical Therapy Modalities, establishing the following combinations, (Rehabilitation) AND (Hand Injuries)) AND

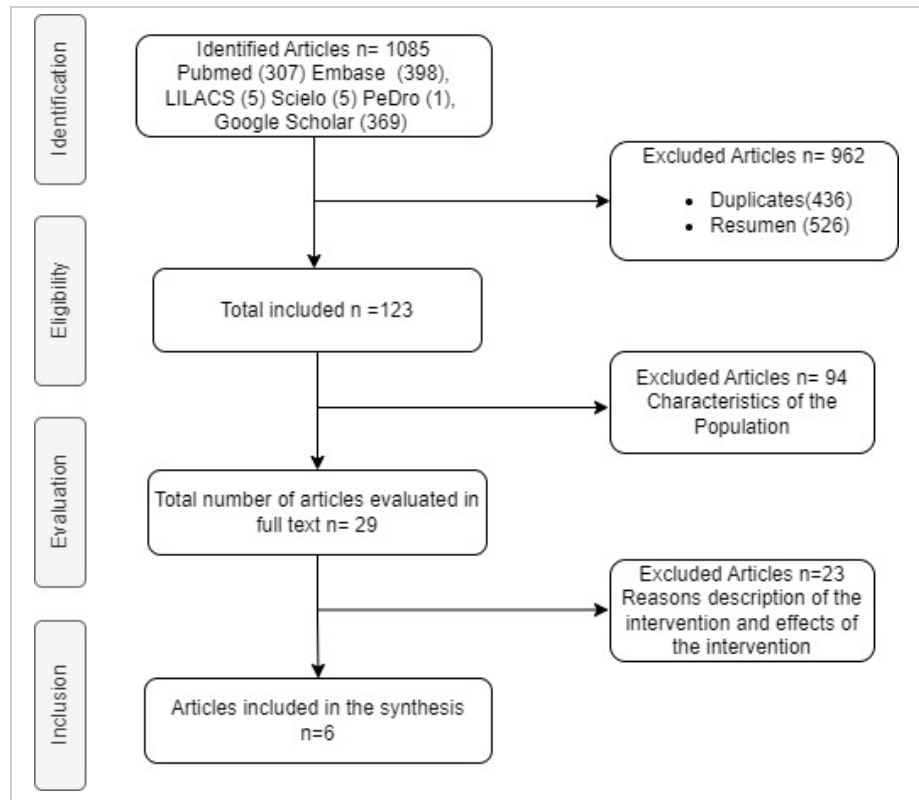


Figure 2. Flowchart of the review.

**Table 1.** Population, injury, and study type characteristics of the articles on proprioceptive wrist rehabilitation.

Author	Country	Population	Diagnostic	Type of Study
Dilek <i>et al.</i> <sup>13</sup>	Spain	Group 1: 14 patients with conventional rehabilitation, 5 men and 12 women. Average age 52.59 Group 2: 19 patients with proprioceptive rehabilitation, 7 men and 12 women. Average age 47.16	Distal-third radius fracture	Single-blind randomized
Wollstein <i>et al.</i> <sup>14</sup>	United States	Group 1: 31 patients with conventional rehabilitation, mean age 63.9 Group 2: 29 patients with proprioceptive rehabilitation, average age 62.3	Distal-third radius fracture	Prospective therapeutic study
Zhiqing <i>et al.</i> <sup>15</sup>	Singapore	One 23-year-old patient	Triangular fibrocartilage injury	Case study
Zhiqing <i>et al.</i> <sup>16</sup>	Singapore	10 patients with proprioceptive rehabilitation have an average age of 33.5	Triangular fibrocartilage injury	Pretest-posttest single-group experimental design
Karagiannopoulos <i>et al.</i> <sup>3</sup>	United States	33 patients with proprioceptive rehabilitation: 20 surgical patients, mean age 58.4 13 non-surgical patients with a mean age 61.6	Distal-third radius fracture	Prospective longitudinal cohort study
Hincapie <i>et al.</i> <sup>17</sup>	United States	One 43-year-old woman	Partial dorsal intercarpal ligament tear and right wrist scapholunate ligament sprain	Case study

QuickDASH = Quick Disabilities of the Arm, Shoulder, and Hand; PRWE = patient-rated wrist evaluation JPS= joint position sense measurement

(Proprioception), rehabilitation [MeSH Terms]) AND (Wrist Injuries [MeSH Terms]) AND (Proprioception [MeSH Terms]), (Hand Injuries) AND (Proprioception), (Wrist Injuries) AND (Proprioception), ((Rehabilitation) AND (Proprioception)) AND (Wrist Joint). For the search of articles in Spanish and Portuguese, the translation of the term was performed with the thesaurus of structured and multilingual vocabulary, DeCS.

Searches were performed in PubMed, Embase, LILACS, PEDro, and Google Scholar databases.

After removing duplicate articles, two authors independently reviewed the selected articles to verify the study typology. Subsequently, the full text was reviewed to define the articles considered in the review. When there was a discrepancy between the authors, it was discussed, and consensus was reached with the third author. The following data were extracted from the selected articles: authors, country, study population, type of study, intervention performed, and main results, as well as the advantages and limitations of the study.

## Results

A total of 1,085 articles were identified in the databases. There were no meta-analysis articles. We removed 436 duplicate articles. The authors excluded 526 articles by abstract. A total of 123 full-text articles were retrieved, of which 94 were excluded because they did not meet the population criteria, and 23 articles were excluded because the description of the proprioceptive intervention was not explicit. The analysis for the review was performed on six articles (Figure 2).

### Characteristics of the included articles

The six selected articles included 125 subjects, with female gender and right-handed dominance predominating. The most frequent diagnoses were distal radius fracture and triangular fibrocartilage injury. Table 1 shows the characteristics of the population and the type of study.

The articles describe the following techniques: graded motor imagery, sensorimotor home protocol, proprioceptive neuromuscular facilitation (PNF), motor work through dart coactivation, and mirror therapy.

In a randomized controlled trial in patients with surgically treated fractures of the distal third of the radius (19 patients), the graded motor imagery technique was used for eight weeks with image recognition and mirror therapy; it was compared with conventional therapy (14 patients),

and progress was evaluated at the second, fifth and, eighth weeks with the visual analog pain scale (VAS), Jamar dynamometer, QuickDASH score (Quick Disabilities of the Arm, Shoulder, and Hand) and the Michigan Hand Questionnaire (MHQ). The intervention group showed improvement in pain intensity at rest and joint mobility ranges compared to the control group, and follow-up upper limb function was equivalent in the control and intervention groups.

The graded motor imagery technique was combined with sensorimotor strategies in patients with distal radius fractures (29 patients) compared to a conventional therapy group (31 patients). The progression of graded motor imagery is not detailed; sensory stimulation was performed by recognizing textures with eyes open and closed. The intervention was performed daily at home, and the evaluation was done in the third week and three months after the intervention. The sensory deficit was evaluated with sensorimotor tests with Semmes-Weinstein monofilaments, static and dynamic 2-point discrimination, vibration tests, temperature, Moberg detection in a timed manner, stereognosis, and proprioception tests<sup>14</sup>. The investigation demonstrated sensory improvement; however, no differences were found in pain sensitivity, functionality, strength, or mobility.

In a case study, mirror therapy was the primary strategy for a patient with a triangular fibrocartilage lesion. This technique was used in the first weeks of intervention, promoting movement awareness exercises through the mirror; from the fifth week on, active muscle strengthening exercises were included with manual resistance in wrist stabilizing muscles and exercises with a gyroscope, which is a device that generates forces in multiple directions, thus stimulating proprioception. In the ninth week, active exercises with external resistance were started<sup>17</sup>. After the intervention, significant changes were achieved in palmar pressure strength, pain, and functionality for the initial assessment.

The other three articles used the proprioceptive rehabilitation technique (PRT)<sup>3,15,16</sup>. Chen et al., applied a protocol to a patient with a triangular fibrocartilage lesion consisting of dart throwing motion (DTM) work to organize manual restoration, adding closed kinetic chain exercises with attachments such as balls and generating weight load as well as bilateral upper limb patterns; then, weight and band work were added, and the load was organized according to the patient's response<sup>15</sup>. The patient's pain and functional limitations decreased. Subsequently, he applied this protocol to ten patients with the same injury with similar results<sup>16</sup>. In the last study, in 33 patients with fractures of the distal third of the radius (20 post-surgical and 13 without previous surgery), proprioceptive therapy was added to conventional rehabilitation without describing the technique or dose. They did not find significant changes concerning the control group<sup>3</sup>.

## Discussion

The term "proprioception" derives from the Latin "proprius" ("belonging to oneself") and "-ception" ("to perceive"). It allows to perceive body parts' location, movement, and action. For this purpose, it considers all central and peripheral structures; therefore, proprioceptive rehabilitation should integrate three principles: kinesthesia, joint position sense, and neuromuscular control, to reduce pain and edema, improve mobility, joint stability, and muscle strength, which translates into greater functionality of the involved segment. These principles are fundamental to optimizing the results of the interventional process. Kinesthesia, by focusing on movement awareness, improves control and coordination, strength, and stability. Work provides improved functionality and establishes a solid foundation for movement, thus enhancing functional capacity and reducing vulnerability to injury. Body awareness, essential for understanding position and movement in space, should be integrated into the rehabilitation process for this purpose as well; for its progression, the recovery times of the tissues involved should be considered<sup>9,18</sup>.



Currently, several approaches work in isolation on the principles of proprioceptive rehabilitation; its applicability has been reported in joints such as the knee and ankle and neurological injuries<sup>19,20</sup>. The risk associated with proprioceptive interventions is low due to the non-invasive nature of these techniques. In terms of economic efficiency, they are cost-effective compared to other therapeutic options since they do not require the purchase of specialized equipment, presenting an economical alternative to improve motor function and quality of life<sup>8,9,21,22</sup>. These advantages of proprioceptive rehabilitation are similar when implemented for traumatic wrist injuries. However, there are limitations such as the number of subjects included in the studies, follow-up during treatment with low rigor and diversity of evaluation instruments.

Therefore, its clinical relevance and effectiveness are necessary for current and future practice in wrist rehabilitation, improving follow-up processes that include proprioceptive principles and integrating the neuromuscular, sensory, and musculoskeletal systems. Likewise, standardization processes should be generated that adjust the intensity and duration of the sessions according to the patient's condition and capabilities, thus reducing potential risk.

Other studies were excluded due to the lack of clarity regarding the interventions' dosage, frequency, and follow-up. The absence of detailed information on these critical elements makes it difficult to assess the effectiveness of the interventions studied effectiveness accurately<sup>5,8,9,19-38</sup>.

## Conclusions

Proprioceptive rehabilitation has demonstrated benefits in lower limb and hip or back recovery; however, rehabilitation of traumatic wrist injuries it is research pending. Well-described data and good-quality designs are needed to routinely propose this strategy in the clinic today.

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