CASE SERIES

EFFECTS OF PASSIVE UPPER EXTREMITY JOINT MOBILIZATION ON PAIN SENSITIVITY AND FUNCTION IN PARTICIPANTS WITH SECONDARY CARPOMETACARPAL OSTEOARTHRITIS: A CASE SERIES

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ABSTRACT

Objective: The purpose of this case series is to report on the effects of passive joint mobilization (PJM) of the shoulder, elbow, and wrist on pain intensity, pain sensitivity, and function in elderly participants with secondary carpometacarpal osteoarthritis (CMC OA).

Methods: Fifteen inpatients from the Department of Physical Therapy, Residenze Sanitarie Assistenziali, Collegno (Italy), with secondary CMC OA (70-90 years old) were included in this study. All patients received PJM of the dominant arm (shoulder, elbow, and wrist) for 4 sessions for 2 weeks. Pain severity was measured by visual analog scale, and pain sensitivity was measured with pressure pain threshold (PPT) at CMC joint, at the tubercle of the scaphoid bone, and at the unciform apophysis of the hamate bone. Tip and tripod pinch strength were measured by a pinch gauge.

Results: Passive joint mobilization reduced pain severity after the first follow-up by 30%, in addition to increased PPT by 13% in the hamate bone. Strength was enhanced after treatment. Tripod pinch increased by 18% in the dominant hand after treatment.

Conclusions: This case series provides preliminary evidence that PJM of upper extremity joints diminished pain and may increase PPT tip and tripod pinch in some participants with secondary CMC OA. (J Manipulative Physiol Ther 2012;35:735-742)

Key Indexing Term: *Pain; Pressure; Carpometacarpal Joints; Osteoarthritis; Manual Therapies; Aged*

Secondary carpometacarpal osteoarthritis (CMC OA) is a degenerative disorder of the carpometacarpal (CMC) joint that causes abrasion, progressive deterioration of the joint surfaces, and new bone formations.[1-3] The relevance of this pathology, compared with participants with asymptomatic hand OA, is increased pain with movement and reduced maximal tip and tripod pinch strength.[1] Compared with those without symptomatic hand OA, participants with this pathology had reduced maximal tip and tripod pinch strength and reported more difficulty in writing, handling, or fingering small objects.[4]

Passive joint mobilizations (PJMs) are passive movements of the joint performed within the physiological range. They can be broadly divided into physiological movements, which emphasize rotation of the bone, and accessory movements, which emphasize translation of the bone.[5] This type of mobilization aims to relieve pain.[6] Physical therapists and other manual therapists commonly use PJM to treat musculoskeletal pain.[7] It is thought that this technique reduces pain by mechanical and neurophysiological

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mechanisms or the combination of both.[8] Passive movements reduce pain by local and spinal mechanisms such as inhibiting reflex muscle contraction,[9] reducing intra-articular pressure,[9] and reducing the level of joint afferent activity.[10] Others indicate that painful joint mobilizations may activate descending control system by stimulating the dorsolateral periaqueductal gray (dPAG) that produce immediately hypoalgesia of noxious mechanical stimuli.[11] In both cases, most of the authors agree that PJM decreases pain, although the mechanism is still unclear.

In the lower limbs, previous reports support the idea of using PJM in a proximal joint to improve a distal one. This has been the case of hip mobilization in patients with knee OA.[12-14] Similarly, in the upper limbs, PJM improves pain in patients with shoulder adhesive capsulitis, after metacarpal fracture or distal radius fracture.[15] We have recently reported that joint accessory mobilization decreases pain and improves strength in patients with secondary CMC OA.[16]

Because PJM includes passive accessory movements,[8,13,16,17] the aim of our study was to investigate the effects of PJM directed to the shoulder, elbow, and wrist without directly addressing CMC joint on pain and pressure pain threshold (PPT) in strength of tip pinch and tripod pinch of the CMC joint.

Methods

Study Population

Fifteen consecutive participants, 2 men and 13 women, 70 to 90 years old who presented secondary CMC OA in the dominant hand were recruited from the Department of Physical Therapy, Residenze Sanitarie Assistenziali, Collegno (Italy). The inclusion criteria involved preserved cognitive capacities according to age, ex-factory workers, housewives, and persons whose use of the dominant hand was higher and systematic. The exclusion criteria involved carpal tunnel syndrome, arthritis, surgical interventions on CMC joint, fingers in spring or D'Quervain tenosynovitis, and degenerative or nondegenerative neurologic conditions in which pain perception could be altered.[18] All participants were given 2 supporting scales, the Beck Depression Inventory (BDI)[19] and the anxiety questionnaire State-Trait Anxiety Inventory,[20] for participant screening. Participants with anxiety or depressive disorders were excluded. The diagnosis was performed by x-ray, and the study was limited to patients with secondary CMC OA stages III and IV according to the Eaton-Littler-Burton classification.[21,22] Informed consent was obtained from all participants, and all procedures were conducted according to the Declaration of Helsinki. This study was supervised by the Department of Physical Therapy, Residenze Sanitarie Assistenziali, which depends on Azienda Sanitaria Locale 3, Collegno (Italy). The protocol (no. 93571/c) was approved by the ethics committee in Azienda Sanitaria Locale 3.

Intervention

During the first part of passive movement, the therapist slowly moved the affected limb, with emphasis on lowering the resistance. After this, the therapist aimed to reach the end range of motion and stretch the structures without causing pain.[9] The patient was in a supine position, arms at the side and shoulder flush with the edge of the bed and without pillow, if permissible. The therapist was in a stride standing position, facing cephalad and parallel to the patient with the near hip next to the right bed.

With the patient and the physiotherapist in the described positions, the therapist placed his near foot forward. Then, the physiotherapist positioned his right elbow on the scapular girdle of the patient and the forearm along the upright arm of the participant. To take precise control of the thumb and fingertips, the physiotherapist took the right hand of the patient. After that, the forearm was raised, the wrist and fingers were taken to neutral position, the shoulder was turned laterally (75°-90°), and the elbow was extended, as well. The mobilization was performed by using simultaneous movements of the elbow, wrist, and hand (flexion) and then back to the initial position (extension). All patients were treated by a university master in manipulative therapy and with more than 10 years of clinical experience in the management of patients with manual procedures.

Outcome Measures

Beck Depression Inventory. We reviewed the internal consistency for the BDI ranges from 0.73 to 0.92, with a mean of 0.86, with α coefficients of .86 and .81 for populations with psychiatric and without psychiatric disorder, respectively.[23] The BDI observed showed high discrimination of depressive symptoms (75%-100%).[19]

State-Trait Anxiety Inventory. We used a self-rated questionnaire divided in 2 parts: anxiety-trait (referring to personality aspects) and anxiety-state (referring to systemic aspects of the context). Responses are in a 1 to 4 scale. *Anxiety-state* refers to how individuals feel "at the moment," and *anxiety-trait* refers to how they "generally feel." Each part varies from 20 to 80 points, and the scores indicate low (0-30), medium (31-49), or high ($\geq$ 50) anxiety levels.[20]

Measurement of pain severity. We measured pain with a visual analog scale (VAS) with a horizontal line 100 mm long, with the anchors "no pain" on its left and "intensive pain" on its right.[24] Patients were instructed to put a mark on the scale to show the intensity of pain while carrying out a key pinch. Then, the VAS intensity was registered by measuring the distance in millimeters from the left anchor to the mark that the participant made on the line. Previous studies have reported that the reliability of VAS has been high (intraclass correlation coefficient [ICC], 0.97).[25]

Measurement of Mechanical Pain Sensitivity. We measured PPT with a mechanical pressure algometer (Wagner Instruments, Greenwich, CT) with a 1-cm^2 rubber-tipped plunger mounted on a force transducer was used for measuring PPT.[26,27] The range of values of the pressure algometer was 0 to 10 kg, with 0.1-kg divisions. *Pressure pain threshold* is defined as the minimal amount of pressure that results in the sense of pressure changing to pain.[28,29] Previous studies have reported an intraexaminer reliability of this procedure ranging from 0.43 to 0.94.[27] The following points were evaluated: CMC joint at the bottom of the anatomical snuffbox, tubercle of the scaphoid bone, and unciform apophysis of the hamate bone.

Pinch Strength. Pinch strength was measured by a mechanical pinch gauge (Baseline, Irvington, NY), with the patient in a sitting position with the shoulder adducted and neutrally rotated and the elbow flexed at 90°.[30-32] Two different measurements were taken. First, we measured the tip pinch between the index and the thumb fingers. Then, we measured tripod pinch, between the index and medial and thumb fingers. The reliability of this procedure to measure pinch strength has been found to be in the order of 0.93.[33]

The reliability of these measurements and instruments has been shown in some items of the subscale of the Australian/Canadian Osteoarthritis Hand Index.[34,35]

Study Protocol

All participants were treated by the principal investigator. Each participant attended 4 intervention sessions for 2 weeks scheduled on separate days, at least 48 hours apart and at the same time of day, and was applied to the dominant arm 3 times during a 4-minute period with 1-minute pauses between periods. Participants were not allowed to take any analgesic or anti-inflammatory drug for approximately 24 hours before each session. The variables were taken in the following order: pain severity, PPT, and pinch strength. For every outcome, 3 measurements were done, with a 1-minute pause period between measurements. The mean of these 3 values was used for analysis. After pretreatment measurements, the physiotherapist treated the patients as described in the "Intervention" section. Posttreatment data were assessed 5 minutes after finished treatment, first follow-up (FU) data were assessed 1 week after the treatment, and second FU data were assessed 2 weeks after the treatment, following the sequence mentioned earlier.

Statistics

Data were analyzed using SPSS package version 15.0 (SPSS Inc, Chicago, IL). Results are expressed as mean plus or minus standard error ICC, and SEM was calculated to assess intraexaminer reliability for VAS, PPT, and pinch strength data. Normal distribution of the sample was analyzed by using the Kolmogorov-Smirnov test. A 1-way analysis of variance with repeated measurements and Bonferroni was used as post hoc test to evaluate statistical significance. Within-group effect sizes were calculated using the Cohen *d* coefficient.[36] For all data of the study, *P* values lower than .05 were considered significant.

Table 1. *Baseline demographics for both groups*

Characteristic	Mean	SD	SEM
Age (y)	83.40	±5.08	1.36
Sex	13/15 (female)		
BDI	6.02	±1.53	0.28
State-Trait Anxiety Inventory	22.87	±3.44	0.92

Values are expressed as mean and SEM.

Results

In the present cases series, the baseline characteristics of the participants are listed in Table 1. No participants dropped out during the different phases of the study, and no adverse effects were detected after the application of the treatments. None of the participants began drug therapy during the course of the study.

Pain

The intraexaminer reliability of VAS measurements of CMC joint was determined as an ICC of 0.95, with a SEM of 14.82.

We found that PJM produced a significant time interaction effect (F = 4.76, P = .006, partial η = 0.25). In addition, pain severity decreased after the intervention, and the major difference was found at the first FU (P = .033) and a tendency was observed in the second FU (Tables 2 and 3; Fig 1A).

Mechanical Pain Sensitivity

Carpometacarpal Joint and Scaphoid Bone. The intraexaminer reliability of PPT measurements with CMC joint and scaphoid bone was determined as ICCs 0.95 and 0.91, respectively. The SEM was 1.81 kg/cm^2 for CMC joint and 3.61 kg/cm^2 for scaphoid bone.

In this specific point, we found no interaction effects; however, a significant effect for time in CMC joint (F = 0.93, P = .43, partial η = 0.062) and scaphoid bone (F = 0.25, P = .86, partial η = 0.018) was observed (Table 3; Fig 1B, C). In addition, we found a trend toward an increase between pretreatment vs posttreatment, first FU, and second FU in all PPT (CMC joint and scaphoid bone).

Hamate Bone. The intraexaminer reliability of PPT measurements of hamate bone was determined as an ICC of 0.89, with a SEM of 4.11 kg/cm^2.

Table 2. *VAS, PPT, and pinch strength assessment of the study at pretreatment, posttreatment, first FU, and second FU*

	Pretreatment	Posttreatment	First FU	Second FU
VAS (mm)				
CMC joint	64.53 ± 3.2	59.63 ± 3.7	45.27 ± 5.4	55.97 ± 5.2
PPT (kg/cm^2)				
CMC joint	4.04 ± 0.37	4.24 ± 0.33	4.58 ± 0.50	4.40 ± 0.52
Scaphoid bone	5.33 ± 0.61	5.55 ± 0.52	5.51 ± 0.50	5.72 ± 0.47
Hamate bone	6.02 ± 0.66	6.69 ± 0.53	7.18 ± 0.57	6.76 ± 0.57
Pinch strength (kg)				
Tip pinch	1.99 ± 0.23	2.15 ± 0.20	2.13 ± 0.24	2.15 ± 0.21
Tripod pinch	2.39 ± 0.17	2.82 ± 0.20	2.67 ± 0.25	2.71 ± 0.24

Values are expressed as mean and SEM.

Table 3. *Within-group changes and within-group effect sizes at each assessment of the study*

	Pretreatment/Posttreatment data	Pretreatment/First FU data	Pretreatment/Second FU data
VAS			
CMC joint	−0.49 (−0.86/1.84) d = 3.66	−1.93 [a] (0.12/3.77) P = .033, d = 2.67	0.86 (−0.96/2.67) d = 2.59
PPT (kg/cm^2)			
CMC joint	−0.21 (−0.89/0.48) d = 0.78	−0.54 (−1.56/0.48) d = 1.23	−0.36 (−1.43/0.71) d = 1.38
Scaphoid bone	−0.23 (−1.59/1.14) d = 2.71	−0.18 (−1.10/0.74) d = 2.67	−0.40 (−2.03/1.23) d = 2.5
Hamate bone	−0.66 (−2.25/0.92) d = 3.02	−1.16 [a] (−2.50/-0.02) P = .045, d = 2.9	−0.73 (−2.14/0.67) d = 3.09
Pinch strength (kg)			
Tip pinch	−0.16 (−0.50/0.18) d = 0.67	−0.14 (−0.64/0.36) d = 0.43	−0.17 (−0.52/0.18) d =0.65
Tripod pinch	−0.43 [a] (−0.86/0.003) P = .05, d = 1.61	−0.28 (−0.75/0.19) d = 0.95	−0.31 (−0.78/0.16) d = 1.11

[a] The difference of the means is significant vs pretreatment (P < .05).

In this regard, we found a significant effect for time interaction (F = 2.98, P = .042, partial η = 0.17). In addition, we found significant differences between pretreatment vs first FU (6.02 ± 2.47 kg/cm^2; P = .045) in the hamate bone (Table 3; Fig 1D). Furthermore, a large within-group effect sizes (d > 1) were found between pretreatment and posttreatment, first FU, and second FU.

Motor Performance

Tip and Tripod Pinch. The intraexaminer reliability of strength measurements with tip pinch and tripod pinch was determined as ICCs of 0.92 and 0.92, respectively. The SEM was 1.24 kg for tip pinch and 1.13 kg for tripod pinch.

We found no significant interaction for time in tip pinch (F = 0.99, P = .40, partial η = 0.067); however, we observed a significant interaction for time in tripod pinch (F = 2.42, P = .014, partial η = 0.22) (Table 3). In addition, we found significant differences between pretreatment vs posttreatment (P = .05) in the tripod pinch (Table 3). Figure 2A and B summarizes the evolution of tip and tripod pinch and during the study. Also, a large within-group effect sizes (d > 1) were found between pretreatment and posttreatment data and first FU and second FU.

Discussion

We found that specific PJM of the shoulder, elbow, and wrist decreased pain immediately after the intervention in participants with secondary CMC OA. In addition, a tendency to increase PPT and pinch strength was noticed in the FU sessions. Also, we found that PJM decreased pain severity after treatment and at both FUs, suggesting a lasting effect of PJM on patients presenting secondary CMC OA, whereas a major and significant improvement was shown in the first FU. We found that PJM increased PPT in the hamate bone at the first FU and also tripod pinch of the dominant hand after the treatment.

To our knowledge, this is the first report using PJM directed to arm joints as a treatment for secondary CMC OA. However, others have found that this type of technique have positive effects on other disorders of the upper extremity.[15] We have recently reported that passive accessory mobilization of CMC joint showed hypoalgesic effects and increases in strength in participants with secondary CMC OA.[16] Similarly, neurodynamic techniques were effective in reducing pain sensitivity and improving motor performance.[37] Considering the results of these previous trials and the present data, it can be asserted

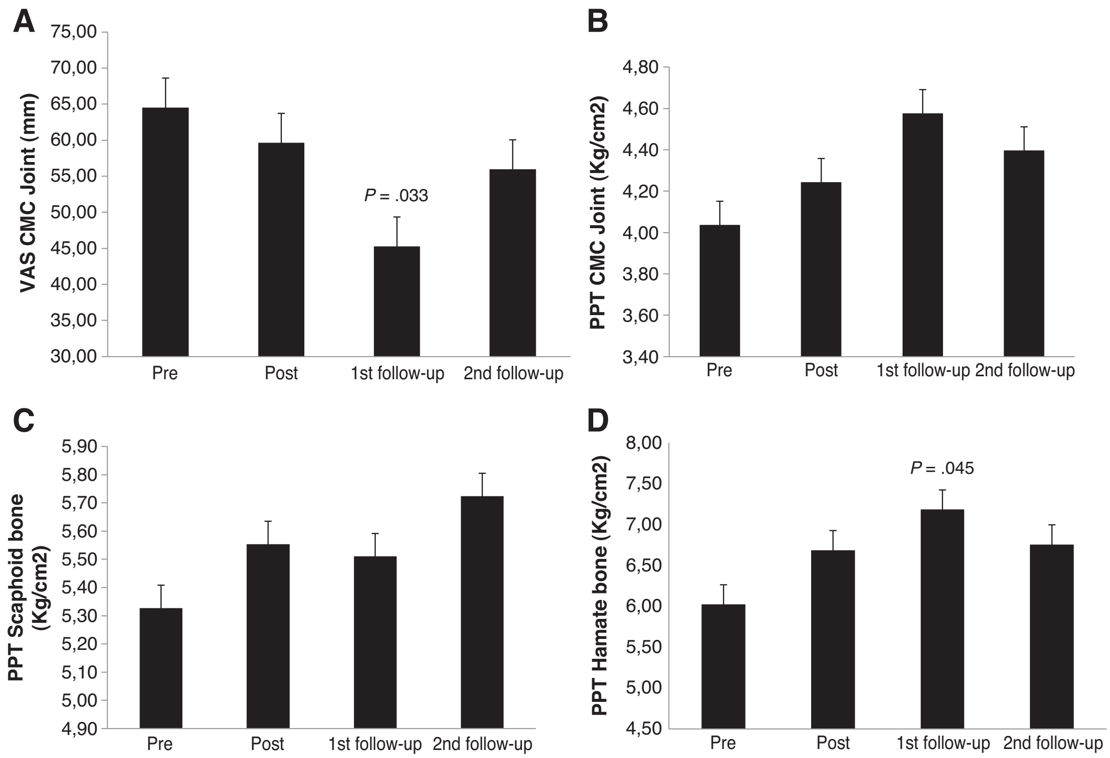

Fig 1. *Effect of PJMs of arm joints on VSA at the CMC joint (A), PPT at the CMC (B), scaphoid bone (C), and hamate bone (D).*

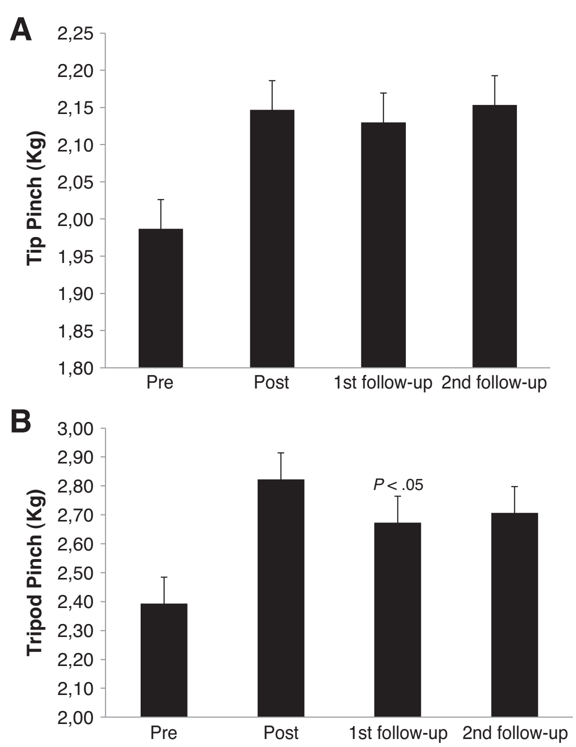

Fig 2. *Effect of PJMs of arm joints on tip pinch (A) and tripod pinch (B).*

that PJM of arm joints may be considered an additional option to physiotherapy treatment applied to patients with secondary CMC OA.

Pain

We found a 30% improvement in pain sensitivity, considered by previous literature to represent a clinically significant difference.[38] Other studies have reported that VAS baseline score was between 34 and 66 mm, where minimal clinical difference in pain is considered a difference of 17.10 mm.[39] Similarly, others considered all pain severity spectrum and reported a minimal clinical difference of 19 mm.[25] Therefore, our results imply the clinical relevance of the treatment.

Pain Mechanical Sensitivity

Increased PPT values were obtained in the CMC joint, scaphoid bone, and hamate bone, demonstrating a reduced sensitivity to mechanical pain in the hand. In fact, PPT values close to the site of injury were demonstrated to reflect sensitization of local mechanical nociceptors.[40] Improvements for CMC joint and scaphoid bone were between 3% and 13%, and based on previous findings, they cannot be retained as clinically significant.[16,25] In contrast, PPT in the hamate bone at the first FU increased by 19%, showing to be superior to the suggested minimal clinical significant change of 15%.[25]

It is relevant to consider that these small improvements were obtained without PJM directed to the injured area; however, the mechanism is still unclear. Many mechanisms can be involved in pain relief, and several theories have been used to explain mechanisms underlying PJM on pain sensitivity.[10,11]

To support reduced pain sensitivity with PJM directed to joints distal to the pathological one, there is some evidence that end-of-range PJM may cause a reduction in distant reflex muscle contraction.[10,41] This reduction in muscle activity is thought to reduce muscle ischemic pain, to reduce muscle tension on periarticular structures, and, as a consequence, to reduce peripheral afferent activity that may provoke pain perception.[10] In fact, similar distal responses have also been observed in animal models.[42]

Additional mechanisms could be also possible. Others sustain that joint mobilizations almost immediately stimulate the dPAG and that, through its noradrenergic system, produces analgesic effect of mechanical nociceptor stimuli.[11] Similarly, studies showed that joint mobilization of the cervical spine had immediate reduced pain sensitivity on noxious mechanical thresholds in the elbows in participants with lateral epicondylalgia.[41,43] In those previous studies, accessory mobilization and high-velocity, low-amplitude manipulation techniques were used,[41,43] whereas we used physiological mobilization. Therefore, we can affirm that our results are in line with their findings.

Motor Effects

Tripod pinch increased posttreatment by 18%; however; this was not maintained until the second FU. In contrast, tip pinch increased in posttreatment by 7% to 8%, and this result was maintained until the second FU. A possible explanation for these results may have to do with central responses. In fact, changes in motor activity may be an additional indication of a centrally mediated response. Animal studies showed that stimulation of the dPAG provoked an increased activity of alpha motor neurons in rats.[44] In humans, accessory mobilization can enhance motor activity alongside hypoalgesic effects by stimulation of the dPAG.[11] Similarly, PJM applied to the cervical spine improved deep neck flexor muscle function in patients with neck pain.[45] Moreover, cervical accessory mobilization[43] or high-velocity and low-amplitude techniques applied to the cervical spine increased also pain-free grip in patients with lateral epicondylalgia.[41] Taken together, the present data may imply that treatment of distal joint-induced beneficial effects in the proximal joint is mediated by central responses, and this could also be the case observed in this study.

Limitations

We recognize that the sample size was small. Because this pathology is often accompanied with depression and neurodegenerative disorders, we had a number of patients with secondary CMC OA that were excluded from the study. We are aware that we only examined the mid short-term effects of arm joint mobilization directed at the secondary CMC OA. Therefore, we cannot affirm that the results will remain in the long term. Studies of long-term effects of arm joints mobilization in secondary CMC OA are also required to confirm our findings. Finally, we recognize that a single treatment procedure does not represent the common clinical practice because patients are usually treated with several mobilizations during their treatment. It would be important to analyze whether inclusion of arm mobilization procedures in clinical practice induces faster and better outcomes. Because conventional physical therapy treatments have found only small improvements,[1,46] it is of crucial importance to investigate new treatments for secondary CMC OA.

Conclusions

This case series found that PJM of upper extremity joints produced pain reduction in the short term and may increase PPT and pinch strength in some patients with dominant-hand CMC OA.

Practical Applications

- Results may be explained by mechanical and neurophysiological mechanisms that underpin PJM.
- This case series found that PJM diminished pain severity and increased PPT and tip pinch in participants with secondary CMC OA.

Funding Sources and Potential Conflicts Of Interest

No funding sources or conflicts of interest were reported for this study.

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