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Scientific/Clinical Article

Effects of client-centered multimodal treatment on impairment, function, and satisfaction of people with thumb carpometacarpal osteoarthritis



Barbara Shankland BSc (OT), MSc, OT(C), erg^{a,*}, Dorcas Beaton BSc (OT), MSc, PhD^b,
Sara Ahmed BSc (PT), MSc, PhD^a, Bernadette Nedelec BSc (OT), PhD, OT(C), erg^a

^a School of Physical and Occupational Therapy, McGill University, Montreal, Quebec, Canada^b Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Ontario, Canada

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ABSTRACT

Study Design: Prepost design.

Introduction: Previous research regarding the non-surgical treatment of thumb carpometacarpal joint osteoarthritis has been based on protocol driven research designs that primarily examined impairment level changes. Exploration is therefore needed to determine the benefits of individually prescribed orthoses, joint protection and assistive device education programs that are based on the activities the person needs to regularly perform.

Purpose of the Study: The primary objective of this study was to examine the effect of client-centered multimodal treatment on activity, participation, impairment, and satisfaction of people with thumb carpometacarpal joint osteoarthritis.

Methods: A total of 60 participants completed the study that used a prepost design. The Canadian Occupational Performance Measure (COPM) was used to identify the participants' performance and satisfaction concerning their self-identified occupational performance issues. Additional outcome measures that were used included the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, total active range of motion (TAROM), lateral pinch strength, and the visual analog scale for pain. All participants completed a client-centered 6-week program that consisted of the use of an orthosis, joint protection, and assistive device education as well as exercises.

Results: At 6 weeks after initiation of treatment, pain, pinch strength, TAROM, the DASH questionnaire and the performance and satisfaction scales of the COPM had significantly improved. The changes in pain, TAROM, and the performance and satisfaction scales of the COPM were all greater than the minimal clinically important difference. The changes in pain and lateral pinch strength were significantly associated with changes in activity and participation.

Discussion: This study demonstrated that a multimodal, client-centered treatment approach resulted in statistically and clinically significant improvement in pain, TAROM and performance and satisfaction as measured by the COPM. The improvement in pain was associated with the participants' improved ability to engage in activities assessed by the DASH.

Conclusions: Our results support the use of client-centered treatment strategies that are targeted to control pain during meaningful activity when working with patients with thumb carpometacarpal joint osteoarthritis therapists.

Level of Evidence: 4.

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Introduction

Osteoarthritis (OA) is a degenerative disease that frequently affects the carpometacarpal (CMC) joint of the thumb. Studies have estimated an incidence of 7% in males, 15% in premenopausal women, and 33% in postmenopausal women.¹ The American College

* Corresponding author. School of Physical and Occupational Therapy, McGill University, 3654 Promenade Sir William Osler, Montreal, Quebec, Canada H3G 1Y5. Tel.: +1 514 398 4400 x1631; fax: +1 514 398 6360.

E-mail address: barbara.shankland@mcgill.ca (B. Shankland).

of Rheumatology and the European League Against Rheumatism have developed conservative treatment guidelines for the care of patients with OA of the thumb CMC joint.^{2,3} Their recommended nonpharmacologic conservative strategies included instruction in joint protection techniques, orthoses, the use of heat before exercises, and the assessment of the ability to perform activities of daily living using assistive devices.^{2,3} Several systematic reviews of the literature that examined conservative management of hand OA^{4–10} concurred with the American College of Rheumatology and European League Against Rheumatism recommendations and concluded that multimodal interventions were particularly effective in treating pain.⁹ Many of the randomized controlled trials examined in the systematic reviews prescribed a specific type of orthosis when determining their efficacy.^{4–12} Because a number of different orthotic designs have been shown to have positive benefits,¹¹ Aebischer et al⁹ recommended that the orthosis should be individually prescribed based on the patient's desired activities; however, this client-centered approach to orthotic prescription has not been specifically investigated.

When providing treatment strategies for clients with thumb CMC joint OA, therapists have tended to focus on impairment-level outcomes.^{13,14} Patients, however, have been found to focus on their ability to participate in meaningful activities rather than impairment-based limitations.¹⁵ Thus, clinical trials should focus on outcomes at both an impairment and an activity and participation level. A systematic review and meta-analysis conducted by Bertozzi et al¹² concluded that there is a paucity of high-level evidence examining “the effects of activity and participation on individuals with CMC OA.”^{12(p2039)} They also recommended that further research should examine patient satisfaction associated with treatment interventions as this has not been adequately investigated.

Client-centered therapy has a strong focus on activity and participation. When using a client-centered approach, the therapist and client work together to identify difficulties in which the person, their occupations, and their environment are taken into consideration to determine optimal treatment approaches and goals.^{16,17} In doing so, the orthosis selection, joint protection education, and recommended assistive devices are all individualized for each client, based on the activities that they want and need to perform. McKee and Rivard¹⁸ reported a case study in which they used a client-centered approach in orthotic fabrication for OA of the thumb CMC joint. They concluded that the client's individual needs must be considered to optimize the benefit from the orthosis. Kjeker¹⁹ performed a Delphi procedure with Norwegian occupational therapists (OTs) working in rheumatology. One of their conclusions was that therapists working in this specialty area should design client-centered exercise programs that encourage patients to remain active in their daily occupations; however, this study did not focus specifically on thumb CMC OA.

Although there is evidence to support a multimodal treatment approach, further exploration is needed to examine the benefits associated with the provision of individually prescribed orthoses and individually tailored joint protection and assistive device education programs that are based on the activities that the person needs to do regularly. In addition, it is necessary to examine the benefits of these approaches at an activity and participation level and to determine the person's satisfaction with the changes after the intervention.

Purpose of the study

The primary objective of this study was to examine the effect of a 6-week client-centered multimodal treatment program on the

activity and participation, impairment, and satisfaction of people with thumb CMC joint OA.

Methods

Study design

A prepost study design was used with assessment points at study entry and 6 weeks after treatment initiation.

Participants

The inclusion criteria for the study were as follows: participants were adults with OA of the CMC joint of the thumb that had been diagnosed by a physician and participants had to be able to communicate in English or French. Participants were excluded if they were receiving concurrent rehabilitation for their thumb CMC OA, if they had a history of thumb CMC joint surgery, or if they had other inflammatory diseases such as rheumatoid arthritis, DeQuervain's tendonitis, carpal tunnel syndrome, or trigger thumb. A publicity letter for the study was sent to rheumatologists, plastic surgeons, and OTs who treat patients with thumb CMC OA in the Greater Montreal area. The study was also announced on the Web site of the Canadian Arthritis Society. Approval for the study was obtained from the McGill Institutional Review Board and the ethics committee of Maisonneuve Rosemont Hospital in Montreal.

Study procedure

Initial visit

Participants who met the inclusion criteria were approached by an assistant who explained the study objectives and determined whether they wished to participate. If they accepted, a consent form was signed. A total of 3 visits were required for each participant. The visits occurred at study entry, 3 weeks, and 6 weeks. No fees were charged for any of the services provided. All clinical assessments and treatments were carried out by the first author who is a member of the Ordre des ergothérapeutes du Québec. The orthoses were made by a qualified orthotist under the supervision of the OT (as this was the current practice due to financial reimbursement regulations).

An initial interview was conducted to obtain demographic data, a history of the condition, and information regarding the participant's home and work environment. Participants were asked to identify occupational performance issues related to their thumb CMC joint OA by using the Canadian Occupational Performance Measure (COPM).²⁰ The COPM was selected because it is a measure based on client-centered practice that is designed for use by occupational therapists to assess client outcomes in the areas of self-care, productivity and leisure.^{20(p83)} The COPM measures changes in the participants' satisfaction and performance related to their self-identified occupational performance issues. A systematic review of the literature by Parker and Sykes²¹ concluded that the COPM facilitates the development of client-centered goals and establishes a partnership between the therapist and the client. The COPM has been found to have good reliability, and its validity has been established with a hand OA population.^{17,20} The COPM was administered as follows: (1) using a semistructured interview, participants identified occupational performance issues that were divided into self-care, leisure, and productivity, (2) each of the identified items was then weighed on a 1–10 scale based on the level of importance the activity had to the participant, (3) the 5 most heavily weighted items were then identified and rated on a 1–10 scale based on self-perceived performance and satisfaction when carrying out the activity.²⁰

In addition to the COPM, the Disabilities of the Arm, Shoulder and Hand (DASH)²² questionnaire was completed to measure the change in upper extremity activity and participation after the client-centered intervention. The DASH is a 30-item self-report questionnaire in which a score ranging from 0 to 100 is obtained. The results of a study by Dixon et al²³ indicated that the DASH contains 19 activity limitation items, 3 participation restriction items, and 7 items that measure both activity limitations and participation restrictions. Content validity and responsiveness were found to be excellent. Test-retest reliability, construct validity, and internal consistency were found to be good.²² The French-Canadian version of the DASH has demonstrated good internal consistency and item-to-item correlations.²⁴

Baseline measurements for pain were obtained using a visual analog scale (VAS). Participants indicated the intensity of their pain by marking a 10 cm line that was anchored by the statements *no pain at all* and *the worst pain imaginable*. Thumb total active range of motion (TAROM) was measured using a finger goniometer. During measurement, the upper extremity was positioned with the elbow flexed to 90°, forearm in neutral rotation, and wrist in a neutral position. To measure flexion and extension of the thumb joints, the goniometer was placed on the dorsal aspect. To measure hyperextension, the goniometer was placed on the volar aspect.²⁵ One trial of lateral pinch strength was carried out using a calibrated B&L pinch gauge (B&L Engineering, Santa Ana, CA). To minimize the demand of forceful effort placed on a thumb with OA, no preliminary trials were carried out. During the measurement of lateral pinch strength, the participant's shoulder was maintained in a neutral posture, elbow was flexed to 90° with neutral forearm rotation, and wrist was placed in slight extension. The participant held the pinch gauge between the pulp of the thumb and the radial aspect of the index finger, which was positioned in flexion.²⁶ To reduce loading on the CMC joint, it was decided that only lateral pinch would be assessed.

Initial visit interventions

The 6-week treatment program was initiated at study entry. The client-centered interventions consisted of patient education about joint protection and assistive devices and the fabrication of an orthosis. Participants also received instruction in performing a standard set of exercises to facilitate CMC joint stability and pinch strength.

Using a client-centered approach, the participant and therapist worked together to determine which thumb CMC OA orthotic design, wearing schedule, and materials were best suited for the participant's occupational needs. Materials that were used included 1/16 inch thermoplastic, neoprene, and leather. The orthotic designs that were used included the following: (1) a thermoplastic short thumb spica that immobilized the thumb metacarpophalangeal (MP) joint in 30° of flexion and the CMC joint in enough opposition to permit the distal phalanx to touch the index finger, (2) a hand-based orthosis with the MP joint of the thumb left free, as described by Colditz,²⁷ made of a hybrid thermoplastic-neoprene material, (3) a leather hand-based orthosis with the MP joint at 30° of flexion, and (4) a forearm-based thermoplastic orthosis that held the wrist in a neutral position and the thumb MP joint at 30° of flexion. Participants with thumb MP joint hyperextension during pinching activities generally preferred to have the joint immobilized by the orthosis to enhance stability. The hybrid neoprene-thermoplastic design that left the MP joint free was preferred by participants who used a computer mouse on a regular basis. The leather orthosis was selected to provide durability during heavy daily activities. The orthosis that immobilized the wrist and thumb was used by a participant who complained of severe constant pain and demonstrated significant deformity of the thumb CMC joint due to

subluxation of the first metacarpal. Participants were asked to record the number of hours per day that they used their orthosis.

Joint protection education was based on the principles of client-centered practice. Instructions were customized to address the problematic activities in self-care, leisure, and productivity identified in the COPM.

Evidence-based thumb exercises were selected to target thumb stability and strength.²⁸ They included the following: (1) squeezing an imaginary ball with the thumb in an abducted position, (2) placing and holding the thumb and little finger in opposition, (3) isometric strengthening of the abductor pollicis longus by applying resistance to the proximal phalanx of the thumb during thumb abduction, and (4) isometric strengthening of the first dorsal interosseous muscle by applying resistance to the proximal phalanx of the index finger during abduction.²⁸ Participants were advised that exercises should not be painful. Accordingly, the frequency and intensity of the exercises were individualized based on the participant's tolerance. Participants were asked to complete a daily log sheet to monitor treatment adherence to their exercises.

Three-week follow-up visit

A follow-up visit was carried out with the participant at 3 weeks to reinforce the joint protection techniques that were provided and to ensure that they were being incorporated into the participant's daily activities. This visit also provided an opportunity to problem solve through activities where barriers had been encountered by the participants when trying to incorporate the joint protection principles. Strengthening exercises were reviewed, and a verification of the orthosis was carried out to ensure that it was comfortable and being worn appropriately.

Six-week visit

At the 6-week visit, participants returned their daily log sheet, and the following outcome measures were repeated: COPM, DASH, thumb TAROM, lateral pinch strength, and pain VAS. Participants were encouraged to continue with management of their thumb CMC joint OA using the treatment strategies that had been provided.

Statistical analyses

Before the initiation of the study, calculations were performed to confirm that an 80% power level was obtained with a sample size of 60.²⁹ The primary outcome was the DASH. The COPM, pain, TAROM, and pinch strength were secondary outcome measures. Basic demographic data of participants and treatment adherence data have been summarized by means, standard deviations, frequency, and percentage. A *t* test for paired data was used to examine the changes in the outcome measures between baseline and 6 weeks. A multiple regression model was used to investigate the effects of pain (VAS) and lateral pinch (lb) at baseline and 6 weeks with respect to changes in activity and participation as defined by the DASH score at 6 weeks minus the DASH score at baseline. Adjustments were made for the variables sex, age, and medication use. Adjustments were also made for possible differences in the DASH score at 6 weeks minus the DASH score at baseline by using it as a covariate in the model. All hypotheses tests were 2-sided, and significance was set at the .05 level. All analyses were performed using SAS, version 9.2 (SAS, Toronto, Ontario, Canada).

Results

Participant characteristics

A total of 72 participants were recruited for the study between 2012 and 2015. There were 12 dropouts due to illness or difficulty

Table 1
Summary of study participants (*n* = 60)

Description of participants	Mean (standard deviation)
Age	63.2 (8.7) y
Gender	Frequency (%) Female: 56 (93) Male: 4 (7)
Handedness	Right-handed: 59 (98) Left-handed: 1 (2)
Right hand treated in study	19 (32)
Left hand treated in study	15 (25)
Both hands treated in study	26 (43)
Type of medication	
Analgesic (acetaminophen)	18 (30)
Nonsteroidal anti-inflammatory drugs	20 (33)
Steroid injection	13 (22)
None	9 (15)

traveling to the follow-up appointments. Of the 60 participants who completed the study, 4 were males and 56 were females. The mean age was 63.2 years. All but one of the participants were right handed. A total of 19 participants were treated for the right hand, 15 for the left hand, and 26 for both hands. When questioned about their use of medications, 18 of the participants reported using acetaminophen, 20 participants used nonsteroidal anti-inflammatory drugs, 13 had received a thumb CMC joint steroid injection within the past 6 months, and 9 used no medication at all.

A summary of the participant demographics may be found in [Table 1](#).

Client-centered intervention

All participants reported that they completed the prescribed exercises. The results showed that 58 participants completed their exercises once a day, 1 participant completed their exercises twice a day, and 1 participant completed their exercises 3 times a day. During the visit at 3 weeks, each participant provided examples of how they were incorporating joint protection techniques when performing daily activities (eg, using a pillow to support a book when reading in bed, using an assistive device to open jars, taking breaks more often while knitting, carrying a bag on their shoulder rather than using their hand, etc.). The mean number of hours per day of orthotic use was 9.3 hours with a range from 0.5 to 22.5 hours. The most common reasons for not using the orthosis were the following: did not want to handle food while wearing an orthosis, found that the orthosis made the hand feel hot, and/or found the orthosis too rigid. Some participants also reduced their usage because they

felt that their pain had improved. Forty-four participants used a thermoplastic short thumb spica that immobilized the thumb MP joint in 30° of flexion and the CMC joint in enough opposition to permit the distal phalanx to touch the index finger. Thirteen participants used a hybrid thermoplastic-neoprene hand-based orthosis with the MP joint of the thumb left free. One participant used a leather hand-based orthosis with the MP joint at 30° of flexion, and 2 participants used a thermoplastic orthosis that held the wrist in a neutral position and the thumb MP joint at 0° of flexion.

Outcome measurements

All outcome measurements demonstrated statistically significant improvement from baseline to 6 weeks. Changes in the pain VAS, COPM scores, and TAROM scores were above the minimal clinically important difference (MCID).^{17,30–33} A summary of the mean raw scores, standard deviation values, change between baseline and 6 weeks, *P* values, and MCID values can be found in [Table 2](#).

The results of the multiple regression analysis demonstrated that, after adjusting for age, sex, and medication use, pain (VAS) at 6 weeks had a statistically significant positive association with changes in activity and participation (DASH). In particular, a 1-unit (1 cm) improvement in pain (VAS) at 6 weeks was associated with a 3.4-point improvement in the mean DASH score. The lateral pinch strength value at 6 weeks also had a statistically significant association with changes in activity and participation (DASH). A 0.87-point decrease in the DASH score was associated with every 1-unit (1 lb) increase in the lateral pinch score. The effects of sex and medication use were not significant. The effects of age were significant. A summary of the results may be found in [Table 3](#).

Discussion

This study examined the effect of client-centered multimodal treatment on impairment, function, and satisfaction of people with thumb CMC joint OA. A 6-week intervention was carried out that provided an orthosis, assistive devices, and client education based on the participant's occupational performance needs. Exercises were prescribed to address thumb strength and stability. Quantitative analysis demonstrated improvement in activity and participation, pain, TAROM, pinch strength, and client satisfaction with this approach. Furthermore, improvements in pain and pinch strength were associated with improvements in activity and participation.

The results demonstrated that from 0 to 6 weeks if there was a 1-unit (1 cm) change in pain (VAS), there would be an associated

Table 2
Summary of outcome measure results

Outcome measure	Raw score: baseline (mean and standard deviation)	Raw score: 6 wk (mean and standard deviation)	Change in raw score	<i>P</i> ^b	MCID (reference)
DASH ^a	43.1 (16.8)	33.8 (16.1)	−9.3	<.0001	15 ³⁴
VAS (cm)	5.3 (2.2)	3.4 (1.9)	−1.9	.0001	0.9 ³⁰
Lateral pinch (lb)	8.4 (4.0)	9.9 (4.5)	1.5	.0013	2.2 ³³
COPM Performance Scale (points)	3.9 (1.5)	6.4 (1.7)	2.5	<.0001	2 ¹⁷
COPM Satisfaction Scale (points)	3.5 (1.5)	6.3 (1.9)	2.8	<.0001	2 ¹⁷
TAROM (°) left hand	114.7 (16.2)	123.1 (14.7)	8.4	.0001	5 ³²
TAROM (°) right hand	112.4 (20.6)	120.3 (17.0)	7.9	.003	5 ³²

MCID = minimal clinically important difference; DASH = Disabilities of the Arm, Shoulder and Hand; VAS = visual analog scale; COPM = Canadian Occupational Performance Measure; TAROM = total active range of motion.

^a A lower DASH score indicates a higher level of activity and participation.

^b Denotes statistically significant *P*.

Table 3

Multiple regression analysis results (effects of pain and lateral pinch strength at baseline and 6 weeks with respect to changes in activity and participation as defined by DASH score 6 weeks–DASH score baseline)

Effect	Estimate (β)	Standard error	T	P
VAS 0 wk	0.32	0.68	0.48	.63
VAS 6 wk	3.4	0.74	4.52	<.0001 ^a
Lateral pinch 0 wk	0.09	0.55	–0.18	.86
Lateral pinch 6 wk	–0.87	0.43	–2.01	.05 ^a
Age	0.4	0.18	2.27	.03 ^a
Sex	1.4	5.4	0.25	.8
Medication (analgesic)	–3.8	4.1	–0.91	.4
Medication (anti-inflammatory)	–2.3	4.0	–0.58	.5
Medication (steroid injection)	–0.14	4.3	–0.03	1.0

DASH = Disabilities of the Arm, Shoulder and Hand; VAS = visual analog scale.

^a Denotes statistically significant P value.

3.4-point change in the DASH score. This result was statistically significant. The mean VAS score decreased by 1.9 cm between study entry and 6 weeks. This change in the VAS score was greater than the MCID³⁰ and statistically significant. The decrease in the DASH score was statistically significant but not greater than the MCID.^{23–32,34} Based on the results of this study, if the ratio of change remained stable, a 4.4-cm change in the VAS would be necessary to generate an MCID in the DASH.

Orthoses for thumb CMC joint OA have been shown to reduce pain.^{27,35,36} In studies examining the efficacy of a thumb orthosis for CMC joint OA, Rannou et al³⁵ had results demonstrating a mean VAS change of 2.22 cm from baseline to 1 year, whereas Gomes Carreira et al³⁶ had a mean VAS change of 1.4 cm from baseline to 180 days. Boustedt et al³⁷ reported a mean VAS change of 1.7 cm and a 10-point change in the DASH score at 1 year after a joint protection education program, home exercises, and the use of an orthosis. Of note, none of the reported changes in VAS scores was above 4 cm, and the DASH score change that was reported by Boustedt et al³⁷ was not greater than the MCID. Thus, previously published results followed the same pattern as those of this study, supporting the conclusion that a client-centered approach where the prescribed orthosis is based on the person's activities achieves comparable results.

The lateral pinch results of this study demonstrated that a 1-unit (1 lb) increase in lateral pinch strength at 6 weeks resulted in a statistically significant 0.87-point decrease in the DASH score. The change in the lateral pinch strength and the change in the DASH score were below the MCID. A period of 6 weeks may be considered too brief when trying to effect significant change in strength with a chronic condition. In their studies of orthosis efficacy for thumb CMC joint OA, Rannou et al³⁵ demonstrated a 5.1 N (1.15 lb-force) increase in lateral pinch strength at 1 month. Gomes Carreira et al³⁶ reported a pinch strength change of 1.76 lb at 6 months. After a 4-month hand-strengthening program for participants with hand OA, Rogers and Wilder³⁸ had a 0.04 lb difference in lateral pinch strength. Boustedt et al³⁷ in their 1-year follow-up results showed a 10-point change in the DASH and a 3 N (0.67 lbs-force) decrease in the lateral pinch strength. Their interventions were carried out for 5 weeks only, and no written log was used to record adherence to the exercise program; thus, there is no documented confirmation of adherence to the exercise program. Participants were allowed to continue with the use of their orthosis for the 1-year follow-up period, which may have facilitated pain control, activity, and participation, which may in part account for the change in the DASH score. The differences between this study and those reported in the literature may be explained by the difference in timelines.

The client-centered approach in this study was facilitated by the use of the COPM. Occupational performance issues were identified at baseline and helped to focus the treatment interventions. This approach differs from a more protocol-driven approach in which the same orthosis and the same list of joint protection techniques are provided to all clients with thumb CMC OA. The benefits of a client-centered approach were supported by the results of this study, which demonstrated statistically significant change and MCID of pain, TAROM, and the satisfaction and performance scores of the COPM between baseline and 6 weeks. Greater client satisfaction may be explained by the fact that the activities showing improvement after the intervention were those that were meaningful to the participant.

This study had several limitations that are described as follows:

- (1) *Grade of OA unknown*: Because it was not possible to have access to the radiology reports, the thumb CMC OA severity grade was unknown. It is possible that participants with a more severe grade would have had greater pain and less strength. Thus, the impact of the treatment intervention on pain and strength may not have been the same for participants with different grades of thumb CMC OA.
- (2) *No objective measurement of adherence to joint protection techniques*: Although participants were debriefed regarding their utilization of joint protection techniques, there was no objective recording method to evaluate adherence to this intervention. Use of a daily journal focusing more specifically on occupational performance issues may be helpful in similar studies in the future. A lower level of adherence could affect the change in pain, strength, activity, and participation.
- (3) *No control group*: Although it is a reasonable assumption that participants would improve with an intervention, the lack of a control group in this study limits the ability to make any cause-effect conclusions. In addition, with no control group, it is not possible to rule out contamination from other treatment influences such as medication.
- (4) *No outcome measures were obtained for tripod pinch and grip strength*: In this study, changes in strength were based on 1 outcome measure only.
- (5) *The level of evidence of this study is low*.

Despite the limitations, this study had several strengths:

- (1) *Different outcome measures*: This study used a variety of outcome measures to examine change after a 6-week client-centered intervention for participants with thumb CMC OA, which allowed for the comparison of impairment changes with activity and participation changes.
- (2) *Longitudinal data*: The longitudinal design allowed for data collection that documented the change in pain, strength, TAROM, activity, and participation subsequent to a 6-week client-centered intervention for participants with thumb CMC OA.

Conclusions

The results of this study demonstrated that a 6-week multimodal client-centered treatment approach resulted in statistically and clinically significant improvement in pain, TAROM, and performance and satisfaction scales of the COPM where the improvement in pain was associated with improvements in activity and participation as measured by change in the DASH. Our results support the use of client-centered treatment strategies that are targeted to control pain during meaningful activity when working with clients with thumb CMC joint OA. Individualized programs may facilitate the client's self-management of their chronic condition.

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Quiz: #491

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- #1. The primary outcome measure was the
 - a. DASH
 - b. COPM
 - c. ASHT Patient Satisfaction Scale
 - d. Mayo Clinic Outcome Measure
- #2. To be considered significant the changes in pre-post testing had to be
 - a. 25% improved
 - b. 50% improved
 - c. less than or equal to the MCID
 - d. greater than the MCID
- #3. Patients with a history of surgery on the thumb CMC were
 - a. considered excellent subjects for inclusion in the study

- b. considered unreliable
 - c. excluded from the study
 - d. included if the surgery was on the non-dominant thumb
- #4. The therapeutic intervention included
 - a. biofeedback, kinesio-taping, immobilization splinting, and exercises
 - b. an orthotic device, joint protection instruction, assistive devices, and exercises
 - c. exercises, an orthotic device, and mirror therapy
 - d. proprioceptive training, strengthening, and ROM exercises
- #5. The study suggests that hand therapy (as described in the article) had a significant benefit to patients with thumb CMC OA
 - a. true
 - b. false

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