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Effects of a dynamic stability approach in conservative intervention of the carpometacarpal joint of the thumb: A retrospective study

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ABSTRACT

Study design: Retrospective cohort.
Introduction: Conservative intervention of carpometacarpal joint (CMC) thumb pain, caused by osteoarthritis and ligament laxity, is frequently seen in hand therapy. Traditional intervention for pain and disability reduction includes orthoses, exercises, and joint protection education. The literature on conservative management is unclear which design or program of exercises create an effective result. Results of a conservative dynamic stability interventional model for thumb pain are presented as a design which positively effects pain and disability.
Purpose of the study: The purposes were to primarily investigate change in pain and disability in persons with CMC pain in a dynamic stability modeled approach to intervention, and secondarily, to assess the average number of visits and the duration of total visits in this model.
Methods: A retrospective chart review was completed on 35 charts of those seen at a multicenter hand therapy clinic. The pain and disability scores from the QuickDASH were used as outcome measures.
Results: The average group pain and disability scores improved by 17.9% ($p < .01$) and 19.3% ($p < .01$) respectively, with average individual disability improvement of 15.7%, which is greater than the accepted MCID. The average patient visits were 2.37 over an average range of 44.5 days. The group demographics match current literature: 31 females to 4 males, with average age of 58 years (range of 30–82 years).
Conclusion: Significant reduction in pain and disability is noted with a conservative dynamic stability modeled approach to intervention, with information on average visits and duration in this model of care for individuals with thumb pain at the CMC joint.
Level of evidence: 4.

Introduction

The pain located at the 1st carpometacarpal joint (CMC) continues to be the enigma of both hand therapists and hand surgeons. Thumb pain contributes to the performance dysfunction in all aspects of activities of daily living, work, and leisure.[1] The prevalence of hand osteoarthritis (OA) is greater in elderly females than males, with the 1st CMC being the most reported painful joint compared with all other hand OA pain.[2] Theis et al.[3] report that arthritis has a significant effect on the U.S. population in terms of work, psychological well-being, and life satisfaction. Radiographic osteoarthritis of the hand is correlated with pain and disability, especially in the dominant hand.[4] Thumb pain from ligament injuries and CMC OA are frequently treated by hand therapists and surgeons. Hypermobility or ligament laxity at the CMC thumb joint is only one of several factors that can lead to the development of CMC joint arthrosis.[5–9] Opposition and pinching exacerbates pressure on the dorsoradial facet of the trapezium, and even a laxity of 1–2 mm may lead to the development of arthrosis, further compromising the function of the thumb. Due to this arthrosis, the 1st CMC is the most common surgical reconstructive site for OA.[10]

Traditionally, conservative measures for thumb CMC in the literature focus in 3 areas: orthotic support, exercise, and joint protection education (JPE) to reduce pain and improve function.[11] Prior studies have demonstrated pain reduction with CMC stabilization orthoses.[12–14] Rannou[15] found pain reduction with long-term wear of a nighttime CMC orthosis. Berggren et al.[16] found

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the addition of a CMC orthosis significantly reduced the number of persons requesting CMC arthroplasty surgery.

Studies have found hand exercise in general reduced pain associated with hand OA.[17–19] Three recent systematic reviews (SR) of orthotics and exercises in the intervention of hand OA, including CMC, have been published. Valdes and Marik[20] found moderate evidence that hand exercises improve pain and hand function. Ye et al.[21] found contrary evidence that hand strengthening exercises, which while recommended, have not yet demonstrated pain reduction. Kjeken et al.[22] found no specific recommendations available for the design of specific hand exercise programs in regards to hand OA, and recommends future research is necessary to determine if a specific exercise design has a beneficial effect on hand OA.

Studies, which are specific to the CMC and which include orthoses and exercise, report pain reduction and functional improvement. A systematic review found CMC orthoses to provide pain reduction, but did not find one more effective than another.[23] Wajon and Ada's[24] comparative study of an experimental thumb orthosis and palmar abduction exercise, to a short opponens orthosis and pinch exercise regime found both reduced pain and improved function. Boustedt et al.[25] found a combination of orthoses, general hand exercises and the inclusion of JPE reduced pain and improved function. While these studies have demonstrated improvement in pain and function, there remains a paucity of information of the most effective exercises, or exercise design, for the CMC area.

Biomechanical studies have highlighted the importance of muscle and osseous stability for the CMC. The biomechanical studies of Brand and Hollister[26] highlighted the importance of the 1st DI as the "lateral thenar muscle," which found that when the "muscles of the thumb were loaded in the position of lateral pinch, removing tension from the first dorsal interosseous resulted in radial subluxation of the CMC joint, which relocated following restoration of the tension to the first dorsal interosseous."[26(p294,295)] A recent EMG study of muscle activation of persons with and without hand OA during of hand dexterity tasks do activate the 1st DI, although persons with hand OA have weaker 1st DI muscle strength, and took longer to complete the tasks.[27] Moulton found the CMC to be most congruent, unloading the volar surface of the trapezium, when the metacarpophalangeal joint (MCP) is positioned at 30° flexion.[6]

The thumb, being the most mobile joint of the hand, requires dynamic stability for its mobility and strength derived from the muscular, osseous and ligamentous systems. Pellegrini states strengthening of the thenars, with the long abductor (APL) and long extensor (EPL), is beneficial in maintaining dynamic stability of the basal thumb joint complex.[11] Boutan found the opponens and 1st DI to have a force couple effect on the base of the 1st metacarpal, and the 1st DI to be a thumb muscle "in its own right," most active during dynamic closed kinetic chain prehensile activities.[28] Taylor describes dynamic stability of the CMC as use of the thumb muscles during function to stabilize the joint and reduce or prevent subluxating shear forces. She also advocates thumb web space restoration, and orthotic support.[29] Neuman and Bielefield[30] note the goal of resistive exercises about the CMC is to promote "muscular-based stability" and functional strength. The above articles do not name the 1st DI in their descriptions of dynamic, or muscular-based, stabilization. Albrecht[31] describes a dynamic stability modeled approach to conservative intervention for persons with a painful thumb. The intervention emphasizes 1st web space restoration, exercises which focus on neuromuscular re-education with an emphasis on the 1st DI, and including the intrinsic and extrinsic thumb muscles for pain-free, thumb movement and function, joint mobilization to improve congruency at the CMC, fitting of appropriate orthoses as needed, and JPE. The hand clinic at our facility has empirically used the dynamic stability modeled approach as described by Albrecht since 2000. Clinically, these patients report pain reduction and functional improvement.

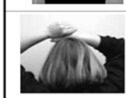
Dynamic stability rehabilitation intervention has been described for other body regions, such as the shoulder and the knee. Dynamic stability is defined as pain-free function during stressful activities in the face of lax or injured ligaments.[32–34] Dynamic joint stability is dependent on many factors, including rapid synchronized muscle activation. Even among patients who are traditionally considered to have hypermobile or even unstable joints, such as overhead athletes and ACL deficient athletes, normal function may be maintained through the enhancement of dynamic joint stability.[35–39] Evidence is emerging that dynamic stability intervention models are more effective than traditional strengthening exercise models for return to function and sport in the presence of joint hypermobility.[40]

Despite favorable clinical outcomes in our facility for persons with thumb pain, little information exists regarding clinical research of this approach to conservative management of CMC pain. In a first step to establish evidence of this intervention, a retrospective study was completed to investigate the clinical findings of our patients with thumb pain. The primary purpose of this retrospective study is to investigate the change in pain and disability for patients with CMC thumb pain who participated in a dynamic stability modeled approach of intervention.

Since little information exists in the literature for the number of visits and over what time frame a conservative thumb CMC intervention program can be effectively conveyed, a secondary outcome was decided upon in the course of data analysis. This is related to the important question of dosage for hand therapy interventions.[41] Prospective studies of conservative intervention have found change in pain and function from as few as 2 visits over 2 weeks,[13] to 4 visits over 9 weeks.[14] Due to the sparseness of prospective studies and lack of retrospective studies on conservative thumb CMC intervention, it was interesting to the primary author to find if a dynamic stability modeled approach to conservative intervention matched previous reports of dosage. Thus, the secondary outcome of ascertaining the average total number of visits and date range of intervention was established.

Methods

The concept of dynamic stability modeled approach to intervention for the thumb pain has been used by a group of hand therapists working in multiple clinics of a large metropolitan health system since 2000. The dynamic stability modeled approach is described as: restoration of the thumb web space, re-education of the intrinsic and extrinsic thumb muscles, with an emphasis on the 1st DI and thumb opponens, abductors, and extensors for restoration of a stable, congruent CMC position, joint mobilization for pain control, muscle strengthening to reinforce muscle patterns which maintain joint stability, orthotic fabrication to stabilize the CMC as necessary, along with the traditional interventions of JPE and adaptive equipment use (Fig. 1). All orthoses fabricated in this modeled approach, stabilize the CMC. The type of specific orthosis is not controlled for, or mandated, but fabricated to fit the anatomy and functional needs of the patient as determined in the evaluation. This scenario is played out in most any hand therapy clinic where intervention for thumb pain occurs. Hallmarks of this approach are the emphasis of the 1st DI as a thenar muscle, muscle re-education in pain-free intervention, and a plan to wean from orthoses when stability and pain free function has been restored. Instruction in dynamic stability has been through continuing education and therapist to therapist informational exchange. Some hand specialist physicians have also been

Techniques	Progress	When patient is able to pinch without pain while not wearing orthosis, it's time to begin to wean from orthosis, resuming wear temporarily if pain returns or for heavy activity.
	Pain 0-10 without orthosis During daily activity: At rest: Lbs. pinched:	Record Pain level reported by patient during activity and at rest while not wearing an orthosis. Record #Lbs. pinched. ("Pinching" is not part of this thumb program, so **defer** further testing during the next two-four sessions, use only Pain-Free pinch testing.)
	Pain 0-10 wearing orthosis Daily activity: At rest: Lbs. pinched:	Record Pain level as above but while wearing orthosis. Describe type of orthosis: Forearm-based, Hand-based, Palm-based, Thenar-based - with or without MP extension block.
	Opposition: Kapandji Scale 0-10/10	Thumb Tip to: Index P1(0) Index P2(1) lateral side of Index P3(2) Index tip(3) long tip(4) ring tip(5) small tip(6) DIP crease(7) PIP crease(8) MP crease(9) Distal Palmar Crease(10)
	Adductor Muscle Release: Pressure, contract-relax, fascial stretching	Record method(s) taught: Pressure to adductor by pinching with opposite thumb or clip, contract-relax with stretch, or manual release. (Picture: Firmly engage web spaces and extend fingers and thumbs to feel stretching of tissues. Hold for 30 seconds. Repeat.)
	Web Space Comparison: After Adductor Release	Report patient's success or failure to widen webspace immediately after performing techniques above.
	Mobilization: Distraction	Instruct patient to grasp involved thumb with opposite hand behind back. Let the weight of the arms distract the joint. Can be done behind back or in front if more comfortable. (Sometimes shoulders are arthritic and painful)
	Mobilization: Reduce dorsal subluxing	Instruct patient to rest involved CMC joint atop skull, insert opposite thumb in webspace, or with gentle self traction on thumb column, hold hand gently and rock it forward and back for 1 to 3 or more minutes. It may feel a bit uncomfortable, but it will be worth it.
	Mobilization: Retro-position	Instruct patient to reach across dorsum of involved hand, wrap fingers around the length of the 1st metacarpal, press hand to chest and gently loosen CMC joint by rolling the involved thumb away from chest. Hold for 1 to 3 or more minutes.
	Strengthening: 1st Dorsal Interosseous	Move the 1st Dorsal Interosseous through full abduction and adduction. Progress: first AROM, then light resistance (rubber band) 10-15x-3x/day, then against maximum resistance: 10-12 times 1x/day.
	"C" Position Strengthening: EPB, ABPB, Opponens	Repeat the same technique while abducting thumb and moving toward opposition. Begin with a light weight rubber band to isolate action,10-15x-3x/day. Progress to use of opposite hand to provide maximum resistance through full range of motion. 10-12 times/once a day
	Place and Hold	Place thumb in opposition to fingertips. Begin to pinch. If MP starts to collapse, Stop. Repeat place and hold until muscles have retrained to perform a firm tip pinch.
	Proprioceptive/Kinesthetic training: Textile Taping For Day and/or Night	Perform a "trial" of textile taping to test for skin tolerance and response. Inform patient of precautions and correct self application and removal of tape.
	Joint Protection Education & Adaptive Equipment	Based on patient's work and leisure activities, teach joint protection techniques. Keep a supply of Adaptive Equipment for patients to test. Provide suggestions about where to find equipment in stores.
Therapist:		

NOTES: "Shoulder" "Zig-Zag" "Reverse Zig-Zag" Interventions: NSAIDS? INJECTIONS? SURGERY? Diagnosis: OA or other or mixed

Fig. 1. Dynamic stability program handout used at Fairview Hand Center.

instructed in the dynamic stability modeled approach which has resulted in specific referrals for this interventional approach.

The date range of the chart review of all patients seen at 7 hand therapy clinics was August 1, 2009 to January 1, 2011 (a total of 17 months). The specific ICD-9 diagnosis codes of 729.5 (upper limb pain), and 715.94 (generalized osteoarthritis of the hand), were chosen for the closest specificity to thumb pain and thumb arthritis. In these clinics, the therapists choose their own therapy diagnosis codes, if the codes are not specified by the referring physician. The specificity of ICD-9 is vague regarding CMC joint pain, thus the more general diagnosis codes are used. Also, the electronic chart retrieval system used was not able to separate out the letter suffixes of the ICD-9 codes, which could have improved the specificity of the chart retrieval. In addition, there was no prior specific mandate by the hand clinics administration with regards to coding for patients with CMC joint pain or thumb arthritis, and no diagnosis code specialists are employed by this department of hand therapy.

Permission was obtained from the Human Research Protection Program of the University of Minnesota's Institutional Review Board to complete this retrospective chart review (IRB # 1107M02341). The initial chart review produced 455 charts. The charts were then hand sorted by the primary author to eliminate those with surgical intervention, and those with more than a singular diagnosis of thumb CMC OA; such as carpal tunnel syndrome, deQuervain's, wrist OA, wrist pain, finger OA, finger pain and any other joint disorders of the elbow, forearm or shoulder. Any charts with the singular diagnosis of thumb CMC OA or pain, bilateral or unilateral, were included in the chart review. All charts reviewed were of adult age. Our age range was from 30 to 82 years, with the average age of 58 years. A 90-day limit between visits was applied due to facility standard of care: a new episode of care is initiated for each person who returns to therapy greater than 90 days after the last visit. After the hand sorting, time limits being applied, and all multiple diagnoses excluded, 35 charts remained for analysis.

The QuickDASH, the 11 question short form of the 30 question Disabilities of the Arm, Shoulder and Hand (DASH), is the self-administered outcome tool used at our hand therapy clinics. The QuickDASH is an outcome tool designed to measure physical function and symptoms in persons with musculoskeletal disorders (MSDs) of the upper limb.[42(p165,166)] The QuickDASH does not have a set age limit, although general guidelines are adults from 16 to 65 years of age. It has 3 modules: disability/symptoms; sports/performing arts; and work.[42] Only the disability/symptom module was used for all charts in this study. All charts in this study had completed QuickDASH at least 2 times in the course of their intervention. The pain scale and total disability ratings of the QuickDASH were used to measure patient-rated change. Scores were retrieved from the initial and the latest, or last QuickDASH recorded in the episode of care, completed at a clinically appropriate status change, such as progress note or discharge.

The QuickDASH has been shown to be reliable, valid, and responsive to change in upper limb musculoskeletal diagnoses.[43–47] The QuickDASH has been found to correlate strongly with its original form, the DASH, with an ICC = 0.96 (0.84–0.98) in persons with upper limb disorders, including CMC OA.[43] The test–retest reliability of the DASH has been found to have a high interclass correlation coefficient ($ICC_{2,1} = 0.96$), and has been found to have strong correlation with the visual analog scale (VAS) of pain, with construct validity ranging from $r = 0.65$ to [Spearman correlation] $r_s = 0.72$.[45] The DASH has been found to have a strong construct validity with other measures of disease or joint specific upper extremity function, such as the Patient Rated Wrist Hand Evaluation (Pearson correlation of $r = 0.82$) in patients with OA of the CMC thumb joint following arthroplasty.[48] Fan et al.[49] compared the QuickDASH to the Physical Component Score (PCS) of the SF-12. This study compared workers with clinical findings of MSDs in several areas: the neck, shoulder, elbow/forearm, and hand/wrist. In the region of the hand and wrist, the correlation to the PCS was $r_s = -0.49$. The DASH was found to have a large effect size after hand therapy intervention, a good responsiveness indicator.[50]

Responsiveness of clinically relevant change after intervention is expressed as meaningful clinically important difference (MCID). The manual for the DASH and QuickDASH[42 (p151)] states that although the MCID can change based upon the sample size and variance of the data, 15% change of disability is considered as an accepted true clinical change not related to chance.

Statistical analysis was performed using SPSS (Version 16.0 for Windows, SPSS, Inc. Chicago, IL). Independent Samples *T*-tests and Paired Samples *T*-tests were performed to assess differences in outcomes between and within groups. Regression analyses were also used to determine independent predictors of outcomes. Significance was set at $p < 0.05$.

Results

A computerized chart review was completed initially to sort out charts of patients with thumb pain. Patients with thumb pain were referred from a variety of sources, such as self-referred, family physicians, general practitioners, rheumatologists, and orthopedic surgeons. Therefore, diagnosis codes used to search included the therapeutic diagnosis of thumb pain, as well as the medical diagnosis code of osteoarthritis. It was decided to complete the first computerized chart review with two ICD-9 codes: upper limb pain, ICD-9 code 729.5 and thumb OA ICD-9 code of 715.94. The upper limb pain code 729.5 has an alpha-code, AY, which specifies this code to thumb pain. However, the computer sorting program could not single out the alpha-code. Therefore the initial computerized chart review was mixed with those not necessarily specific to thumb pain, or mixed with those with multiple diagnoses other than thumb pain.

The first chart review identified a total of 455 charts with the two diagnosis codes. These charts were then hand sorted by the primary author to exclude all charts with diagnoses other than those related to the CMC of the thumb. Charts were excluded if other diagnoses, such as, but not limited to, carpal tunnel syndrome, deQuervain's tenosynovitis, finger pain, or elbow pain were accompanied by thumb pain. This number was then reduced to 35, those with a singular therapeutic diagnosis of CMC thumb pain or medical diagnosis of thumb CMC OA. The chart was accepted if one or both thumbs were diagnosed with CMC thumb pain or OA, and if there were at least 2 visits in which a QuickDASH score was included. These two scores are referred to as the initial score and the latest score, meaning the last score recorded nearest the last visit. The gender mix was 31 females and 4 males, and the average age was 58 (range 30–82 years), both which correlate to the demographics of the population of people with CMC thumb pain.[2] The primary outcomes were pain and function, reported as a disability score. All charts reviewed were found to have documentation of the dynamic stability modeled approach of intervention. These 35 charts reported an average initial visit QuickDASH pain score (taken directly from question 9) of 3.34, on a Likert-type scale of 1 for no pain, to 5 for extreme pain. The average latest visit pain significantly improved to a score of 2.74, for a 17.9% reduction in pain ($p < .01$). The QuickDASH disability score range is 0–100, where a greater score is interpreted to mean greater disability. Looking at the group of charts, the overall QuickDASH disability score significantly improved from an average initial visit score of 37.0 to an average latest visit score of 29.9, a change score of 7.1 points for an overall improvement of 19.3% ($p < .01$) (Table 1). A second way to determine overall change score is to calculate each individual's percentage of change from initial to latest score, and average this percentage change across all subjects. With this method, the current study revealed an average individual change percentage of 15.7%. In spite of the small sample, both these ways of calculating the disability change scores exceed the accepted MCID change percentage of 15%. The secondary outcomes were total visits and the date range of the episode from start to finish.

Table 1
Change in overall group score: QuickDASH pain and disability

	Initial score	Latest score	Overall group change (%)	Significance
Pain	3.34	2.74	17.9	$p < .01$
QuickDASH	37.0	29.9	19.3	$p < .01$

The average number of total visits was 2.37, with a range of 2–9 visits. Only 2 charts had greater than 3 total visits. The average number of total days of the episode of care, from initial visit to discharge was 44.5 days, with a range of 17–195 days. Again, the limit between consecutive visits for a single episode was 90 days, although some episodes of care extended beyond 90 days. (If a person had any two consecutive visits greater than 90 days apart, this began a second episode of care, thus creating two separate charts. No data of the first episode was mixed with the subsequent episode.)

Although all relationships were positive, the linear regression models revealed no significant predictive relationship between age or gender and outcome scores, or between initial pain score, initial disability score and change in score ($p > .05$ for each) (Figs. 2–5). With the relatively small sample size, there were no demographic variables that correlated with (or were predictive of) any of the QuickDASH outcomes.

Discussion

The thumb's inherent osseous instability relies on soft tissue and neuromuscular support for its stability and strength, much like the shoulder.[37] Boutan et al.[28] has studied the interrelationship between the 1st dorsal interosseous (1st DI) and the opponens to stabilize the CMC joint. Brand and Hollister, in their classic text of 1985,[26] described the role of the 1st DI as a CMC stabilizer, with distal and ulnar-ward vectors to counteract the dorsoradial stress forces at the CMC joint during lateral pinch and power grip. Its vector forces create the unusual role of distraction rather than compression at the CMC joint. The muscle fibers of the 1st DI do not cross the CMC joint, nor does it provide overt power, therefore, it has long been overlooked as an important muscle in the study or intervention of the thumb.[26(p294)] Brand also states that the contracture of the thumb web space limits the full pronation of the thumb, in turn preventing tip-to-tip prehension, causing the index finger to oppose to the lateral aspect of the thumb, and creating a crank action at the MCP with progressive loss of thumb metacarpal abduction and rotation.[26(p208)] Therefore, full thumb abduction is required to allow full thumb pronation for opposition with metacarpal abduction, with the counteraction of the 1st DI stabilization to allow for pinch/prehension with a stable CMC joint.

Current trends in knee and shoulder rehabilitation are moving clinically from a traditional strengthening approach to a more kinematic functional approach using the entire set of muscles which have control around the specific joint to keep the joint centralized, restoring strong, pain free function.[35–40] For injury of the anterior cruciate ligament of the knee (ACL), the focus on dynamic stability is twofold. First, it is functional. If strength and ROM are restored, but the person is not able to recruit the muscles quickly and in a synchronized manner, the joint can still be unstable. Among ACL non-copers, people who do not functioning well after injury, it has been found they actually over-constrain their tibia, or co-contract, holding the tibia in a more compressed joint position. When these people are exposed to any perturbation, or disturbance of the environment, i.e., rough ground, they are unable to respond and end up with an instability episode. Secondly, the rigid non-responsive co-contractions that have been advocated in the past through traditional strengthening and ROM exercises actually are believed to exacerbate joint degeneration (Wendy Hurd, Ph.D, PT, personal communication, July 2012). In knee studies, a specialized form of neuromuscular training, termed perturbation training, for the person with anterior cruciate ligamentous insufficiency has been shown to reduce this co-contraction, which in turn results in improved gait mechanics and higher levels of function.[35,36,38,51] It has also been found that joint co-contraction leads to compression, furthering the degenerative process of the joint.[35,36,39] Studies also have demonstrated traditional exercise with specific neuromuscular intervention has reduced pain and disability.[35,36]

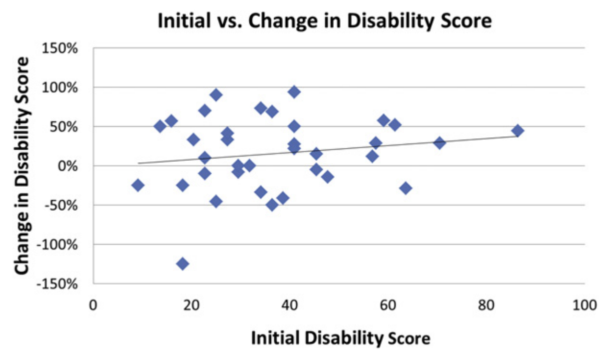


Fig. 3. Initial vs. change in disability score (no statistically significant relationship).

The shoulder has poor osseous stability and relies on the dynamic neuromuscular system of the rotator cuff for its stability. Neuromuscular joint control has been found to be altered in the presence of joint instability. Emerging clinical evidence demonstrates reduction of co-contraction and restoring the order of muscle recruitment has a more positive and functional effect than traditional strengthening.[37] It is suggested the stability of the CMC joint of thumb can be thus described. Dynamic stability for the thumb speaks to the restoration of the order and strength of muscle recruitment throughout its full ROM. Reasons for the loss of thumb stability are many; fracture, dislocation, overuse, and natural state of lax ligaments. Restoration of dynamic stability involves the osseous, ligamentous and muscular systems of the thumb CMC joint with the goal to restore the arthrokinematics that allow the

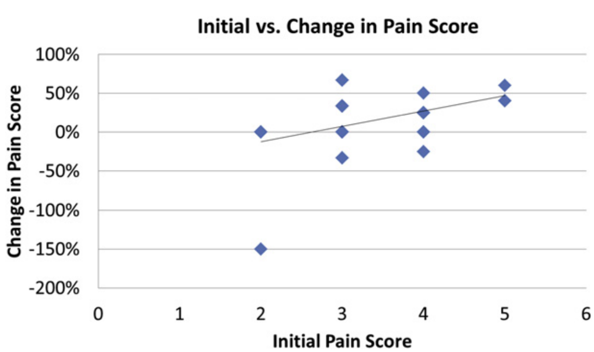


Fig. 2. Change in initial vs. change in pain scores (no statistically significant relationship).

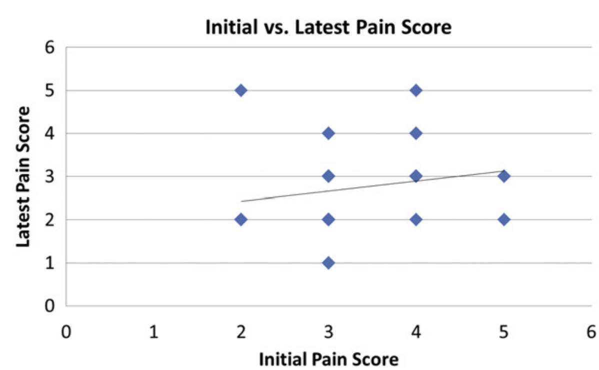


Fig. 4. Initial vs. latest pain score (no statistically significant relationship).

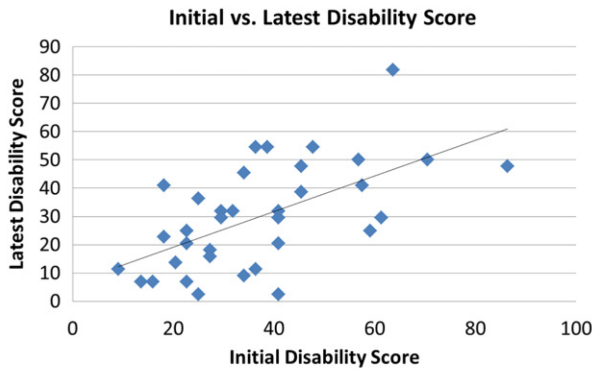


Fig. 5. Initial vs. latest disability score (no statistically significant relationship).

thumb to function in a pain-free, functional range of motion. Clinically, therapeutic intervention goals for the stability in these joints are to reduce pain and increase functional strength.[37] Clinical measures of change from the patient's perspective are pain and disability.

It is well established in the literature that conservative thumb intervention includes exercises, orthotic support, JPE and adaptive equipment information.[11–25] The standard of the dynamic stability modeled approach to intervention that has been employed at our 7 clinics since 2000, with generally good results reported by the patients, therapists, and physicians, therefore a retrospective design was chosen to study the effect of this model of intervention. The order of the dynamic stability modeled approach intervention plan is at the clinical discretion of the therapist with the person, and the findings of their evaluation and assessment. Exercise intervention is based on the concept of the biomechanical and arthrokinematics of thumb dynamic stability for that person. A key component of this approach is the re-education of the 1st DI as an integral part of the thumb muscle complex for stability, as well as re-education of the balance of musculature around the thumb, including intrinsics and extrinsics. Orthosis fabrication, if necessary, in this modeled approach is to match the needs of the person. The type of CMC orthosis used for the individual is not specified and the dosage of wear is not established, except to be used until pain-free function occurs out of the orthosis. The JPE strategies are not formalized, but included as clinically deemed appropriate by the therapist with the person. The retrospective study was limited to those who presented with thumb CMC pain for conservative intervention, without regard to, or information of, the stage of OA of the thumb, if that was their diagnosis. Stage of thumb CMC OA[5] information does not always accompany the patient, as some patients are referred from outside of this health facility or without the expertise of a board certified Hand Surgeon. As well, thumb pain can occur without the diagnosis of OA. One chart included one who did not require an orthosis. Interestingly, this was the chart of the youngest person, who was a male. The dynamic stability modeled approach provides orthotic support as clinically necessary. This scenario is replicated in most clinical situations where conservative intervention occurs for persons with thumb pain.

The primary purpose of this study was to determine the effect on pain and disability using the dynamic stability modeled approach on thumb CMC conservative intervention. The significant results contribute to the evidence from the previous studies for pain and function.[11–25] The secondary purpose demonstrated this positive effect at an average of approximately 2 visits over approximately 6 weeks (2.37 over an average range of 44.5 visits), a close match to the previous short-term follow-up prospective studies.[13,14,24]

The limitations of this study are inherent to the retrospective study design. The modeled approach to CMC intervention has not been studied previously. Each therapist in our clinics has been instructed in the dynamic stability model of intervention through several in-house, local continuing education courses, in addition to individual instruction for each new therapist. This retrospective review included intervention which occurred at 7 separate hand therapy clinics; a total of 16 hand therapists, plus 6 casual hand therapists. All are Occupational Therapists, 13 with Certification in Hand Therapy. The order of intervention is a clinical decision between the therapist and person. The basic order is a guided approach of pain reduction through pain-free web space restoration, neuromuscular re-education to restore the balance and order of activation of all thumb muscles with an emphasis on the 1st DI, therapeutic exercise for strengthening to maintain thumb joint stability, joint mobilization for pain control, orthotic support as needed, JPE, and modalities (Fig. 1). The type of orthosis fabricated was not controlled for; however each orthosis, when included, stabilized the CMC. It was not the intent of this study to control for inclusion of orthoses, as orthoses as needed by the patient is an integral part of this modeled approach. As well, JPE was not controlled for as it is an integral part of the approach.

Another limitation could be that adherence to the modeled approach was not controlled for or monitored. As this was a retrospective chart review of outcomes of this approach, the included charts were not analyzed for adherence. It is recommended future prospective studies include program adherence.

Another limitation was the choice by the author to limit the computerized chart review to only two ICD-9 diagnosis codes, 729.5, pain in limb, and 715.94, generalized OA of the hand. Other codes describe thumb pain, such as 715.34, thumb CMC osteoarthrosis, and 715.24, traumatic arthritis of thumb CMC. Had these codes been included possibly more charts would have been found for review. The computerized chart review was unable to select the ICD-9 pain codes of with the separate letter codes (729.5 AY) to specify thumb pain, thus generating 455 in the first review. In addition, there was no consistent facility coding standard for those who had undertaken CMC arthroplasty. The limitation related to therapists choosing their own codes rather than professional coders is accepted. With the advent of ICD-10, more specificity will be available for localized osteoarthrosis of each hand joint. Clinics would benefit from administrative standards for diagnosis coding by therapists in the absence of a professional qualified diagnosis coder.

A strength of this study is the consistent use of an outcome tool, the QuickDASH, to gather clinical outcome data for a group of persons with the same diagnosis. In addition, this is the first clinical study of a dynamic stability approach to CMC thumb pain. Despite the small sample, significance was demonstrated in the change of pain and disability. It is plausible that intervention for persons with every stage of CMC OA occurred, so it could be extrapolated that dynamic stability intervention can have a positive effect for all stages of thumb CMC OA.

Further research is needed biomechanically as well as clinically. What is known is that CMC orthoses have been found to provide radiographic osseous stability.[8,9] What is not known is the change in radiographic subluxation with exercise added to the current evidence for conservative management of the painful thumb. Future biomechanical studies are planned to investigate the muscular contribution of the 1st DI and opponens to the stability of the CMC as well as prospective studies to determine if the dynamic stability approach demonstrates a radiographic change at the CMC. Furthermore, prospective clinical studies are also needed to compare the design of dynamic stability exercises to traditional conservative thumb exercise programs. There are many unanswered clinical questions about the care of the painful thumb, and more clinical research is needed to establish efficacious (effective and low-cost) evidence-based exercise programs for pain reduction and functional improvement in conservative intervention.

Conclusion

The clinical contribution of this study is that the dynamic stability modeled approach is consistent with other conservative intervention studies[12–17,24] which demonstrate significant reduction of pain and disability. This study is also the first to report the number of average visits retrospectively for conservative thumb pain intervention, which adds to the evidence of dosage for this population. This may also demonstrate the efficacy of intervention by hand therapists in this population.

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#1. The primary purpose of this clinical study of thumb pain was
- a. to prove a dynamic stability model of intervention for thumb pain is effective
- b. to investigate the change in pain and disability using a conservative model of intervention
- c. to find which orthosis works best for thumb CMC pain
- d. to prove joint protection education is important

#2. The statistically significant changes in pain and disability are reported as
- a. $p < .005$
- b. $p < .05$
- c. $p < .001$
- d. $p < .01$

#3. The outcome tool used to measure change in pain and disability for this study was the
- a. Patient Rated Wrist Hand Evaluation
- b. Michigan Hand Outcomes Questionnaire
- c. QuickDASH
- d. Upper Limb Functional Index

#4. The design of this clinical research study is reported as
- a. expert opinion
- b. a retrospective cohort
- c. a case series
- d. a randomized clinical trial

#5. The dynamic stability modeled approach to thumb pain intervention includes more than an orthosis and joint protection
- a. true
- b. false

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