The Push® MetaGrip® Thumb CMC Brace

A White Paper

Describing the Stabilizing Mechanism of the Push MetaGrip

BraceLab

Raleigh, NC, USA

Exclusive US Distributor of

push® braces

www.BraceLab.com

The Push® MetaGrip® Thumb CMC Brace

To the reader:

- The terms brace, splint, and orthosis are synonymous; the term brace is used in this paper.
- The joint at the base of the thumb has multiple names: 1) carpometacarpal or CMC joint, 2) basal joint, 3) trapezialmetacarpal or TM joint, and 4) trapeziometacarpal joint or TMJ. The term CMC joint is used in this paper.
- The Push® brace described in this paper is called the Push MetaGrip® in the US and is called the Push ortho Thumb Brace CMC outside the US.

Thumb CMC Osteoarthritis

Osteoarthritis of the joint at the base of the thumb, the carpometacarpal (CMC) joint, causes pain with resisted thumb motions and particularly with forceful pinching. (See Figure 1.) This creates difficulty with everyday tasks such as twisting open a jar lid, turning a key in a lock, turning doorknobs, sustained pinching or writing, picking up a large book, holding a cup of tea/coffee, doing needlework/hand crafts, carrying a heavy object, playing golf/tennis and using scissors, etc.[1-4]

Figure 1: X-ray view of a left thumb with osteoarthritis of the thumb CMC joint (circle).

Approximately one in four women and one in twelve men in older age groups have osteoarthritis (OA) of this essential joint.[2,3,5-10] Pain and disability are significantly higher among patients with thumb CMC OA than those without[11] and the thumb CMC joint ranks as the most common site of upper extremity surgery related to osteoarthritis.[1,2,9,12]

Pain creates difficulty with everyday tasks.

Development of Thumb CMC OA

The thumb CMC joint has a large range of motion enabled by the inherently lax joint ligaments. (See Figure 2.) When thumb CMC joint osteoarthritis develops, the ligaments supporting the joint become insufficient and pathological joint motion develops. The pull of the stronger thumb muscles against these inadequate ligaments results in the most common pathological motion at the CMC joint: dorsal translation. Dorsal translation is the movement of the first metacarpal bone as it slides

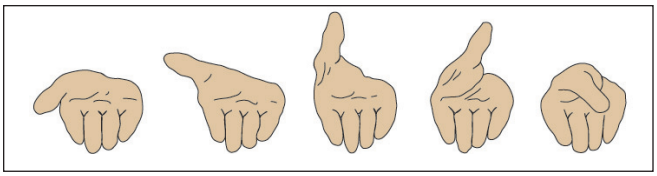

Figure 2: The range of motion of the thumb CMC joint from a position of full extension (left) to full flexion (right).

on the stationary trapezium in the direction of the dorsum (top) of the thumb (See Figure 3).

Dorsal translation occurs when the thenar muscles contract: the thumb metacarpal tilts; the distal end of the bone moves toward the palm and the proximal end moves dorsally (See Figure 3C). It is believed that this shift of motion, even when slight, creates pain. In the early stages of thumb CMC osteoarthritis, dorsal translation represents a small shift in joint alignment. As osteoarthritis progresses, the metacarpal base moves

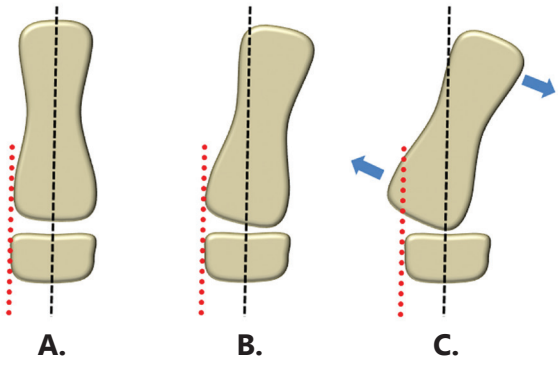

Figure 3: This schematic drawing of a volar view of a left thumb illustrates the movement of the thumb metacarpal on the trapezium (red dotted line is dorsum). A) Normal thumb CMC joint at rest with metacarpal and trapezium in alignment. B) Normal thumb CMC joint flexion; note the bones remain in alignment and C) Thumb CMC joint with osteoarthritis where first metacarpal base moves out of alignment in dorsal direction (dorsal translation) while the metacarpal head flexes forward.

further and further dorsally, and may even dislocate relative to the trapezium.[9]

Bracing CMC Osteoarthritis

Bracing of the osteoarthritic thumb CMC joint is standard non-surgical care for pain relief. [1,2,7,11-24] Both the National Collaborating Centre for Chronic Conditions in the United Kingdom and the evidence-based European League against Rheumatism (EULAR) recommend bracing as part of thumb CMC osteoarthritis treatment.[15,25]

Bracing of the osteoarthritic thumb CMC joint is standard non-surgical care for pain relief.

Numerous studies have investigated the effect of bracing on pain and function but none include a definition of the primary kinematic function of any brace. In other words, apart from general immobilization of the thumb CMC joint, there is no explanation of the precise mechanism by which the brace design achieves pain reduction or increased function.[11] To accomplish immobilization of the thumb CMC joint, most braces also incorporate the thumb metacarpophalangeal (MP) joint or the adjacent wrist joint.[1-3,13,16,22,26,27] (See Figure 4.) The challenge of bracing the osteoarthritic thumb CMC joint is to balance the opposing goals of providing joint stability while also allowing mobility.[28]

The challenge of treating thumb CMC joint osteoarthritis is to balance the opposing goals of providing both stability and mobility.

Figure 4: Examples of brace designs for the thumb CMC joint which include CMC joint and thumb MP and/or wrist joints.

Immobilization or Stabilization?

Immobilization seeks to decrease inflammation by providing periods of rest to the joint. The role of inflammation in osteoarthritis remains controversial,[29] bringing into question whether immobilization in a brace is the optimal treatment for thumb CMC osteoarthritis. It is well known that prolonged immobilization decreases muscle strength, which in turn decreases joint stability.[20] If immobilization is the chosen treatment for thumb CMC OA, the resulting decrease in stabilizing muscle strength is likely a contributing factor to the progression of the pathological imbalance at the joint.

Motion, joint loading, and muscle strengthening have been shown to improve joint stability in patients with OA in large joints.[30,31] Although data for small non-weight-bearing joints is lacking, recent publications on the treatment of thumb CMC OA suggest that exercises and bracing facilitate pain control and use of the thumb in a balanced manner.[11,23,24,26,27,32-38]

Braces that do not impede daily activities allow longer periods of wear, which have been shown to decrease pain.[13,16,22,26,27,39] Because the design of many thumb braces hinders function, however, such braces are often worn only at night, and normal daily activities continue without bracing support.[20] Consequently the dynamic force imbalance that encourages thumb CMC joint deformity continues to influence pathological progression during the day.[40]

The Ideal Brace

The optimal brace for isolated CMC joint osteoarthritis would stabilize only the thumb CMC joint, controlling pain by preventing dorsal translation while allowing maximal function. The brace would also encourage a balanced posture of the thumb during function so that it could be worn during nearly all activities. Maintaining ideal joint alignment during thumb muscle contraction may increase function, decrease pain, and potentially slow or control the deformity progression.[18,21,33,41,42]

An ideal brace would stabilize only the thumb CMC joint, controlling pain by preventing dorsal translation of the metacarpal base.

Since CMC joint osteoarthritis is typically limited to the CMC joint, the ideal thumb brace design need not restrict other joints. Although some individuals with OA develop associated MP or wrist joint pathology and inclusion of either/both joints may be indicated for those individuals, this is not descriptive of the majority of those with thumb CMC osteoarthritis. Additionally,

since activities requiring pinch are the primary cause of thumb CMC joint symptoms,[9] the smaller brace design leaves critical sensory areas free while allowing unimpeded pinching, fingering, handling and gripping activities.

A Different Design Approach: Use of a Pseudo-Hydraulic Environment

The Push MetaGrip brace developed by Push® Braces excludes adjacent joints, specifically limits CMC joint dorsal translation, and allows maximum function.[26] This is accomplished through dynamic stabilization using a pseudo-hydraulic environment. Originally developed in the mid-20th century as a way to stabilize long bones during fracture healing, a pseudo-hydraulic environment uses pressure created by contracting muscles within a closed cylinder to stabilize the bone encircled by the muscles.[43]

The Push MetaGrip stabilizes the thumb metacarpal by firmly encircling the thenar muscles. As the muscles enlarge during muscle contraction, they fill the snugly-fitting cylinder, creating internal pressure within the brace which stabilizes the metacarpal. (See Figure 5.) The brace does not need to cover the joint to provide this stability; it only needs to surround the thenar muscles. When the MetaGrip brace is in place, the very muscle contraction which normally causes the base of the first metacarpal to translate dorsally on the trapezium will, instead, stabilize the base of the metacarpal. This phenomenon is called "dynamic stabilization."

In contrast to an immobilization design, a brace using the pseudo-hydraulic principle allows some motion within the "cylinder." Those expecting traditional immobilization from the Push MetaGrip are surprised by the thumb mobility possible while wearing the brace. Thumb CMC motion is possible within the mid-range while wearing the brace, but when the thenar muscles contract, the muscle contraction stabilizes the first metacarpal and CMC joint movement is restricted. The Push MetaGrip thus uniquely provides the most support when it is needed the most—during active use of the thumb. Consequently, an individual trying on the Push MetaGrip who does not have thumb osteoarthritis or CMC joint hypermobility will be unable to experience the restriction of dorsal translation the brace provides.

The Push MetaGrip uniquely provides the most support when it is needed the most—during active use of the thumb.

For the pseudo-hydraulic environment to provide stability the brace must precisely and snugly fit the contours and size of the relaxed thenar muscles. Because individual thumb sizes and shapes vary, the Push MetaGrip provides an adjustable custom fitting by incorporating a malleable, bi-contoured aluminum reinforcement around the thenar muscle area of the brace. This metal must be firmly contoured to fit snugly around the relaxed thenar muscles. (See Figure 6 & 7.) If the fit is loose or imprecise, the pseudo-hydraulic environment does not exist.

Since symptom severity is influenced by joint loading,[40] a brace limiting metacarpal translation under load addresses the desired goal. Such a brace will likely be more effective both in alleviating symptoms and in potentially influencing the course of the disease as compared to an immobilization brace that is rarely worn when most needed because its cumbersome design restricts function.[26,27,44]

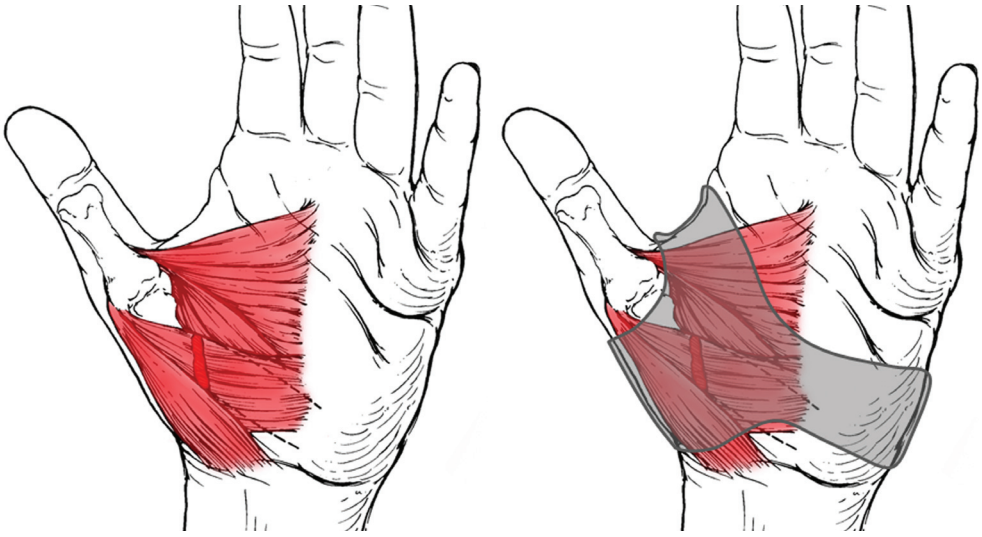

Figure 5: A) The thenar muscles (the flexor pollicis brevis is cut away to show the underlying opponens pollicis) which enlarge when they contract. B) The Push MetaGrip encircles these muscles, creating stablizing internal pressure when the muscles contract.

Muscle Use

Finally, and perhaps most importantly, disuse atrophy does not occur because the thenar muscles are actively contracting in the ideal mid-

Figure 6: X-ray showing the multi-contoured, bendable aluminum reinforcement surrounding the thenar muscles.

Figure 7: The aluminum insert must be snugly fitted around the relaxed thumb muscles.

position while in the Push MetaGrip brace. Unlike an immobilization brace, the Push MetaGrip facilitates balanced use of the stabilizing thumb muscles, increasing the likelihood that brace wear may positively influence the course of the disease. By maintaining a balanced posture when under load, the patient can potentially retrain the thumb muscles to allow weaning from the brace over time. This is in sharp contrast to immobilization braces which prevent muscle use, thereby weakening the intrinsic thumb muscles.

The metal insert must be firmly contoured to snugly fit around the thenar muscles.

Can a Small Brace be Effective?

As stated above, many braces endeavor to immobilize the thumb CMC joint and thus usually include the MP joint and may also include the wrist joint. Those who encounter the minimal design of the Push MetaGrip brace question whether a small brace can be effective. (See Figure 8.)

The Push MetaGrip significantly restricts thumb CMC joint motion while maintaining function.

A study correlating the joint restriction provided and the function allowed by four braces showed the Push MetaGrip (the only brace not including other joints) significantly restricted thumb CMC joint motion in all directions, although it retained the largest range of motion.[44]

Two other studies comparing braces including both thumb CMC & MP joints with those including only the thumb CMC joint came to the same conclusions:

· Braces that include only the CMC joint have pain relief equal to that of braces including two joints.

· Functional measures in both studies identified the one joint brace allows more retention of function.

· Patient preference is strongly in favor of one joint inclusion. [26,27]

Other studies have investigated patient compliance and pain relief using a variety of braces. These studies have also concluded that patients prefer a smaller brace and that a smaller brace can provide pain relief.[16,17,19,22,39,45-48]

Figure 8: The Push MetaGrip thumb CMC brace covers minimal area.

Indications for the Push MetaGrip

Although the Push MetaGrip was designed to specifically limit dorsal translation of the first metacarpal on the trapezium, the CMC joint stability provided by the brace makes it suitable for other applications.

Post-Surgery Use

The goal of surgical reconstruction of the thumb CMC joint is to re-create stability while still allowing functional mobility. Because the Push MetaGrip brace only allows muscle contraction with thumb CMC joint in mid-range, it is the ideal post-operative brace following thumb CMC joint reconstruction. The healing joint capsule is protected from the stress of end range joint motion. Unlike braces that immobilize the joint, the Push brace prepares the individual for effective weaning from external support by facilitating muscle strengthening while simultaneously protecting healing tissues. The brace can be fitted following removal of the surgical dressing when the wound is stable, allowing the patient immediate protected use of the thumb for light activities.

The stability the brace provides makes it suitable for other clinical applications.

Thumb CMC Joint Hypermobility

Given the degree of motion the relatively lax ligaments allow at the normal thumb CMC joint, individuals with joint hypermobility often experience excessive motion at this joint, rendering it unstable during loading. Sometimes these hypermobile joints are symptomatic. Even if pain free, the use of the Push MetaGrip to stabilize the joint while under load enhances the ability of the thumb to hold and manipulate objects. The brace has been used successfully by individuals with general hypermobility as well as those with excessive hypermobility such as Ehlers-Danlos syndrome.

Achieving the Impossible: Joint Stability and Pain-Free Mobility

Since the release of the uniquely designed Push MetaGrip in the United States in 2011, many patients with thumb CMC osteoarthritis have reported wearing the MetaGrip for pain control during a wide range of vocational and avocational activities (Figure 9), suggesting that the Push MetaGrip uniquely meets the contradictory goal of providing both mobility and stability of the thumb CMC joint.

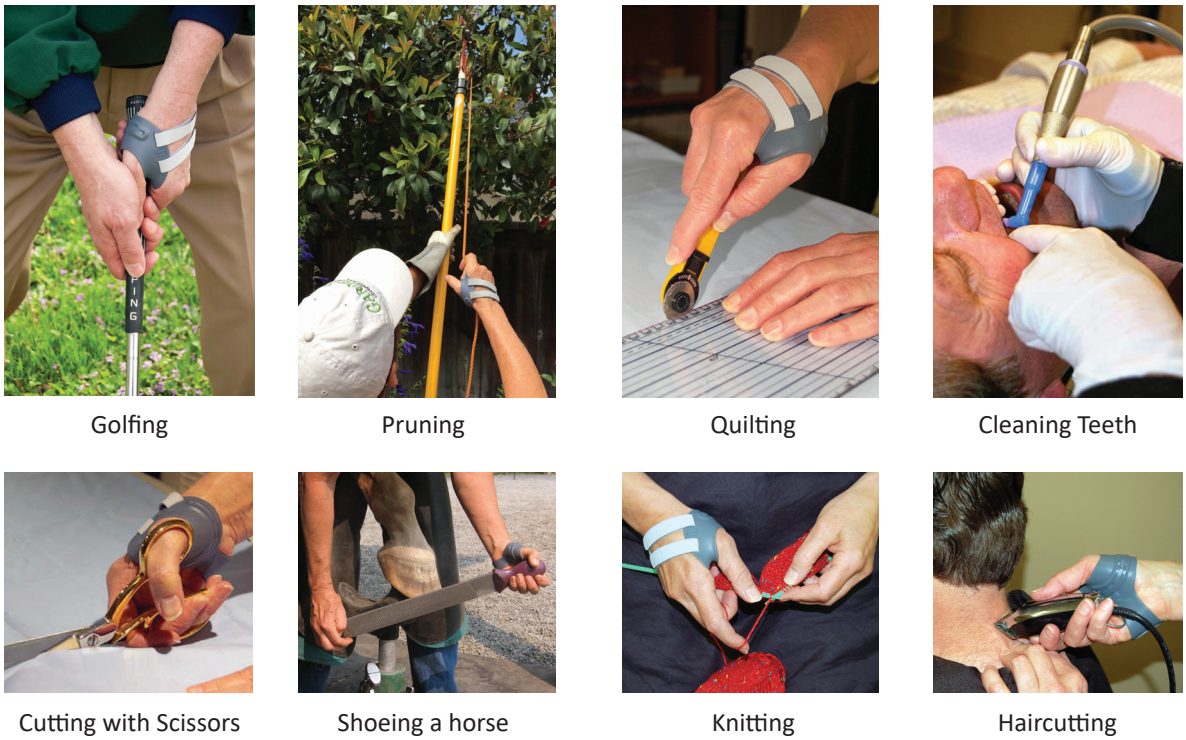

Figure 9: Examples of vocational and avocational activities while wearing the Push MetaGrip.

REFERENCES

1. Pai S, Talwalkar S, Hayton M. Presentation and management of arthritis affecting the trapezio-metacarpal joint. Acta Ortho Belg 2006;72:3-10.
2. Barron OA, Glickel SZ, Eaton RG. Basal joint arthritis of the thumb. J Am Acad Orthop Surg 2000;8:314-23.
3. Dias R, Chandrasenan V, Burke F. Basal thumb arthritis. Postgrad Med J 2007;83:40-3.
4. Zhang Y, Niu J, Kelly-Hayes M. Prevalence of symptomatic hand osteoarthritis and its impact on functional status among the elderly: The Framingham Study. Am J Epidemiol 2002;156:1021-7.
5. Swigart C, Eaton R, Glickel S, Johnson C. Splinting in the treatment of arthritis of the first carpometacarpal joint. J Hand Surg [Am] 1999;24A:86-91.
6. Armstrong A, Hunter J, Davis TR. The prevalence of degenerative arthritis of the base of the thumb in postmenopausal women. J Hand Surg [Am] 1994;24A:340-1.
7. Dahaghin S, Bierma-Zeinstra S, Ginai A, et al. Prevalence and pattern of radiographic hand osteoarthritis and association with pain and disability (the Rotterdam study). Ann Rheum Dis 2005;64:682-7.
8. Haara M, Heliövaara M, Kröger H, et al. Osteoarthritis in the carpometacarpal joint of the thumb. Prevalence and associations with disability and mortality. J Bone Joint Surg 2004;86-A:1452-7.
9. Pellegrini VD, Jr. Osteoarthritis at the base of the thumb. Orthop Clin North Am 1992;23:83-102.
10. Dillon C, Hirsch R, Rasch E, Gu Q. Symptomatic hand osteoarthritis in the United States: prevalence and functional impairment estimates from the third U.S. National Health and Nutrition Examination Survey, 1991-1994. Am J Phys Med & Rehab 2007;86:12-21.
11. Kjeken I, Smedslund G, Moe R, et al. Systematic review of design and effects of splints and exercise programs in hand osteoarthritis. Arthritis Care Res 2011;63:834-48.
12. Van Heest A, Kallemeier P. Thumb carpal metacarpal arthritis. J Am Acad Orthop Surg 2008;16:140-51.
13. Swigart CR. Arthritis of the base of the thumb. Curr Rev Musculoskelet 2008;1:142-6.
14. Murphy N, Dasari B, Adams J. A review of osteoarthritis of the trapeziometacarpal joint (TMJ). J Rheum Occup Ther 2009;24:8-11.
15. Zhang W, Doherty M, Leeb B, et al. EULAR evidence based recommendations for the diagnosis of hand osteoarthritis—report of task force of the EULAR Standing Committee for International Clinical Studies Including Therapeutics (ESCISIT). Ann Rheum Dis 2007;66:377-88.
16. Boustedt C, Nordenskiöld U, Lundgren Nilsson A. Effects of a hand-joint protection programme with an addition of splinting and exercise. Clin Rheumatol 2009;28:793-9.
17. Berggren M, Joost-Davidsson A, Lindstrand J, et al. Reduction in the need for operation after conservative treatment of osteoarthritis of the first carpometacarpal joint: a seven year prospective study. Scand J Plast Reconstr Hand Surg 2001;35:415-7.
18. Weiss S, LaStayo P, Mills A, Bramlet D. Prospective analysis of splinting the first carpometacarpal joint: an objective, subjective and radiographic assessment. J Hand Ther 2000;13:218-27.
19. Weiss S, LaStayo P, Mills A, Bramlet D. Splinting the degenerative basal joint: Custom-made or prefabricated neoprene? J Hand Ther 2004;17:401-6.
20. Rannou F, Dimet J, Boutron I. Splint for base-of-thumb osteoarthritis. Annals Int Med 2009;150:661-9.
21. Wajon A. Clinical splinting successes: the thumb "strap splint" for dynamic stability of the trapeziometacarpal joint. J Hand Ther 2000;13:236-7.
22. Gomes Carreira A, Jones A, Natour J. Assessment of the effectiveness of a functional splint for osteoarthritis of the trapeziometacarpal joint of the dominant hand: a randomized controlled study. J Rehabil Med 2010;42:469-74.
23. Valdes KA, Marik T. A systematic review of conservative interventions for osteoarthritis of the hand. J Hand Ther 2010;23:334-51.
24. O'Brien V, McGaha J. Current practice patterns in conservative thumb CMC joint care: Survey results. J Hand Ther 2014;27:14-22.
25. National Collaborating Centre for Chronic Conditions. Osteoarthritis: national clinical guideline for care and management in adults. London: Royal College of Physicians, 2008.
26. van der Vegt AE, Grond R; Grüschke JS, et al. The effect of two different orthoses on pain, hand function, patient satisfaction and preference in patients with thumb carpometacarpal osteoarthritis. Bone Joint J 2017;99-B:237-44.
27. Cantero-Téllez RV, Villafañe JH, Valdes K, Berjano P. Effect of immobilization of metacarpophalangeal joint in thumb carpometacarpal osteoarthritis on pain and function. A quasi-experimental trial. J Hand Ther 2017; doi: 10.1016/j.jht.2016.11.005. [Epub ahead of print]
28. Pellegrini VD, Jr. The basal articulations of the thumb: pain, instability, and osteoarthritis. In: Peimer CA, ed. Surgery of the Hand and Upper Extremity. New York: McGraw-Hill; 1996:1019-42.
29. Sokolove J, Lepus C. Role of inflammation in the pathogenesis of oesteoarthritis: latest findings and interpretation. Ther Adv Musculoskelet Dis 2013;5:77-94.
30. Fransen M, McConnell S, Harmer AR, et al. Exercise for osteoarthritis of the knee: a Cochrane systematic review. Br J Sports Med 2015;49:1554-7.
31. Alkatan M, Baker JR, Machin DR, et al. Improved function and reduced pain after swimming and cycling training in patients with osteoarthritis. J Rheumatol 2016.
32. Lockard M. Exercise for the patient with upper quadrant osteoarthritis. J Hand Ther 2000;13:175-83.
33. Taylor J. Restoration of dynamic stability in early osteoarthritis of the carpometacarpal joint of the thumb. Brit J Hand Ther 2000;5:37-41.
34. Neumann D, Bielefeld T. The carpometacarpal joint of the thumb: stability, deformity, and therapeutic intervention. J Orthop Sports Phys Ther 2003;33:386-98.
35. Moran ME. Osteoarthritis and occupational therapy intervention. Phys Med Rehab: State of the Art Reviews 2001;15:65-81.
36. O'Brien V, Giveans M. Effects of dynamic stability approach in conservative intervention of the carpometacarpal joint of the thumb: A retrospective study. J Hand Ther 2013;26:44-52.
37. Valdes KA, von der Heyde R. An exercise program for carpo-

metacarpal osteoarthritis based on biomechanical principles. J Hand Ther 2012:251-63.
38. Ye L, Kalichman L, Spittle A, et al. Effects of rehabilitative intervention on pain, function, and physical impairment in people with hand osteoarthritis: a systematic review. Arthritis Res Ther 2011;13:1-13.
39. Wajon A, Ada L. No difference between two splint and exercise regimens for people with osteoarthritis of the thumb: A randomised controlled trial. Aust J Physio 2005;51:245-9.
40. Segal R, Avrahami E, Lebdinski E, et al. The impact of hemiparalysis on the expression of osteoarthritis. Arthritis Rheum 1998;41:2249-56.
41. McKee P, Eason-Klatt M. Multi-center study comparing two styles of orthoses for individuals with thumb carpometacarpal osteoarthritis. J Hand Ther 2006;19:446-7.
42. Colditz JC. The biomechanics of a thumb CMC immobilization splint: design and fitting. J Hand Ther 2000;13:228-35.
43. Sarmiento A, Kinman PB, Galvin EG, et al. Functional bracing of fractures of the shaft of the humerus. J Bone Joint Surg 1977;59-A:596-601.
44. Hamann N, Heidemann J, Heinrich K, et al. Stabilization effectiveness and functionality of different thumb orthoses in female patients with first carpometacarpal joint osteoarthritis. Clin Biomech 2014;29:1170-6.
45. Bani M, Arazpour M, Kashani R, et al. Comparison of custom-made and prefabricated neoprene splinting in patients with first carpometacarpal joint osteoarthritis. Disabil Rehabil Assist Technol 2013;8:232-7.
46. Bani M, Arazpour M, Kashani R, et al. The effect of custom-made splints in patients with the first carpometacarpal joint osteoarthritis. Prosthet Orthot Int 2013:139-44.
47. Becker S, Bot A, Curley S, et al. A prospective randomized comparison of neoprene vs thermoplast hand-based thumb spica splinting for trapeziometacarpal arthrosis. Osteoarthritis Cartilage 2013;21:668-75.
48. Wilder F, Barrett J, Farina E. Joint-specific prevalence of osteoarthritis of the hand. Osteoarth Cart 2006;14:953-7.

The U.S. Pricing, Data Analysis and Coding contractor has assigned two HCPCS codes for the Push® MetaGrip®:

- **L3923**-Hand finger orthosis, without joints, may include soft interface, straps, prefabricated item that has been trimmed, bent, molded assembled, or otherwise customized to fit a specific patient by an individual with expertise
- **L3924**-Hand finger orthosis, without joints, may include soft interface, straps, prefabricated, off-the-shelf