Journal of Hand Therapy 32 (2019) 35–40

Contents lists available at ScienceDirect

Journal of Hand Therapy

journal homepage: www.jhandtherapy.org

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Scientific/Clinical Article

The diagnostic clinical value of thumb metacarpal grind, pressure-shear, flexion, and extension tests for carpometacarpal osteoarthritis

Yaron Sela MD [a], Jodi Seftchick MOT, OTR/L, CHT [b], William L. Wang BBA [c], Mark E. Baratz MD [a,*]

[a] UPMC – University of Pittsburgh Medical Center, Orthopaedic Surgery, Community Medicine Incorporated, Pittsburgh, PA, USA
[b] University of Pittsburgh Medical Center, Centers for Rehab Services, Pittsburgh, PA, USA
[c] Department of Orthopaedic Surgery, University of Pittsburgh School of Medicine, Pittsburgh, PA, USA

ARTICLE INFO

Article history:
Received 31 May 2017
Accepted 20 September 2017
Available online 14 November 2017

Keywords:
Thumb carpometacarpal arthritis
Grind test
Pressure-shear test
Metacarpal flexion test
Metacarpal extension test

ABSTRACT

Study design: Clinical measurement.
Introduction: Common provocative maneuvers to differentiate thumb carpometacarpal (CMC) osteoarthritis from other sources of pain are the grind, metacarpal (MC) flexion, and MC extension tests. A maneuver known as the pressure-shear test is described here.
Purpose of the study: To compare the diagnostic value of the grind, metacarpal flexion, metacarpal extension, and pressure-shear tests for CMC osteoarthritis of the thumb.
Methods: The diagnostic accuracy of each test was compared in 127 thumbs from 104 patients. Sensitivity, specificity, and predictive values of each test were calculated. In a secondary analysis, polychoric correlation coefficients were used to assess the correlation of each test with severity defined by Eaton-Littler stage.
Results: The overall diagnostic accuracy of the thumb MC grind, pressure-shear, flexion, and extension tests were 70%, 98%, 47%, and 55%, respectively. The sensitivities were 64%, 99%, 36%, and 46%, respectively, and specificities were 100%, 95%, 100%, and 100%, respectively. For the diagnosis of Thumb CMC arthritis, the MC pressure-shear test was superior overall in terms of overall diagnostic accuracy and sensitivity, while having comparable specificity to the other maneuvers.
Conclusion: The pressure-shear test was found to be superior to the commonly used grind maneuver and the provocative maneuvers of MC flexion and extension tests to confirm diagnosis of CMC osteoarthritis.

Introduction

Thumb osteoarthritis (OA) is one of the most painful and debilitating diseases of the hand that affects a large segment of the adult population, with radiographic prevalence reaching 90% in both men and women by 80 years.[1] This condition may cause pain at the base of the thumb, progressive loss of thumb motion, loss of strength, and decreased coordination, worsening later in the course of disease.[2]

Review of the literature demonstrates that radiographs assist in the assessment of carpometacarpal (CMC) joint disease, but there is not a reliable system for classification of disease severity.[3-5] Currently, diagnosis and treatment of thumb CMC arthritis is based on the surgeon's qualitative assessment of the history, physical examination, and radiographs. Attention is focused on the location, duration, onset, frequency, intensity, and quality of the pain.[6]

The clinical diagnosis is a vital aspect of an orthopedic surgeon's practice. Selecting tests that will provide the most accurate information are crucial to successful treatment. Determining the best diagnostic tests for use in clinical situations requires an ability to appraise evidence that describes the accuracy and interpretation of the results of testing.[7]

The grind test is frequently used to differentiate other sources of pain from thumb CMC arthritis, although there are

Funding: This project was not supported through any specific grant.
Conflict of interest: No authors of the article received funding, grants, or in-kind support in support of the research or preparation of the article. No authors had an association or financial involvement (ie, consultancies/advisory board, stock ownerships/options, equity interest, patents received or pending, royalties/honorary) with any organization or commercial entity having a financial interest in or financial conflict with the subject matter or research presented in the article.
Ethical committee: This study was approved by the Institutional Review Board of University of Pittsburgh Medical Center.
* Corresponding author. Orthopaedic Specialists – UPMC, 2000 Oxford Drive, Suite 510, Bethel Park, PA 15102, USA. Tel.: +1 412 863 4981.
E-mail address: baratzme@upmc.edu (M.E. Baratz).

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https://doi.org/10.1016/j.jht.2017.09.005

limited data to support its prognostic value.[1,8,9] There are even less data in the literature comparing the grind test to other provocative tests for the diagnosis of thumb CMC joint arthritis.

The purpose of this study was to compare the diagnostic value, in terms of sensitivity and specificity, of 4 different provocative maneuvers, including the grind test, metacarpal (MC) flexion, MC extension, and pressure-shear tests for CMC OA of the thumb. The validity of these tests was determined by comparing the results with that of Eaton-Littler classification system of radiologic evaluation of the CMC joint, for confirming CMC OA while assigning a stage of the disease.

Methods

Subjects

This study was approved by the Institutional Review Board at the University of Pittsburgh Medical Center. We retrospectively evaluated patients who were seen in our clinic from January 1, 2015 to December 31, 2015. The patients were identified using a database of musculoskeletal injuries coding system. During the 1-year period, we were able to collect the charts of 127 patients, from which 104 patients met the inclusion criteria. Twenty-three patients were excluded because of missing data. Eight patients were missing radiographs, and 15 patients did not have sufficient data from the physical examination. A total of 104 patients with 127 thumbs remained in the sample for final analysis.

Inclusion criteria consisted of participants who were older than 18 years, were suffering with radial-sided hand or wrist pain, and who had multiple radiographic views of the relevant wrist or hand. Exclusion criteria included pediatric population and previous surgery on the thumb CMC joint.

Examiners

The senior author read all the hand radiographs, and if CMC OA was noted, he assigned a stage of OA based on the Eaton-Littler classification system.[10] A board-eligible hand surgeon also independently interpreted all the hand radiographs. Intraclass correlation (ICC) was performed to determine the level of agreement between the board-certified hand surgeon and board-eligible hand surgeon.

Test procedure

After establishing that the patient was in clinic for basal thumb pain, the patient was evaluated with a grind test, MC flexion, MC extension, and pressure-shear tests performed by the senior author.

During the testing, the examiner asked the participant to report if he or she experienced any pain in that region during each of the provocative maneuvers. If so, it was recorded as a positive value for that particular test.

The *grind test* (Figure 1A) was performed by the examiner grasping the participant's hand with his hand for support on the examination table. The patient's wrist and finger metacarpals were placed in a neutral position. With his other hand, the examiner performed a grind test by grasping and rotating the subjects thumb MC while applying axial compression of the MC onto the trapezium. The grind test was considered positive if the subject reported any pain (even a slight painful sensation) or other sensations such as crepitus in the basal joint region of the thumb.[11-13]

The *pressure-shear test* (Figure 1B) was performed by the examiner grasping the participant's hand with his hand for support on the examination table. The patient's wrist and finger metacarpals were placed in a neutral position. The examiner then

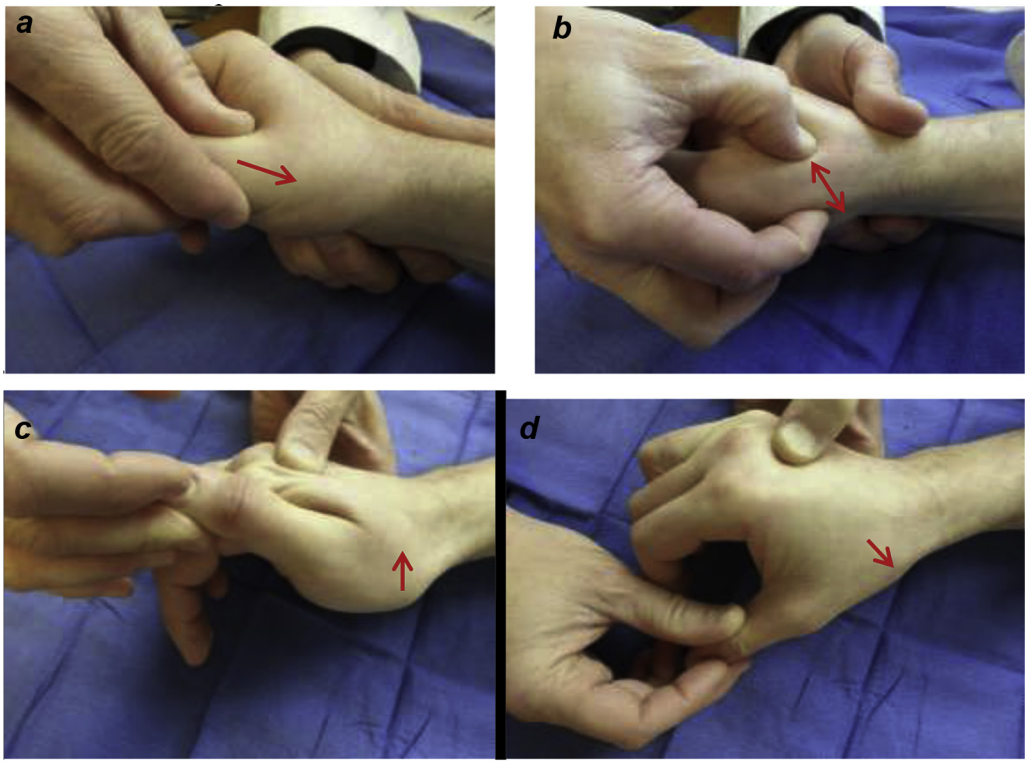

Figure 1. (**A**) The grind test. (**B**) The metacarpal pressure-shear test. (**C**) The metacarpal extension test. (**D**) The metacarpal flexion test.

Table 1
Frequency and percentages of radiographic interpretations by the attending physician and hand fellow

Physician	Normal radiograph, *n* (%)	Eaton-Littler classification			
		I, *n* (%)	II, *n* (%)	III, *n* (%)	IV, *n* (%)
Board-certified hand surgeon	22 (17)	0 (0)	27 (21)	56 (44)	22 (17)
Hand fellow	22 (17)	4 (3)	32 (25)	47 (37)	22 (17)

applied pressure over the anterior oblique ligament (AOL) and created a shearing force across the CMC joint by rocking the MC across the trapezium. The test was considered positive if the subject reported any pain (even a slight painful sensation) in the basal joint region of the thumb.

The *MC flexion and MC extension tests* (Figures 1C and 1D) were performed with the examiner grasping the participant's hand with his hand for support on the examination table. The patient's wrist and finger metacarpals were placed in a neutral position. The other hand of the examiner placed the MC in flexion. After soliciting a response to whether the flexed position created pain, the MC was extended. The tests were considered positive if the subject reported any pain (even a slight painful sensation) in the basal joint region of the thumb.

Descriptive statistics and statistical analysis were performed using SPSS, version 22 (IBM Corporation, Armonk, NY). Polychoric correlation coefficients were computed using R 3.0.0 software (R Foundation for Statistical Computing, Vienna, Austria) and the user-written package psych. To assess reliability of the radiographic measurements, ICC was performed to compare radiographic evaluation graded using the Eaton-Littler classification system between a board-certified hand surgeon and a board-eligible hand surgeon. Patients with Eaton-Littler classifications stage I-IV were designated as positive cases for the purpose of calculating overall diagnostic accuracy, sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). This classification formed the basis for this study benchmark, against which each of the clinical diagnostic tests' results (positive or negative) was compared. Diagnostic accuracy was calculated as the total percentage of thumbs for which each clinical diagnostic test reached the same positive or negative conclusion as the radiograph. Posterior-anterior and lateral thumb radiographs were using the Eaton stage I-IV classification of OA.

Within cases defined as positive by the certified hand surgeon (Eaton-Littler stage I or greater), polychoric correlation coefficients were computed to further assess if the thumb MC grind, pressure-shear, flexion, and extension tests are associated with CMC OA radiograph severity. These correlation coefficients provide effect size estimates but no tests of statistical significance, so linear-by-linear test of trend *P* values are used as a rough approximation, with 2-sided $P < .05$ indicating a significant association.

Results

There were a total of 127 thumbs from 104 participants, with 23 of the participants having bilateral thumb involvement. Seventy-one (68%) were women, and 33 (32%) were men. The mean age was 59 years (range, 22-91). There was almost equal distribution between the 2 sides, with 60 right-side thumbs and 67 left-side thumbs. The ICC between board-certified surgeon and board-eligible surgeon for radiographic evaluation based on the Eaton-Littler classification was 0.932, in an analysis that included controls that were assigned stage 0. Of note, the board-certified surgeon and board-eligible surgeon agreed perfectly on stage 0 classification of all 22 thumbs identified as controls. Excluding controls and assessing exclusively the severity of positive cases, the ICC was 0.755. Due to the high reliability demonstrated by these ICC values, the Eaton-Littler classifications were used for all subsequent analyses. Please refer to Table 1 for a summary of the radiographic interpretations.

The true prevalence of CMC OA in our sample, based on radiographic evidence, was 105 of 127 thumbs (83%). The apparent prevalence of CMC OA, or the rate of positive tests, for the thumb MC grind, pressure-shear, flexion, and extension tests was 53%, 83%, 30%, and 38%, respectively.

All the 4 clinical diagnostic tests demonstrated high specificity. The specificity for the grind, pressure-shear, flexion, and extension tests was 100%, 95%, 100%, and 100%, respectively. There were differences in sensitivity values between these 4 tests. The sensitivities of thumb MC grind, pressure-shear, flexion, and extension tests were 64% (54-73), 99% (95-100), 36% (27-46), and 46% (36-56), respectively. Please refer to Table 2 for a summary of the diagnostic accuracy, sensitivity, specificity, PPV, and NPV for the clinical diagnostic tests.

The linear-by-linear test of trend indicated that the grind and extension tests were statistically significant in terms of test positive rates increasing linearly with radiographic classifications with *P* values of .015 and .008, respectively. Consistent with this finding are the polychoric correlation coefficients for the grind, pressure-shear, flexion, and extension tests of 0.33, 0.12, 0.25, and 0.36, respectively. Please refer to Tables 3 and 4 for summaries of the linear-by-linear association test and the polychoric correlation test.

Discussion

We developed the provocative maneuver to create tension in the anterior capsule containing the AOL, while placing pressure on the ligament under tension simultaneously shearing the MC across the trapezium. It is our impression that most of the discomfort from this maneuver emanates from the anterior capsule and AOL indicating the presence of CMC OA.

The radiographic interpretations using the Eaton-Littler classification system demonstrated high reliability between the board-certified surgeon and board-eligible surgeon, making it a useful tool for evaluating CMC OA in our sample. The pressure-shear test was the superior clinical diagnostic test compared with the MC grind, flexion, and extension tests as evidenced by its high diagnostic accuracy, sensitivity, and specificity. Of the 127 thumbs in our sample, the pressure-shear test erroneously classified only 2 patients, which included 1 case and 1 control. The second best

Table 2
Statistical analysis of the 4 diagnostic tests for thumb CMC arthritis

Test	Diagnostic accuracy	Sensitivity	Specificity	PPV	NPV
	95% CI				
Grind test	70 (61-78)	64 (54-73)	100 (78-100)	100 (92-100)	37 (25-50)
MC pressure-shear test	98 (94-100)	99 (95-100)	95 (77-100)	99 (95-100)	95 (77-100)
MC flexion test	47 (38-56)	36 (27-46)	100 (78-100)	100 (87-100)	25 (16-35)
MC extension test	55 (46-64)	46 (36-56)	100 (78-100)	100 (89-100)	28 (18-39)

CMC = carpometacarpal; CI = confidence interval; PPV = positive predictive value; NPV = negative predictive value; MC = metacarpal.

Table 3
Linear-by-linear test of trend among patients with thumb CMC arthritis, as defined by board-certified hand surgeon radiograph interpretation

	Eaton-Littler type II, *n* (%)[a]	Eaton-Littler type III, *n* (%)	Eaton-Littler type IV, *n* (%)	*P*
(+) Grind test	11 (41)	40 (71)	16 (73)	.015
(+) MC pressure-shear test	26 (96)	56 (100)	22 (100)	.467
(+) MC flexion test	4 (15)	26 (46)	8 (36)	.085
(+) MC extension test	7 (26)	27 (48)	14 (64)	.008

CMC = carpometacarpal; MC = metacarpal.
[a] The board-certified hand surgeon did not classify any patients in the cohort with Eaton-Littler type I CMC osteoarthritis.

diagnostic test, in our study, was the grind test. Similar to the flexion and extension tests, the grind test had perfect specificity. However, the grind test had markedly higher diagnostic accuracy and sensitivity compared with the flexion and extension tests.

Both PPV and NPV depend on the prevalence of the CMC OA. Given that the prevalence of CMC arthritis in our study sample is 83%, the PPV and NPV calculated in the study are only applicable to patient populations that present to a surgery clinic with radial-sided hand or wrist pain. In contrast, sensitivity and specificity do not depend on disease prevalence and are broadly generalizable to various populations.

Positive and negative likelihood ratios were not reported in this study because the positive likelihood ratio could not be calculated for the flexion, extension, and grind tests. These tests were found to have perfect specificity, which results in an undefined likelihood ratio. It was the impression of the authors that reporting an incomplete set of positive and negative likelihood ratios would not be of informative value.

This study showed that the grind test, MC flexion, MC extension, and pressure-shear tests can be useful in the diagnosis of thumb CMC OA; however, the lesser known pressure-shear test was more sensitive with higher diagnostic accuracy compared with the other tests. We found 3 studies in the literature that evaluated thumb basal joint arthritis provocation tests.

Merritt et al[8] concluded that a positive grind test is very useful for confirming a diagnosis of thumb CMC OA. They additionally concluded that a negative grind test is also useful in identifying persons who do not have thumb CMC OA. Both the sensitivity and the negative predictive value were only moderate, and a negative grind test did not necessarily reflect negative radiographic evidence of thumb CMC OA.[8]

Gelberman et al[1] concluded that each of the adduction and extension tests proved to be more sensitive than the grind test for the detection of CMC arthritis. They additionally stated that the MC adduction and extension maneuvers demonstrated excellent utility as a screening test for identifying CMC arthritis. The sensitivity of both these tests exceeded the grind test without compromising specificity. They also stated that the grind tests' poor sensitivity makes it a less useful screening tool because this maneuver does not consistently produce symptoms in patients with symptomatic trapeziometacarpal arthritis.[1]

Table 4
Polychoric correlation (−1 to 1) between board-certified surgeon's radiographic evaluation and grind, pressure-shear, flexion, and extension tests

	Correlation coefficient
Grind test	0.33
MC pressure-shear test	0.12
MC flexion test	0.25
MC extension test	0.36

MC = metacarpal.

Choa et al[9] whose study showed that the traction shift (subluxation-relocation) was more specific than the grind test. They concluded that the traction-shift test had greater sensitivity (66.7%) and specificity (100%) than the grind test (30% and 96.7%, respectively) while also demonstrating superior PPV (100%) and NPV (75%) than the grind test (90% and 58%, respectively). Choa et al[9] recommended that the grind test is not required for clinical examination of CMC OA and instead preferred the traction-shift test.

Limitations

Our study is limited by its retrospective nature. The optimal design for examining our 4 physical examination tests would be a prospective blind comparison between the tests and the correlation with the X-rays, in a consecutive series of patients from a relevant clinical population. The study also used 1 examiner, which limits the ability to generalize the results.

An individual who does not know the test results and clinical presentation should judge the radiographs if blinding is not maintained. Judgments of the radiographs may be influenced by expectations based on knowledge of the patient's test results or by some other clinical information.[7] In our study, both surgeons were blinded to the physical examination results when they retrospectively evaluated the radiographs. In all subjects, the grind test was performed first followed subsequently by the MC flexion, MC extension, and pressure-shear tests for each patient. Because the pressure-shear test was the last test performed by the examiner, it is possible that the joint was more painful and irritated.

Conclusion

Thumb CMC OA is a common problem encountered in hand surgery and hand therapy. The pressure-shear test seems to be superior to the commonly used grind maneuver and to the provocative maneuvers of MC flexion and MC extension for CMC OA diagnosis.

Acknowledgments

The authors thank Joelle Tighe and Edward Donley for assisting with the article submission. They also thank Daniel Winger and Li Wang at the Clinical & Translational Science Institute at the University of Pittsburgh for their help with the statistical analysis of this study.

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1. To establish inclusion in the study radiographs were performed and analyzed by
   a. a CHT
   b. a board certified hand surgeon
   c. a house radiologist
   d. an outside (i.e. not from the author's institution) expert in CMC arthritis
2. All tests were
   a. named but not described in mechanical detail
   b. equally accurate as diagnostic tools
   c. partially described such that experienced CHTs would likely have difficulty duplicating the tests clinically
   d. described in sufficient detail such that experienced CHTs could duplicate the tests clinically
3. The degree of CMC arthritis was determined using the _____ classification system
   a. Hunter-Mackin
   b. Osterman-Bora
   c. Eaton-Littler
   d. Evans-Burkhalter
4. The pressure-shear test was shown to have greater_____ than the other tests
   a. specificity
   b. sensitivity
   c. reliability
   d. validity
5. The pressure-shear test was shown to be the most diagnostically accurate test
   a. true
   b. false

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