Factors Associated With Radiographic Trapeziometacarpal Arthrosis in Patients Not Seeking Care for This Condition

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Abstract

Background: A common adage among hand surgeons is that the symptoms of trapeziometacarpal (TMC) arthrosis vary among patients independent of the radiographic severity. We studied factors associated with radiographic severity of TMC arthrosis, thumb pain, thumb-specific disability, pinch strength, and grip strength in patients not seeking care for TMC arthrosis. Our primary null hypothesis was that there are no factors independently associated with radiographic severity of TMC arthrosis according to the Eaton classification among patients not seeking care for TMC arthrosis. **Methods:** We enrolled 59 adult patients not seeking care for TMC arthrosis. We graded patients' radiographic TMC arthrosis and asked all patients to complete a set of questionnaires: demographic survey, pain scale, TMC joint arthrosis–related symptoms and disability questionnaire (TASD), and a depression questionnaire. Metacarpophalangeal hyperextension and pinch and grip strength were measured, and the grind test and shoulder sign were performed. **Results:** Older age was the only factor associated with more advanced radiographic pathophysiology of TMC arthrosis. One in 5 patients not seeking care for TMC arthrosis experienced thumb pain; no factors were independently associated with having pain or limitations related to TMC arthrosis. Youth and male sex were associated with stronger pinch and grip strength. **Conclusions:** There are a large number of patients with relatively asymptomatic TMC arthrosis. Metacarpophalangeal hyperextension and female sex may have a relationship with symptoms, but further study is needed. Our data support the concept that TMC arthrosis does not correlate with radiographic arthrosis.

Keywords: Eaton, incidental, MCP hyperextension, risk factors, trapeziometacarpal arthrosis

Introduction

Although trapeziometacarpal (TMC) arthrosis is highly prevalent, not all patients seek care from a hand surgeon for pain or disability.^{4,21} It is commonly believed that patients with more severe symptoms tend to seek medical attention, while those with milder symptoms do not.^{5,7,16} Some studies have suggested there is more variation in magnitude of disability than there is variation in pathophysiology. For instance, patients with incidental clinical signs of advanced TMC arthrosis such as crepitation with the grind test have less pain, fewer limitations, fewer depressive symptoms, less catastrophic thinking, and greater self-efficacy when in pain than patients seeking care for severe TMC arthrosis.⁵ Nevertheless, deformity and radiographic changes are often used to justify a recommendation for surgery.^{5,7,14}

A common adage among hand surgeons is that the symptoms of TMC arthrosis vary among patients independent of radiographic severity. This study seeks to investigate this concept. Radiographic TMC arthrosis is more common and

increasingly severe with age and perhaps sex, but it remains unclear whether there are other independent predictors of radiographic severity in TMC arthrosis.^{4,7,21}

Our primary null hypothesis was that there are no factors independently associated with radiographic severity of incidental TMC arthrosis according to the Eaton classification among patients not seeking care for TMC arthrosis. Secondary aims were to study factors associated with pain and disability in these patients. Therefore, we sought factors

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associated with thumb pain, thumb arthrosis–related symptoms and disability, pinch strength, and grip strength among patients not seeking care for TMC arthrosis.

Materials and Methods

Study Design

With Internal Review Board approval, we performed a cross-sectional study. We invited 78 patients greater than 55 years old presenting for the first time to one of 2 surgeons in an upper extremity clinic within a tertiary care center in the northeastern United States. Patients were enrolled between January 2015 and June 2016—one clinic day per week. Exclusion criteria were prior consultation for TMC arthrosis with a hand surgeon, prior nonoperative or operative treatment of TMC arthrosis, prior diagnosis of rheumatoid arthritis or psoriasis, and if patients were seeking care for thumb-related problem(s) or complaint(s) at the time of visit. Sixteen patients chose not to participate in this study and 3 patients did not complete this study due to time constraints, leaving 59 patients for analysis. After obtaining written, informed consent, patients were asked by a research fellow not involved in patient care to complete the following: (1) a sociodemographic survey; (2) numerical rating scale (NRS) for thumb pain at rest and with activity (0–10); (3) questionnaire regarding TMC arthrosis–related symptoms and functional status; and (4) Patient-Reported Outcomes Measurement Information System (PROMIS)–Depression. If the patient experienced thumb pain, we recorded the date of symptom onset. The research fellow also measured thumb metacarpophalangeal (MCP) hyperextension, grip strength, and pinch strength. A Robert view radiograph of each patient's thumbs using mini C-arm fluoroscopy was obtained.

In addition, the physician completed a physical exam and recorded thumb findings (grind test, shoulder sign, and static and passive MCP hyperextension). Each patient's medical record was reviewed following the visit for final diagnosis (Online Appendix 1) and whether the diagnosis involved the right, left, or both sides.

Measurements

Our primary outcome measure was radiographic TMC arthrosis grade according to the Eaton classification.^{11,18} One of the attending surgeons, blinded to the patient's identity, graded the radiographs for each patient. This outcome variable was categorized as either Eaton grade I, grade II, or grade III/IV; we chose to consolidate stages III/IV into one group as our focus was on the TMC joint and not the scaphotrapezotrapezoidal (STT) joint. After grading all radiographs, we included 1 hand per patient for analysis by choosing the hand with the more advanced pathology. Four

patients had a radiograph available of one hand, and 3 patients had a condition which influenced our physical exam findings; for these 3 patients, we included the hand for which they were not seeking care.

Overall pain intensity at the base of the thumb(s) was measured with an 11-point numerical scale from 0 representing no pain to 10 representing the worst pain ever.¹² The variable thumb pain was dichotomized as either experiencing thumb pain or not experiencing thumb pain.

The TMC joint arthrosis–related symptoms and disability questionnaire (TASD) scores TMC arthrosis symptoms and disability on a 5-point Likert-scale.⁶ The questionnaire consists of 7 questions assessing TMC arthrosis symptoms and 5 questions assessing TMC arthrosis–related disability. Scores range from 12 to 60 points, with higher scores indicating more symptoms or greater disability.

Key pinch strength was measured with a B&L pinch gauge and grip strength with a Jamar dynamometer¹⁷; both were recorded as the average of 3 attempts.

Regarding the collected sociodemographic variables, we dichotomized race (white or nonwhite), marital status (married or not married), and avocation (using hands or not using hands), and categorized the variable occupation (high hand activity, medium hand activity, or low hand activity). The body mass index was calculated for each patient from the vital signs.

The PROMIS Depression questionnaire measures the severity of depression. Based on patients' answers, a *T* score was employed; the PROMIS depression mean of 50 corresponds with the mean for the U.S. general population.¹⁹

Metacarpophalangeal hyperextension (degrees) was measured in active extension and pinch position using a goniometer and was dichotomized as either having hyperextension or not.

During the physical exam, the physician recorded whether the patient had a positive grind test—this was considered positive when a combined rotation and axial compression of the TMC joint elicited pain in the examined joint—and whether the patient presented with a shoulder sign—radial prominence from dorsal subluxation at the base of the thumb.

Sample Size Calculation

An a priori sample size calculation, using a 2-sided Spearman correlation coefficient, showed that we needed 84 patients with α set at 0.05 and a power of 80%, to detect a 0.30 correlation between Eaton classification and a continuous predictor. Due to a violation in proper fluoroscopy use, enrollment for this study was prematurely terminated. This analysis includes the 59 patients who completed the study. A posttest power calculation (dichotomizing Eaton stage: 41 patients with Eaton stage I/II vs 18 patients with Eaton stage III) demonstrated that 59 patients provided 80%

statistical power to detect a significant difference in proportion of 0.39 with a 2-tailed alpha of 0.05 between the 2 groups regarding avocation using hands.

Statistical Analysis

Potential association of explanatory variables with our main outcome variable—Eaton classification—was assessed using the analysis of variance (ANOVA), Kruskal-Wallis, and 2-sided Fisher exact test based on variable type and distribution.

For our secondary hypotheses, thumb pain (dichotomous outcome), and TASD score, pinch strength, and grip strength (continuous outcomes), bivariate analysis was also performed. Association of explanatory variables with our secondary outcome variables was assessed using Spearman or Pearson correlation, ANOVA, Mann-Whitney *U* test, 2-sided Fisher exact test, Kruskal-Wallis test, and an unpaired Student *t* test, based on variable type and distribution.

Continuous data were tested for their normality using the Shapiro-Wilk test and presented as either mean with standard deviation (SD), median with interquartile range (IQR), or the correlation between 2 continuous variables. Dichotomous and categorical data were presented as frequencies with percentages.

We entered all significant ($P < .05$) and near-significant ($P < .10$) variables in the multivariable analysis to control for potential confounders; multivariable logistic regression analysis was used to determine factors independently associated with the presence of thumb pain and multivariable linear regression analysis to determine factors independently associated with higher TASD score, stronger pinch, and stronger grip strength.

Odds ratios (ORs) or coefficients were provided with 95% confidence intervals (CI) and *P* values. A 2-tailed *P* value of less than .05 was considered significant.

The area under the receiver operating characteristic curve, pseudo R^2 , and the Hosmer-Lemeshow test were calculated for our multivariable logistic regression analysis and the R^2 for our multivariable linear regression analysis to assess model fit and variation in our outcome variable that could be explained by the variables included in the model.

Patient Characteristics

Our study population consisted of 32 women (54%) and 27 men with a median (IQR) age of 67 (61-76) years. Most patients were white (95%), were married (69%), and had Eaton grade II TMC arthrosis (61%).

Results

In bivariate analysis, older age was the only factor associated with a more advanced stage of TMC arthrosis accord-

ing to the Eaton classification ($P = .038$; Table 1). Therefore, we did not perform multivariable analysis.

In bivariate analysis, thumb pain was related to active thumb MCP hyperextension ($P = .038$; Table 2). No factors were independently associated with experiencing thumb pain in multivariable logistic regression analysis (Table 3).

Female gender ($P = .014$) was associated with a higher TASD score in bivariate analysis (Table 4). In the multivariable linear regression analysis, no factors were independently associated with a higher TASD score (Table 5).

In bivariate analysis, the following factors were associated with stronger pinch strength: younger age ($P = .049$), male gender ($P < .001$), and not having a shoulder sign ($P = .038$) (Online Appendix 2). Multivariable linear regression analysis showed that younger patients (coefficient: -1.0 ; SE: 0.31 ; 95% CI: -1.6 to -0.40 ; $P = .0020$) and male patients (coefficient: 39 ; SE: 5.2 ; 95% CI: $29-50$; $P < .001$) were more likely to have stronger pinch strength (Online Appendix 3A).

Younger age ($P = .0016$), being male ($P < .001$), non-dominant hand ($P = .044$), and a negative grind test ($P = .022$) were associated with having stronger grip strength in bivariate analysis (Online Appendix 2). In multivariable linear regression analysis, younger age (coefficient: -0.95 ; SE: 0.30 ; 95% CI: -1.55 to -0.35 ; $P = .0020$) and being male (coefficient: 39 ; SE: 5.3 ; 95% CI: $28-49$; $P < .001$) were independently associated with stronger grip strength (Online Appendix 3B).

Discussion

We studied factors associated with radiographic severity, pain, disability, pinch strength, and grip strength in patients not seeking care for TMC arthrosis. Older age was the only factor associated with more advanced radiographic TMC arthrosis. One in 5 patients not seeking care for TMC arthrosis experienced thumb pain; no factors were independently associated with having pain or limitations related to TMC arthrosis. Youth and male sex were associated with stronger pinch and grip strength.

This study has some limitations. First, we had to terminate the study prematurely, which limited the power of the study to demonstrate an association with each of the explanatory variables. For instance, MCP hyperextension could be associated with greater pain intensity in a larger study (Table 3). A larger study might have identified the relatively consistent association of magnitude of disability with symptoms of depression (Table 5). Second, this study was performed in a single urban hospital with mostly white patients, which might not reflect the average US population. Third, all patients we included were seeking care for another hand or upper extremity condition. Other conditions may have affected the grip and pinch strength. We tried to anticipate this confounder. In 3 patients, we evaluated the TMC joint of the contralateral upper extremity for analysis because the

Table 1. Bivariate Analysis: Factors Associated With Eaton Classification (n = 59).

	Eaton stage I (n = 5, 8%)	Eaton stage II (n = 36, 61%)	Eaton stage III (n = 18, 31%)	P value
ANOVA, mean (SD)				
Education, y	14 (2.4)	16 (2.6)	16 (3.4)	.51
Kruskal-Wallis test, median (IQR)				
Age, y	61 (56-66)	66 (62-70)	75 (66-82)	.038
Body mass index	23 (21-27)	28 (23-31)	29 (24-33)	.25
PROMIS–Depression	41 (34-50)	45 (34-50)	41 (34-48)	.91
Fisher exact test, n (%)				
Male	2 (40)	20 (56)	5 (28)	.15
White	5 (100)	35 (97)	16 (89)	.16
Married	3 (60)	27 (75)	10 (56)	.23
Smoker	1 (20)	1 (3)	1 (6)	.50
Dominant hand	1 (20)	14 (39)	11 (61)	.17
Avocation using hands	3 (60)	21 (58)	13 (72)	.60
Occupation				.33
High hand activity	3 (60)	8 (22)	4 (22)	
Medium hand activity	0 (0)	13 (36)	8 (44)	
Low hand activity	2 (40)	15 (42)	6 (33)	

Note. Bold *P* values represent statistically significant *P* values. ANOVA = analysis of variance; IQR = interquartile range; PROMIS = Patient-Reported Outcomes Measurement Information System.

Table 2. Bivariate Analysis: Factors Associated With Thumb Pain (n = 59).

	Thumb pain		P value
	Yes (n = 11, 19%)	No (n = 48, 81%)	
t test, mean (SD)			
Education, y	16 (3.6)	15 (2.7)	.39
Mann-Whitney <i>U</i> test, median (IQR)			
Age, y	66 (58-82)	68 (62-76)	.34
Body mass index	24 (23-28)	28 (24-32)	.20
PROMIS–Depression	46 (34-50)	42 (34-50)	.84
Fisher exact test, n (%)			
Male	3 (27)	24 (50)	.20
White	11 (100)	45 (94)	.99
Married	7 (64)	33 (69)	.73
Smoker	1 (9)	2 (4)	.47
Dominant hand	5 (45)	21 (44)	.59
Prior hand or arm surgery	5 (45)	27 (56)	.74
Avocation using hands	7 (64)	30 (63)	.99
Shoulder sign	4 (36)	6 (13)	.079 ^a
Active thumb MCP joint hyperextension	10 (91)	26 (54)	.038^a
Thumb MCP joint hyperextension in pinch position	10 (91)	31 (65)	.15
Eaton classification			.15
Stage I	0 (0)	5 (100)	
Stage II	6 (17)	30 (83)	
Stage III	5 (28)	13 (72)	
Occupation			0.99
High hand activity	3 (27)	12 (25)	
Medium hand activity	4 (36)	17 (35)	
Low hand activity	4 (36)	19 (40)	

Note. Bold *P* values represent statistically significant *P* values. IQR = interquartile range; PROMIS = Patient-Reported Outcomes Measurement Information System; MCP = metacarpophalangeal.

^aIncluded in multivariable logistic regression analysis.

Table 3. Multivariable Logistic Regression Analysis: Factors Associated With Thumb Pain (n = 59).

Parameter	Odds ratio	Standard error	95% CI	P value
Active thumb MCP joint hyperextension	8.3	9.2	0.96-72	.055
Shoulder sign	3.9	3.2	0.79-19	.096

Note. Area under the receiver operating characteristic curve = 0.75; Pseudo R^2 = 0.15. P value for Hosmer-Lemeshow test = .55. CI = confidence interval; MCP = metacarpophalangeal.

Table 4. Bivariate Analysis: Factors Associated With TMC Joint Arthrosis–Related Symptoms and Disability Questionnaire (n = 59).

	Correlation	P value
Spearman correlation		
Age, y	NS	.29
Body mass index	NS	.078 ^a
Education, y	NS	.60
PROMIS–Depression	NS	.077 ^a
Mann-Whitney U test, median (IQR)		
Sex		.014^a
Male	12 (12-14)	
Female	14 (12-20)	
White	NS	.65
Married	NS	.49
Smoker	NS	.55
Dominant hand	NS	.44
Prior hand or arm surgery	NS	.52
Avocation using hands	NS	.50
Positive grind test	NS	.14
Shoulder sign	NS	.19
Active thumb MCP joint hyperextension	NS	.93
Thumb MCP joint hyperextension in pinch position	NS	.42
Kruskal-Wallis test, median (IQR)		
Eaton classification (stage I, II, III)	NS	.37
Occupation (high, medium, low hand activity)	NS	.74

Note. Bold P values represent statistically significant P values. TMC = trapeziometacarpal; PROMIS = Patient-Reported Outcomes Measurement Information System; IQR = interquartile range; MCP = metacarpophalangeal; NS = not significant.

^aIncluded in multivariable linear regression analysis.

presenting condition could influence physical exam findings. Also, our results might be different if we focused on a set of subjects with a single presenting complaint. We chose to include the complete spectrum of hand and upper extremity conditions as we feel it represents the typical patient population presenting to an upper extremity service. Fourth,

the Eaton grading was based on a single Robert view and graded by one hand surgeon, but we anticipate that interrater differences would contribute minimally to the results presented here.¹⁵ And finally, for our variable hyperextension of the thumb MCP joint, we only measured the degrees of maximal hyperextension.

In line with current evidence,^{4,14,21} the only factor associated with more advanced radiographic TMC arthrosis was older age. We did not observe an association between hand use and TMC arthrosis.

More severe arthritis was not associated with greater pain. Active thumb MCP hyperextension might have been independently associated with greater thumb pain if the study was larger. Prior studies have associated the occurrence of MCP hyperextension deformity with more advanced stages of TMC arthrosis, and MCP hyperextension in our study functions as a surrogate for TMC severity, especially in patients with stage III/IV disease.¹ An alternative interpretation is that MCP hyperextension has a biomechanical effect that exacerbates TMC arthrosis, or the arthrosis experienced by patients with MCP hyperextension is biomechanically different than those without MCP hyperextension. Residual pain after TMC arthroplasty is often ascribed to undertreated thumb MCP hyperextension, but there are limited data to support this idea to date.^{3,9,10,13}

No factors were independently associated with greater symptoms and limitations from TMC arthrosis. A larger number of patients might have detected small correlations with symptoms of depression—correlations that are observed in other studies.⁸ Similarly for the association with female sex in bivariate analysis, previous literature reports 10 to 15 times higher numbers of women with symptomatic TMC arthrosis.²² There is speculation that there is a higher degree of stress on the TMC joint in women because of the difference in anatomic shape and size of trapezial surface.²

Our observation that younger and male patients had stronger pinch and grip strength is as expected. Men have stronger pinch strength than women on average.²³ Strength also decreases with increasing age.²⁰

The examination of patients not seeking care for TMC arthrosis can give us insights into why patients may develop symptoms in a way that the study of symptomatic patients cannot. Thumb MCP hyperextension likely has some contribution to TMC joint pain and female sex may have some relationship to patients who experience symptoms from TMC arthrosis, but it is unclear how and to what degree these factors play a role. Our study supports the concept that the symptoms of TMC arthrosis do not correlate to radiographic severity but did not have adequate power to establish that there is no relationship. Despite this, we can recognize that radiographic severity is not a good predictor of symptoms and approaches to TMC arthrosis should take this into account.

Table 5. Multivariable Linear Regression Analysis: Factors Associated With Higher TASD Score (n = 59).

Parameter	Coefficient	Standard error	95% CI	P value
Body mass index	-0.025	0.13	-0.29 to 0.24	.85
PROMIS–Depression	0.16	0.083	-0.010 to 0.32	.066
Male	-2.6	1.5	-5.5 to 0.41	.090

Note. $R^2 = 0.10$. TMC = trapeziometacarpal; TASD = TMC joint arthrosis–related symptoms and disability questionnaire; CI = confidence interval; PROMIS = Patient-Reported Outcomes Measurement Information System.

Authors' Note

The work was performed at the Department of Orthopedic Surgery, Hand and Upper Extremity Service, Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts, USA

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Statement of Informed Consent

Written informed consent was obtained for each patient.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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