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Examining the Association Between Musculoskeletal Injuries and Carpal Tunnel Syndrome in Manual Laborers

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Abstract

Introduction—The association between musculoskeletal injuries and carpal tunnel syndrome (CTS) has not been investigated in a large, population-based study.

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Dr. Quandt participated in study concept and design, acquisition of data, analysis and interpretation of data, critical revision of the manuscript for important intellectual content, and study supervision.

Methods—Latino manual laborers were recruited as part of a study of work-related health conditions. Each had a clinical examination, completed a hand diagram, and had nerve conduction studies.

Results—512 individuals completed all testing. An association was found between rotator cuff syndrome and CTS, with an adjusted odds ratio of 2.25 ($P = 0.01$) for the right arm, 2.08 ($P = 0.03$) for the left arm, and 1.84 ($P = 0.03$) for all individuals. Associations between epicondylitis and CTS did not reach statistical significance.

Conclusions—Individuals with rotator cuff syndrome have a higher prevalence of CTS. Further investigations will be needed to examine for causation and to determine if one condition typically occurs first and leads to the other.

Keywords

Rotator cuff syndrome; epicondylitis; carpal tunnel syndrome; manual labor; low back pain

Introduction

Carpal tunnel syndrome (CTS) is a condition in which pain, numbness, and/or weakness occur in the wrist, hand, and fingers as a result of irritation to the median nerve at the wrist.[1] It affects 3% of adults and results in over $1 billion in health care expenditures annually in the United States.[2–5] CTS is very common and costly, thus identification of risk factors and associated conditions is of interest, as they may provide targets for prevention and treatment efforts.

Known risk factors for CTS include female gender, pregnancy, obesity, and manual labor; and it is suspected that adverse ergonomic factors such as repetitive movements or certain postures may also increase the risk of CTS.[1,6,7] Musculoskeletal injuries, which are also common in manual laborers,[8] may force affected individuals to adopt adverse postures, which could increase the risk of CTS. Conversely, CTS could be the initiating condition that leads to adverse posture and increases the risk of musculoskeletal injuries. An association between CTS and musculoskeletal injuries (rotator cuff syndrome and lateral epicondylitis) has been demonstrated in large database studies in which the diagnoses were included in the medical record but not confirmed with specific testing,[9,10] but population-based studies in which confirmative clinical examinations and diagnostic testing are performed have not been conducted to analyze this association. Therefore, this study was designed to assess the association between CTS and musculoskeletal injuries in Latino manual laborers, all of whom underwent clinical examinations for the conditions of interest.

Methods

This study was part of a larger project to evaluate the prevalence and incidence of dermatologic, respiratory, musculoskeletal, and neuromuscular conditions in Latino poultry workers and other manual workers, and aspects of this study, including methodology, have been described previously.[6,8,11] The Wake Forest School of Medicine Institutional Review Board approved the study. All participants signed informed consent, and each participant was paid $40 for participating in the initial interview and data collection clinic.

Participants

Individuals recruited to participate in this study were Latino poultry and non-poultry manual-labor workers from 4 rural counties in western North Carolina (Burke, Surry, Wilkes, and Yadkin). In order for participants to be recruited for this study, they must have worked 35 hours or more in a manual-labor job, be self-identified as Hispanic or Latino, and have been at least 18 years old. A non-managerial job was the major benchmark for the classification of a manual labor position, which included jobs in industries such as manufacturing, construction, landscaping, and hospitality. A member of this community worked with the research team to recruit participants.

Data Collection

During the span of the study (June 2009 to November 2010) community and study personnel recruited participants, and those who chose to participate underwent an hour-long interview during which they answered questions regarding their work and health. These participants were then invited to attend data collection clinics that took place on 7 Sundays during the course of the study. At the clinics, participants completed a short questionnaire in which they reported any changes in occupation or health since the initial meeting. Participants also self-reported any pain in the shoulders, elbows, or low back that occurred 2 or more days during the preceding month. Two sports medicine physicians blinded to the participants' occupation conducted musculoskeletal examinations, with particular focus on the site of pain. These sports medicine physicians then established a clinical diagnosis of rotator cuff syndrome, epicondylitis, low back pain, or no musculoskeletal condition.

At the data collection clinics, participants also underwent nerve conduction studies on bilateral wrists, after the hands were warmed to 32 degrees C. Median and ulnar antidromic sensory studies were done via stimulation of the wrist 140 mm proximal to ring electrodes located on the second and fifth fingers. A Teca TD10 Electromyograph (Teca Corporation, Pleasantville, KY) was used to obtain the nerve conduction data. Orthodromic median motor studies, recorded from the abductor pollicis brevis muscle were performed on those without median sensory nerve action potentials. The technicians who performed the studies were unaware of participant's clinical evaluation or occupation, and all had at least 5 years of experience.

Measurements

Self-reported symptoms and a focused examination were used to define specific musculoskeletal injuries. The criteria for rotator cuff syndrome, epicondylitis, and low back pain were based on previously published case definitions.[12,13] Rotator cuff syndrome was defined as pain associated with resistance during shoulder abduction, external rotation, internal rotation, elbow flexion, or painful arc on active upper arm elevation. Epicondylitis was defined as local pain associated with resistance during wrist extension (lateral) or wrist flexion (medial). Low back pain was defined as pain felt in the lumbar region due to extension, active flexion, left or right side-bending and twisting, or tenderness to palpation.

CTS was defined based upon a combination of the Katz hand diagram and nerve conduction studies.[14] Each hand diagram was scored independently by 2 neurologists, and no scores differed. Those who scored a 1, 2, or 3 on the hand diagram were assigned an overall score of 1, and others were assigned a score of 0. Median and ulnar sensory peak latencies were compared to assess for slowing of the median nerve conduction velocity. If the median latency was less than 0.49 ms longer than the ulnar, it was scored as 0; if it was 0.50 to 0.79 ms longer, it was scored as 1; and if it was greater than 0.80 ms longer, it was scored as 2. The symptom score and nerve conduction score were then added, and a total score of 0 was defined as "no CTS," 1–2 as "possible CTS," and 3 as "CTS." This scoring system was applied to each wrist that was studied; and individuals were defined as having "no CTS" if both wrists were scored as 0, "possible CTS" if 1 or both wrists were scored as 1 or 2, and "CTS" if either wrist was scored as 3. This is the same scoring system used in previous large-scale studies of CTS, including studies of prevalence and incidence in this same population.[6,11,15]

Statistical Analyses

Continuous variables were evaluated as means and standard deviations, and discrete variables were evaluated as percentages and frequencies. Musculoskeletal injuries were treated as dichotomized variables for each individual, whereas CTS was treated as both a dichotomized variable and an ordinal variable, with "CTS," "possible CTS," and "no CTS" options in all the analyses (dichotomized to "CTS" and "possible CTS versus "no CTS"). In addition, analyses were performed on an individual level (without regard to affected side) as well as by left or right side. For example, models were created to answer the questions: (1) "If participants have rotator cuff syndrome (independent of affected side), are they more likely to have CTS (independent of affected side)?"; and (2) "If participants have right-sided rotator cuff syndrome, are they more likely to have right-sided CTS?"

Multivariate logistic regression models were created to address these questions, with CTS (either dichotomized or ordinal) as the outcome variable. Each model controlled for age, gender, body mass index (BMI), and occupation. All models also controlled for site strata and dwelling clustering, to account for study design. Results were analyzed using both a multivariate model including all musculoskeletal variables and individual multivariate models in which only a single musculoskeletal variable was included in each model. However, since a high association was found between rotator cuff syndrome and epicondylitis, only individual models are reported. In addition, none of the models showed an association between low back pain and CTS, so the modeling and results focused on just rotator cuff syndrome and epicondylitis and their association with CTS. All analyses were performed using SAS 9.4 (Cary, NC) and a 2-sided P-value < 0.05 was considered statistically significant.

Results

A total of 512 participants had musculoskeletal examinations, filled out the Katz hand diagram, and underwent nerve conduction studies. The mean age was 34.7, 45.7% were women, the mean BMI was 28.7, and 56.1% were poultry workers. When all participants were considered, 14.6% had rotator cuff syndrome, 5.7% had epicondylitis, and 48.6% had CTS (41.9% possible CTS and 6.6% CTS) in at least 1 upper extremity for each condition.

When considering just those with rotator cuff syndrome, 62.6% had CTS (49.3% possible CTS and 13.3% CTS), and when considering just those with epicondylitis, 72.4% had CTS (51.7% possible CTS and 20.7% CTS) (Table 1).

When modeling was conducted on an individual level, without regard to the affected side, those with rotator cuff syndrome had an adjusted odds ratio of having CTS of 1.66 ($P = 0.09$) when CTS was a dichotomized variable and an adjusted odds ratio of having more CTS of 1.84 ($P = 0.03$) when CTS was an ordinal variable. Similarly, those with epicondylitis had an adjusted odds ratio of having CTS of 1.91 ($P = 0.26$) when CTS was a dichotomized variable and an adjusted odds ratio of having more CTS of 2.26 ($P = 0.08$) when CTS was an ordinal variable (Table 2).

When modeling was conducted on a side-specific basis, further significant associations were detected between rotator cuff syndrome and CTS. Those with right-sided rotator cuff syndrome had an adjusted odds ratio of having right-sided CTS of 2.12 ($P = 0.03$) when CTS was a dichotomized variable and an adjusted odds ratio of 2.25 ($P = 0.01$) when CTS was an ordinal variable. On the left side, the adjusted odds ratio between rotator cuff syndrome and CTS was 1.71 ($P = 0.11$) with CTS as a dichotomized variable and 2.08 ($P = 0.03$) when CTS was an ordinal variable. As was found on an individual basis, when epicondylitis was examined on a side-specific basis the associations with CTS did not reach statistical significance (Table 3).

Discussion

This large, population-based study with primary data collection evaluated for an association between clinically-confirmed musculoskeletal injuries and CTS. The results show that those with rotator cuff syndrome and epicondylitis have more CTS than manual laborers without these musculoskeletal conditions. However, the association reached statistical significance only for rotator cuff syndrome and CTS. Although the association between epicondylitis and CTS did not reach statistical significance, this may be because there were fewer individuals in this study with epicondylitis than with rotator cuff syndrome. Since the rate of CTS in those with epicondylitis was actually higher than in those with rotator cuff syndrome, this suggests that perhaps inclusion of a larger number of study participants with epicondylitis would have shown a statistically significant association.

The association between rotator cuff syndrome and CTS appears consistent, as it was statistically significant each time the 2 conditions were evaluated with CTS as an ordinal variable. When CTS was considered as a dichotomized variable, the *P*-value was 0.03 for the right side, 0.11 for left side, and 0.09 for individuals. As with epicondylitis, it is suspected that a larger sample of participants may have resulted in more statistical tests reaching significance for the association between rotator cuff syndrome and CTS.

Two previous studies have examined the associations of rotator cuff syndrome and epicondylitis with CTS through case-control studies. Titchener and colleagues evaluated approximately 5000 patients in The Health Improvement Network database, which includes records from 479 general practices in the United Kingdom. Similar to our study, they found a significant association between rotator cuff syndrome and CTS (odds ratio of 1.55).[10] They were also able to show a significant association between lateral epicondylitis and CTS (odds ratio 1.50).[9] Their studies differed from our investigation in that they relied on diagnostic coding by primary care specialists, without standardized case definitions, directed histories or physical examinations, or electrodiagnostic testing.

While our study was able to show an association between musculoskeletal injuries and CTS, it was not designed to determine which upper extremity condition developed first. It seems plausible that musculoskeletal injuries lead to a change in posture, which ultimately results in CTS. However, it is also plausible that CTS is the inciting condition, which subsequently results in the development of musculoskeletal injuries. Further prospective investigations will be needed to determine which condition is the inciting event, and it is certainly possible that the development of either condition predisposes to the development of the other.

While this study had several strengths, including a large sample size and detailed clinical evaluations, there were some limitations. First, although there were 512 participants, we found only 75 with rotator cuff syndrome and 29 with epicondylitis. Second, there was an association between rotator cuff syndrome and epicondylitis, so it is difficult to tell for certain which musculoskeletal injury was more strongly associated with CTS. Third, imaging of the rotator cuff and epicondyle were not performed to provide another confirmatory test for the musculoskeletal conditions, as was done with nerve conduction studies and CTS. However, these musculoskeletal conditions are often diagnosed clinically, and imaging was not feasible from a financial or time standpoint. Future studies, perhaps using ultrasound to define both CTS and musculoskeletal conditions, could provide objective imaging evidence for all conditions evaluated. Fourth, it is not known if those who volunteered for the study are similar to the entire population of poultry workers, and it is possible that those with medical conditions may have been more likely to participate in this research. The poultry companies did not participate in this research, so the demographics of those working for the poultry companies are not known and therefore cannot be compared to the population in this study. However, it should be noted that this study did not focus only on musculoskeletal conditions, as it also investigated dermatologic and respiratory conditions. Finally, other underlying diagnoses, such as diabetes, inflammatory arthritis, and fibromyalgia were not accounted for in the statistical models, so it is possible that an underlying condition may explain the association between musculoskeletal injuries and CTS.[16] Interestingly, rotator cuff syndrome and epicondylitis may be less inflammatory than originally thought, and more related to neovascularization and mucoid degeneration.[17] Therefore, it is possible that a predisposition to such sub-synovial degeneration may increase the risk of a variety of musculoskeletal conditions, though this theory is not well-developed and is in need of much more investigation.

This large study is informative, as it confirms an association between musculoskeletal injuries and CTS. Further research will be needed to determine if 1 condition typically precedes the other. However, even without this knowledge it will be important for clinicians, manual laborers, employers, and policy makers to know of this association, as it may lead to earlier protective interventions in manual laborers with upper extremity musculoskeletal injuries who do not have CTS, and vice versa.

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Abbreviations

BMI	Body mass index
CTS	Carpal tunnel syndrome

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Table 1

Demographics of 512 Manual Laborers

Variable	Mean (Standard Deviation) or Percentage
Age	34.7 (10.4)
Women	45.7%
BMI	28.7 (4.9)
Poultry occupation	56.1%
Rotator cuff syndrome	14.6%
Epicondylitis	5.7%
Possible CTS	
All	41.9%
Those with rotator cuff syndrome	49.3%
Those with epicondylitis	51.7%
CTS	
All	6.6%
Those with rotator cuff syndrome	13.3%
Those with epicondylitis	20.7%

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Table 2

The Risk of CTS in Individuals with Rotator Cuff Syndrome and Epicondylitis (Analyses Independent of Side)

	Adjusted Odds Ratio	95% Confidence Interval	*P-value*
Log Odds of Having CTS vs No CTS (Dichotomized)			
Rotator cuff syndrome	1.66	0.92 to 2.99	0.09
Epicondylitis	1.91	0.62 to 5.91	0.26
Log Odds of Having More CTS (Ordinal)			
Rotator cuff syndrome	1.84	1.06 to 3.20	0.03
Epicondylitis	2.26	0.91 to 5.64	0.08

Values in this table are based on multivariate logistic regression, controlling for age, gender, BMI, and occupation.

Table 3

The Risk of CTS in Individuals with Rotator Cuff Syndrome and Epicondylitis (Side-Specific Analyses)

	Adjusted Odds Ratio	95% Confidence Interval	*P*-value
Log Odds of Having CTS vs No CTS (Dichotomized)			
Right Rotator Cuff Syndrome	2.12	1.06 to 4.23	0.03
Left Rotator Cuff Syndrome	1.71	0.89 to 3.28	0.11
Right Epicondylitis	1.79	0.59 to 5.47	0.31
Left Epicondylitis	2.29	0.63 to 8.33	0.21
Log Odds of Having More CTS (Ordinal)			
Right Rotator Cuff Syndrome	2.25	1.18 to 4.29	0.01
Left Rotator Cuff Syndrome	2.08	1.08 to 3.99	0.03
Right Epicondylitis	2.18	0.84 to 5.67	0.11
Left Epicondylitis	2.61	0.83 to 8.18	0.10

Values in this table are based on multivariate logistic regression, controlling for age, gender, BMI, and occupation.