

An Association between Carpal Tunnel Syndrome and Migraine Headaches—National Health Interview Survey, 2010

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Background: Migraine headaches have not historically been considered a compression neuropathy. Recent studies suggest that some migraines are successfully treated by targeted peripheral nerve decompression. Other compression neuropathies have previously been associated with one another. The goal of this study is to evaluate whether an association exists between migraines and carpal tunnel syndrome (CTS), the most common compression neuropathy.

Methods: Data from 25,880 respondents of the cross-sectional 2010 National Health Interview Survey were used to calculate nationally representative prevalence estimates and 95% confidence intervals (95% CIs) of CTS and migraine headaches. Logistic regression was used to calculate adjusted odds ratios (aORs) and 95% CI for the degree of association between migraines and CTS after controlling for known demographic and health-related factors.

Results: CTS was associated with older age, female gender, obesity, diabetes, and smoking. CTS was less common in Hispanics and Asians. Migraine was associated with younger age, female gender, obesity, diabetes, and current smoking. Migraine was less common in Asians. Migraine prevalence was 34% in those with CTS compared with 16% in those without CTS (aOR, 2.60; 95% CI, 2.16–3.13). CTS prevalence in patients with migraine headache was 8% compared with 3% in those without migraine headache (aOR, 2.67; 95% CI, 2.22–3.22).

Conclusions: This study is the first to demonstrate an association between CTS and migraine headache. Longitudinal and genetic studies with physician verification of migraine headaches and CTS are needed to further define this association. (*Plast Reconstr Surg Glob Open* 2015;3:e333; doi: 10.1097/GOX.0000000000000257; Published online 19 March 2015.)

Carpal tunnel syndrome and migraine headache are common disorders, affecting up to 6%^{1–5} and 15%^{6–12} of the adult population, respectively. Both result in substantial burden to patients and soci-

ety. Migraine headaches cause 112 million bedridden days per year^{13,14} and generate annual costs totaling up to 17 billion dollars in the United States alone.^{14,15} Carpal tunnel syndrome in the United States annually costs society in excess of 2 billion dollars.^{16,17} In spite of the high prevalence and socioeconomic burden imposed by carpal tunnel syndrome and migraine headache, the precise etiology of both conditions remains poorly understood.

Carpal tunnel syndrome is the most common disorder in a larger family of compression neuropathies, which includes cubital tunnel syndrome, peroneal neuropathy, tarsal tunnel syndrome, ra-

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dial tunnel syndrome, pronator syndrome, thoracic outlet syndrome, and others.^{18,19} Several studies in the literature support an epidemiologic association between different compression neuropathies such as cubital tunnel syndrome and carpal tunnel syndrome^{20,21} and thoracic outlet syndrome and carpal tunnel syndrome.^{22–26} The cause of these associations is poorly understood and may be multifactorial.

Migraine headache, on the other hand, has not historically been considered to be a compression neuropathy. Recently, however, there is some evidence that migraine headache may be triggered by nerve compression in the head and neck, with some patients responding to nerve decompression by surgical release.^{27–32} In addition, the effects of botulinum toxin, either by direct action on the nerve or by weakening of the overlying muscle, may point further to this theory.^{33–38} The purpose of this study is to evaluate the hypothesis that an association exists between carpal tunnel syndrome and migraine headache.

MATERIALS AND METHODS

Data from the Adult Core module of the 2010 National Health Interview Survey (NHIS) were used to calculate prevalence estimates for carpal tunnel syndrome and migraine headache.³⁹ The NHIS is an annual, in-person health survey of the civilian, non-institutionalized population of the United States. The survey is administrated throughout the year. Analyses were restricted to adults that provided complete information for carpal tunnel syndrome status, migraine headache status, and covariates as listed below. Race/ethnicity groups were excluded if unable to be included in the logistic regression analysis due to too few respondents. All estimates were calculated using provided final sample weights to produce nationally representative estimates that adjust for the stratified sampling design of the survey.

A case of carpal tunnel syndrome was defined as a respondent who answered “yes” to both questions, “Have you ever been told by a doctor or other health professional that you have a condition affecting the wrist and hand called carpal tunnel syndrome?” and “During the past 12 months have you had carpal tunnel syndrome?” A case of migraine headache was defined as a respondent who answered “yes” to the question, “During the past 3 months, did you have severe headache or migraine?” Demographic covariates included age (18–34, 35–49, 50–64, and ≥65 years); gender; and race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and Asian). Health status and behavior covariates included body mass index (BMI) (≤ 24.99 = healthy or underweight, 25.00–29.99 = overweight, and ≥ 30.00 = obese); dia-

betes status (yes/no); and smoking status (current, former, and never). These covariates have all previously been associated with these conditions and were available in this database. These age groups were selected to provide similar ranges of age (15- to 17-year range in youngest 3 groups) and to ensure sufficient responses in each group to allow for reliable reporting of statistics. The BMI categories are based on categories defined by the Centers for Disease Control and Prevention.⁴⁰

Statistical Analysis

All analyses were performed with SAS software, version 9.3 (SAS Institute, Cary, N.C.). All respondents—including those with missing data—remained in the analysis universe to maintain accurate variance estimates, with domain analyses performed for those records with and without missing variable data. Given the stratified sampling design, the SURVEYFREQ function was used to determine weighted distribution and prevalence rates with 95% confidence intervals (CIs) by each covariate for both carpal tunnel syndrome and migraine headache. Chi-square analyses were used to determine statistically significant differences among subgroups. All covariates were found to be significant ($P < 0.05$) in bivariate analyses and were included in the multivariate regression models. The multivariate logistic regression models were used to control for confounding by covariates. Given the sampling design, the SURVEYLOGISTIC function was used to calculate weighted adjusted odds ratios (aORs) with 95% CI for having carpal tunnel syndrome and for having migraine headache. Collinearity was evaluated by calculating variance inflation factors (VIFs) for each covariate. All VIFs were less than 2, below the common convention criterion of $VIF < 10$.⁴¹

RESULTS

Of the 27,157 respondents who completed the Sample Adult module of the survey, 1277 (4.7%) were excluded due to incomplete data or insufficient respondents within a race/ethnicity group. The final analysis was based on 25,880 respondents, of which 952 (3.7%) had carpal tunnel syndrome and 4212 (16.3%) had migraine headache as defined above. Table 1 displays the weighted distribution of those with carpal tunnel syndrome and those with migraine headache by demographic and health characteristics.

Table 2 demonstrates the weighted prevalence with 95% CI and aOR for having carpal tunnel syndrome or migraine headache by these demographic and health characteristics, with bold figures denoting statistical significance. In terms of demographics,

Table 1. Weighted Distribution of Those with Carpal Tunnel Syndrome and Those with Migraine Headache by General and Health Characteristics, National Health Interview Survey 2010

Demographic Category	Carpal Tunnel Syndrome (N = 952)	Migraine Headache (N = 4212)
	Weighted % (95% CI)	Weighted % (95% CI)
General		
Age group (years)		
18–34	10.6 (8.1–13.1)	37.9 (35.9–39.9)
35–49	31.1 (27.3–34.9)	33.6 (31.6–35.5)
50–64	40.4 (36.4–44.4)	22.0 (20.4–23.5)
≥ 65	18.0 (15.0–20.9)	6.5 (5.7–7.4)
Gender		
Male	33.5 (29.7–37.2)	33.2 (31.5–35.0)
Female	66.5 (62.8–70.3)	66.8 (65.0–68.5)
Race/ethnicity		
Non-Hispanic White	74.3 (71.0–77.6)	68.5 (66.8–70.3)
Non-Hispanic Black	14.0 (11.4–16.6)	13.9 (12.6–15.2)
Hispanic	9.7 (7.8–11.7)	14.6 (13.4–15.8)
Asian	1.9 (0.9–2.9)	3.0 (2.4–3.6)
Health status and behaviors		
Body mass index		
Normal or underweight	23.8 (21.0–26.6)	36.2 (34.4–38.1)
Overweight	33.3 (29.9–36.8)	31.1 (29.4–32.9)
Obese	42.9 (39.1–46.7)	32.6 (30.9–34.4)
Diabetes mellitus		
Yes	20.4 (17.2–23.6)	10.1 (9.0–11.2)
No	79.6 (76.4–82.8)	89.9 (88.8–91.0)
Smoking status		
Current smoker	25.9 (22.6–29.3)	26.3 (24.6–27.9)
Former smoker	26.6 (23.1–30.1)	17.4 (16.0–18.8)
Never smoked	47.4 (43.7–51.2)	56.3 (54.4–58.3)
Total	100	100

the prevalence of carpal tunnel syndrome increased with age, peaking in the 49- to 64-year-old group. On the other hand, prevalence of migraine headache generally decreased with age. Female gender was associated with both carpal tunnel syndrome and migraine headache. Carpal tunnel syndrome was less prevalent among Hispanics and Asians compared to the reference group (non-Hispanic White), and migraine headache was less prevalent among Asians compared to the reference group (non-Hispanic White). In terms of health status and behavior variables, increased BMI was associated with both carpal tunnel syndrome and migraine headache, as was diabetes mellitus. Both current smoker status and former smoker status were associated with an increased odds of carpal tunnel syndrome, whereas only current smoker status was associated with an increased odds of migraine headache.

Table 3 demonstrates the weighted prevalence and aOR of having carpal tunnel syndrome or migraine headache in the presence or absence of the other condition. A significant positive correlation was found after adjusting for demographic and health/behavior variables. The prevalence of migraine headache was 34% in those with carpal tunnel syndrome compared with 16% in those without carpal tunnel syndrome (aOR, 2.60). The prevalence of carpal tunnel syndrome in patients with migraine

headache was 8% compared with 3% in those without migraine headache (aOR, 2.67).

DISCUSSION

The current study is the first to demonstrate an association between carpal tunnel syndrome and migraine headache. Carpal tunnel syndrome is the most common disease process within the larger family of compression neuropathies. Migraine headache, on the other hand, has not historically been considered to be a compression neuropathy. Although some authors previously proposed an extracranial component to migraine pathogenesis,^{42,43} further recent evidence supports that some migraine headaches may be associated with nerve compression within the head and neck.^{28–30,34,44} This concept remains controversial and is debated heavily within the medical community.⁴⁵ Of note, a recent survey of members of the American Headache Society reported that nerve blocks and trigger point injections are commonly used by its members to treat migraine headache,⁴⁶ and several other studies support targeted injections of botulinum toxin or local anesthetic for the treatment of migraine headaches.^{33–38,47–49}

There are several limitations to this study. The most notable is that the survey question for migraine headache was worded “migraine or severe headache.” This lack of specificity may have led to a number of

Table 2. Weighted Prevalence and Adjusted Odds Ratio of Carpal Tunnel Syndrome or Migraine Headache by General and Health Characteristics, National Health Interview Survey 2010

Demographic Category	Carpal Tunnel Syndrome (N = 952)		Migraine Headache (N = 4212)	
	Weighted % (95% CI)	aOR (95% CI)	Weighted % (95% CI)	aOR (95% CI)
General				
Age group (years)				
18–34	1.2 (0.9–1.5)	Reference	19.9 (18.8–21.1)	Reference
35–49	4.1 (3.5–4.6)	3.05 (2.28–4.09)	20.1 (18.9–21.3)	0.92 (0.83–1.02)
49–64	5.8 (5.0–6.6)	4.33 (3.21–5.85)	14.4 (13.4–15.4)	0.57 (0.51–0.63)
≥ 65	3.8 (3.2–4.4)	3.11 (2.21–4.39)	6.3 (5.5–7.1)	0.23 (0.19–0.27)
Gender				
Male	2.4 (2.1–2.8)	Reference	11.0 (10.3–11.7)	Reference
Female	4.7 (4.3–5.1)	1.93 (1.60–2.31)	21.5 (20.6–22.3)	2.40 (2.18–2.63)
Race/ethnicity				
Non-Hispanic White	3.8 (3.5–4.2)	Reference	16.1 (15.5–16.8)	Reference
Non-Hispanic Black	4.2 (3.4–5.0)	1.02 (0.82–1.26)	18.9 (17.5–20.3)	1.03 (0.92–1.14)
Hispanic	2.5 (2.0–3.0)	0.72 (0.56–0.92)	16.8 (15.6–18.1)	0.95 (0.85–1.05)
Asian	1.5 (0.7–2.2)	0.52 (0.31–0.88)	10.3 (8.4–12.2)	0.61 (0.49–0.75)
Health status and behaviors				
Body mass index				
Normal or underweight	2.3 (2.0–2.6)	Reference	15.8 (14.8–16.7)	Reference
Overweight	3.4 (3.0–3.9)	1.50 (1.24–1.80)	14.6 (13.8–15.5)	1.11 (1.00–1.23)
Obese	5.5 (4.9–6.1)	2.01 (1.65–2.45)	19.1 (18.0–20.2)	1.33 (1.19–1.49)
Diabetes mellitus				
Yes	7.1 (5.9–8.3)	1.59 (1.27–1.98)	16.0 (14.4–17.7)	1.32 (1.15–1.53)
No	3.2 (2.9–3.5)	Reference	16.3 (15.7–16.9)	Reference
Smoking status				
Current smoker	4.8 (4.1–5.5)	1.64 (1.35–1.98)	22.1 (20.7–23.4)	1.57 (1.41–1.74)
Former smoker	4.4 (3.7–5.0)	1.29 (1.06–1.59)	13.0 (12.0–14.0)	1.06 (0.95–1.19)
Never smoked	2.9 (2.6–3.2)	Reference	15.6 (14.9–16.4)	Reference
Overall	3.6 (3.3–3.9)		16.3 (15.8–16.8)	

Bold values indicate statistical significance.

Table 3. Weighted Prevalence and Adjusted Odds Ratio of Carpal Tunnel Syndrome or Migraine Headache in the Presence or Absence of the Other Condition, National Health Interview Survey 2010

	Carpal Tunnel Syndrome (N = 952)		Migraine Headache (N = 4212)	
	Weighted % (95% CI)	aOR (95% CI)	Weighted % (95% CI)	aOR (95% CI)
Carpal tunnel syndrome				
Yes	—	—	34.4 (30.7–38.1)	2.60 (2.16–3.13)
No	—	—	15.6 (15.1–16.2)	Reference
Migraine headache				
Yes	7.6 (6.6–8.5)	2.67 (2.22–3.22)	—	—
No	2.8 (2.6–3.1)	Reference	—	—

Bold values indicate statistical significance.

false-positive respondents without true migraine headaches. Respondents with other types of headaches such as occipital neuralgia, new daily persistent headaches, cluster headaches, and others could have been included. However, the migraine prevalence in the current study, both in terms of overall prevalence (16.3%) and prevalence by age group and gender, is consistent with previously published migraine-specific studies.^{6,7,9,12} In a 2006 study of 145,335 participants, the prevalence of migraine headache in the adult population using the International Classification of Headache Disorders (ICHD) criteria was found to be 15%.^{9,50} Using the International Classification of Headache Disorders-2 criteria, they calculated that over 30% of additional respondents fulfill the criteria for Probable Migraine, a subtype in which greater than 1 in 4 patients should

be considered for preventive migraine care.^{9,51,52} In our study, there was additional concordance with the published literature on migraine epidemiology with the positive correlations seen between migraine and risk factors such as obesity^{53–56} and smoking.^{57,58} Finally, it should be noted that numerous other studies have used the same database (NHIS) to study migraine headache, providing precedent for the use of this database in our current study.^{12,55,59–61} However, even though the migraine headache overall prevalence and subgroup prevalence found in this study are consistent with the existing literature, and the NHIS database has previously been used for studying migraine headache, the wording of the survey remains an important limitation. The results of this study should be interpreted within this limited context.

Another limitation is the fact that this was a survey-based study and did not consist of patients with carpal tunnel syndrome or migraine headache diagnoses confirmed by a medical professional. The survey questions rely upon the respondents' understanding of their own health status. Respondents with mild or early symptoms may not have been aware of their disease process, such as can occur with carpal tunnel syndrome. This may have led to underreporting or resulted in a bias toward more severe manifestations of disease. Also, because of the survey design, noncivilian and institutionalized persons were not accounted for, which could skew the results. Smaller ethnic groups such as Native American Indian and Alaskan Native were unable to be separately analyzed due to an insufficient number of respondents. Socioeconomic data, such as income, are missing for a large number of records and could not be incorporated into the model. Other studies have demonstrated a higher prevalence of migraine headache among households in lower income groups.^{6,7,62}

Another limitation is that carpal tunnel syndrome and migraine headache are treatable conditions, so the wording of the survey questions (eg, "within the last 12 months") likely resulted in negative respondents who may have had either disease process in the past. Furthermore, because carpal tunnel syndrome and migraine headache have different age distributions, with migraine headache more prevalent in younger age groups and carpal tunnel prevalence increasing with age, the wording of the questions may underestimate the true strength of the association. For example, the association would be missed for a person who had migraine headaches that resolved at a younger age, followed by the development of carpal tunnel syndrome at an older age. The association may have been stronger had it been possible to identify patients who had ever had migraine headache.

One of the strengths of the current study is that the NHIS is designed to be nationally representative, adding to the generalizability of our study.³⁹ Also, the survey design allows for inclusion of underrepresented age groups and ethnicities such as the elderly, Asian, Hispanic, and non-Hispanic Black populations. This can be especially useful for identifying populations at significantly higher or lower risk, providing clues about etiology. This study is also consistent with previously identified risk factors as above for both carpal tunnel syndrome and migraine headache, supporting the validity of the analysis. Furthermore, these risk factors were adjusted for in the statistical analysis, making the aOR a more realistic indicator of association.

Similar to other peripheral neuropathies such as carpal tunnel syndrome, the precise pathophysiology of migraine headache remains unclear. The underlying cause connecting seemingly unrelated compression neuropathies such as carpal tunnel syndrome and cubital tunnel syndrome,^{20,21} and between carpal tunnel syndrome and thoracic outlet syndrome,^{25,26} currently remains unknown. The contributing factors may include a common associated comorbidity^{4,11,58,63-67} or a common genetic factor,^{68,69} leading to increased susceptibility to compression within the peripheral nervous system. In 1988, Delton et al⁷⁰ demonstrated in an animal model that the nerves of animals with diabetes are more susceptible to compression than the nerves of animals without diabetes. However, diabetes was adjusted for within the current study, making this an unlikely cause for the association between migraine headache and carpal tunnel syndrome. Furthermore, although diabetes is a well-defined risk factor for carpal tunnel syndrome,^{4,63,64} the association between diabetes and migraine headache is less clear in the literature.^{11,65,66}

Multiple compression neuropathies have also been noted in other situations. The "double-crush" phenomenon is well described and occurs when compression of a nerve at one location impedes axonal flow, making the nerve more susceptible to compression at another location.^{25,71} Although this may explain some cases of associated compression neuropathies within the same nerve tract, it does not explain associated compression neuropathies that occur within anatomically distinct peripheral nerves and would not explain the association between carpal tunnel syndrome and migraine headache.

Hereditary neuropathy with liability to pressure palsies (HNPP) is an uncommon condition that results in recurrent focal compression neuropathies, primarily of the median, ulnar, and peroneal nerves.^{68,69} Hereditary neuropathy with liability to pressure palsies is an autosomal dominant disease and has been attributed to a defect in chromosome 17 that results in abnormal myelin protein 22.^{72,73} Although this rare disease does not account for the association between carpal tunnel syndrome and migraine headache, it does demonstrate that an underlying genetic abnormality can result in susceptibility to nerve compression throughout the entire peripheral nervous system.

There is increasing recognition of a central nervous system component to peripheral neuropathies.⁷⁴⁻⁷⁶ Similarly, our understanding of migraine headaches is growing to incorporate peripheral nervous system contributions to what is often considered a purely central pathology. We are not proposing that migraines are purely peripheral phenomena, though, especially because some migraineurs who are pain-free after sur-

gical release continue to experience auras.³¹ An alternative explanation is that peripheral compression or irritation leads to central sensitization which increases the likelihood of suffering from future peripheral neuropathy in other areas.⁷⁷ Because migraine headache is more common in younger patients, and carpal tunnel syndrome is more prevalent in older patients, migraine headache could conceivably sensitize the central nervous system to develop pain from later nerve compression in the carpal tunnel.

Based on the findings of this study and prior studies, it may be worthwhile in patients with migraine to perform an examination for peripheral nerve compression in the head and neck. Potential compression points include the supraorbital and supratrochlear,^{27,29,48,78–80} auriculotemporal,^{29,81,82} zygomaticotemporal,^{83,84} greater occipital,^{44,47,48,85} third occipital,^{86,87} and lesser occipital^{48,86,88} nerves. Accurate clinical assessment of the origin of any peripheral pain based on history and physical examination of these surface landmarks may broaden our knowledge of the relative contribution of these nerves to migraine symptoms.

Further research is warranted to determine the value of migraine headache as an early indicator of patients who are more likely to develop carpal tunnel syndrome in the future. Identification of migraine headache as a predictor of future carpal tunnel syndrome would allow for earlier diagnosis and treatment, or even prevention, of carpal tunnel syndrome by modification of risk factors. Further research also needs to be performed to evaluate predisposing and genetic factors in those with higher prevalence, protective factors in those with lower prevalence, and the efficacy of interventions to prevent the development of these diseases.

CONCLUSIONS

In conclusion, this study demonstrates an association between carpal tunnel syndrome and migraine headache, independent of numerous risk factors and comorbidities. This association suggests the possibility, although not demonstrated in this study, of a common systemic or neurologic risk factor. In addition, migraine headache may be an early warning sign of an increased risk of future carpal tunnel syndrome. Further studies—including genetic and longitudinal studies with physician verification of diagnoses—are needed to further define the relationship between carpal tunnel and migraine headache.

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