World Neurosurgery: X 21 (2024) 100237

Contents lists available at ScienceDirect

World Neurosurgery: X

journal homepage: www.journals.elsevier.com/world-neurosurgery-x

Prevalence of carpal tunnel syndrome symptoms among neurosurgical spine surgeons

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ARTICLE INFO

Keywords:
Carpal tunnel syndrome
Hand arm vibration syndrome
Spine surgeons
Occupational health
Vibration exposure

ABSTRACT

Background: Neurosurgeons, particularly spine surgeons, have high exposure to vibrations via electric or pneumatic drills and repetitive motion. Although no data exist for the prevalence of carpal tunnel syndrome (CTS) among these surgeons, anecdotal evidence suggests the rate of symptoms is higher than in the general population.
Methods: An anonymous questionnaire was developed to assess demographics, practice patterns, presence of CTS symptoms, and treatment (time off, bracing, medication, injections, surgery). The survey was sent via anonymous email link to members of the AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerve.
Results: 101 members responded: 44 reported at least one symptom related to CTS (43.6%). There was no statistically significant relationship between overall or spine case volume, the number of cases performed annually/daily, and CTS symptoms. Respondents working in non-teaching settings were significantly more likely to have CTS symptoms than academic teaching institutions (50.0% v. 45.0%; $p = 0.0112$).
Conclusions: Our survey demonstrated CTS to be more prevalent in spine neurosurgeons (43.6%) than in the general population (1–5%). The lack of significant association between most practice-based metrics and CTS symptoms may indicate that respondents have a minimum case volume that exceeds the amount of vibration exposure/repetitive motion to develop symptoms. The significantly increased prevalence of CTS among neurosurgeons at non-teaching institutions suggests that residents provide operative assistance offsetting the vibration exposure/repetitive motion by attendings. Further research may determine the root cause for the high prevalence of CTS in spine neurosurgeons and devise methods for reducing vibration exposure.

1. Introduction

Carpal tunnel syndrome (CTS) is an entrapment syndrome characterized by numbness and paresthesias in the first three digits, with nocturnal symptoms and/or worsening with wrist flexion or extension (i.e., driving a car, carrying a cell phone). Late-stage CTS may show weakness in median innervated hand intrinsic muscles and thenar atrophy.[1]

Occupational vibration exposure has been linked to Hand-Arm-Vibration-Syndrome (HAV), with symptoms commonly including CTS and Raynaud's phenomenon.[2] A significant body of literature describes an increased prevalence of CTS among individuals with work-related exposure to repetitive movements or vibration-producing equipment. However, most of this literature focuses on occupational exposure in industrial and agricultural settings,[3–8] where both repetitive movements and vibration-producing heavy machinery are the putative cause. Some literature describes exposure to smaller hand-held vibration-producing equipment and the prevalence of CTS. The prevalence of CTS in dentists, orthopedic surgeons, plastic surgeons, and tattoo artists has been reviewed.[9–11]

Neurosurgeons, particularly spine-focused neurosurgeons, have high exposure to vibration producing surgical drills and repetitive motion as part of their operative practice. There is currently no literature focused on the risks posed by this occupational exposure. We report the results of an anonymous survey of spine-focused neurosurgeons regarding the practice patterns and the prevalence of CTS symptoms.

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https://doi.org/10.1016/j.wnsx.2023.100237
Received 8 June 2023; Accepted 26 September 2023
Available online 30 September 2023

Abbreviations

CTS	carpal tunnel syndrome
DSPN	disorders of the spine and peripheral nerve
EVL	exposure limit value
HAV	hand-arm-vibration syndrome

2. Materials and methods

A questionnaire was developed to assess basic demographic information, practice patterns annual case volume, average daily cases, operative days per week, spine: cranial case volume), presence of other CTS risk factors, presence of CTS symptoms, and any treatment required for CTS (time off, bracing, medication, injections, surgery).

The survey was sent via an anonymous email link to the AANS/CNS Joint Section on Disorders of the Spine and Peripheral Nerve (DSPN) membership. The survey form is included as supplemental data. Responses were collected via Qualtrics (Provo, Utah) and exported for statistical analysis with SPSS. Statistical significance was assessed using the Chi-Square, Fisher Exact, and Kruskal–Wallis test. Not all respondents provided answers for all questions; percentages were calculated using the total number of responses as the denominator.

3. Results

The survey was emailed to 1416 members of the DSPN; 101 individuals responded, for a response rate of 7.1%. Most respondents were between the ages of 41–60 (range: 41–78). Eighty-nine respondents were male (89.9%). Forty-five respondents worked in an academic teaching hospital (45%), while 50 respondents worked in non-teaching settings (i.e., academic non-teaching hospital, community hospital, private practice). Table 1 lists the demographics of all respondents and delineates additional risk factors and practice characteristics for respondents with and without CTS symptoms.

Forty-four neurosurgeons reported at least one symptom related to CTS (43.6%). Of these, 33/44 (75%) endorsed “numbness/tingling in the thumb or first two fingers;” 37/44 (84.1%) endorsed “nocturnal wrist/hand pain or paresthesias;” 33/44 (75%) “symptoms that resolve with shaking the hand;” 8/44 (18.2%) “hand weakness” in the median innervated muscle groups, and 5/44 (11.4%) “thenar atrophy.” Table 2 illustrates the symptoms experienced by respondents, and interventions used for symptom management.

There was no statistically significant relationship between demographics, practice patterns, other CTS risk factors, and CTS symptoms. However, when practice location was broadly considered as teaching versus non-teaching institutions, there was a statistically significant difference in the prevalence of CTS, with neurosurgeons at non-teaching institutions having a higher prevalence of CTS ($p = 0.0112$), although when practice was further subdivided into academic non-teaching, academic/teaching, community practice, and private practice, we did not find a statistical significance ($p = 0.2639$). Respondents who endorsed CTS symptoms were asked more detailed questions regarding treatment options. Of these, 10/44 (23.3%) had attempted nocturnal bracing; 3/44 (6.8%) had undergone steroid injections; 3/44 (6.8%) had used long-term NSAIDs; 5/44 (11.6%) had undergone a carpal tunnel release, and 0/44 had taken time off from operative work because of their CTS symptoms.

4. Discussion

Our pilot survey demonstrated that the symptoms of CTS are reported more commonly in a population of spine neurosurgeons (43.6%) than within the general population (1–5%).[12,13] Although we did not

Table 1
Demographics for all respondents as a whole and demographics along with practice-specific information for respondents with and without CTS symptoms.

Overall Population			
Surgeon Age, n (%)			
30–40	14 (14.3%)		
41–50	25 (25.5%)		
51–60	33 (33.7%)		
61–70	15 (15.3%)		
71 or older	11 (11.2%		
Gender, n (%)			
Female	9 (9.1%)		
Male	89 (89.9%)		
Other/prefer not to respond	1 (1.0%)		
Board Status, n (%)			
Board Certified	90 (90.9%)		
Board Eligible	6 (6.1%)		
Other	3 (3.0%)		
Current Practice Type, n (%)			
Academic non-Teaching	5 (5.0%)		
Academic Teaching	45 (45.0%)		
Community Hospital	16 (16.0%)		
Private Practice	29 (29.0%)		
Other	5 (5.0%)		
Carpal Tunnel Symptoms			
	No ($n = 57$)	Yes ($n = 44$)	*p*-value
Current Tobacco Use, n (%)			
No	55 (98.2%)	43 (100.0%)	
Yes	1 (1.8%)	0 (0.0%)	
Former Tobacco Use, n (%)			
No	54 (96.4%)	38 (88.4%)	
Yes	2 (3.6%)	5 (11.6%)	
Overweight/Obese-, n (%)			
No	45 (80.4%)	34 (77.3%)	
Yes	11 (19/6%)	10 (22.7%)	
Rheumatoid Arthritis, n (%)			
No	56 (100.0%)	43 (100.0%)	
Surgeon Age, n (%)			0.1793
30–40	6 (11.1%)	8 (18.2%)	
41–50	19 (35.2%)	6 (13.6%)	
51–60	16 (29.6%)	17 (38.6%)	
61–70	7 (13.0%)	8 (18.2%)	
71 or older	6 (11.1%)	5 (11.4%)	
Days Operating Per Week, n (%)			0.594
1	3 (5.6%)	1 (2.3%)	
2	20 (37.0%)	14 (31.8%)	
3	27 (50.0%)	22 (50.0%)	
4	2 (3.7%)	5 (11.4%)	
5 or more	2 (3.7%)	2 (4.5%)	
Average Cases performed per year, n (%)			0.9336
100 or fewer	4 (7.3%)	2 (4.5%)	
101–150	4 (7.3%)	1 (2.3%)	
151–200	6 (10.9%)	7 (15.9%)	
201–250	9 (16.4%)	11 (25.0%	
251–300	13 (23.6%)	9 (20.5%)	
301–350	6 (10.9%)	5 (11.4%)	
351–400	4 (7.3%)	3 (6.8%)	
401–450	5 (9.1%)	4 (9.1%)	
451–500	3 (5.5%)	1 (2.3%)	
More than 500	1 (1.8%)	1 (2.3%)	
Cases performed in a single operative day			0.2469
Median	3	2	
IQR	2.0, 3.0	2.0, 3.0	
Spinal Case Volume (%)			0.5581
Median	85	80	
IQR	70, 95	75, 90	
Cranial Case Volume (%)			0.0837
Median	9.5	15	
IQR	1, 20	5, 20	
Other Case Volume (%)			0.0758
Median	1	5	
IQR	0, 5	0, 10	
Spinal Case Volume (%)			0.5581
Median	85	80	
IQR	70, 95	75, 90	
Board Status, n (%)			0.7513

(*continued on next page*)

Table 1 (*continued*)

Overall Population			
Board Certified	51 (92.7%)	39 (88.6%)	
Board Eligible	3 (5.5%)	3 (6.8%)	
Other	1 (1.8%)	2 (4.5%)	
Current Practice Type, n (%)			0.2639
Academic Non-Teaching	3 (5.4%)	2 (4.5%)	
Academic/Teaching	30 (53.6%)	15 (34.1%)	
Community Hospital	6 (10.7%)	10 (22.7%)	
Private Practice	14 (25.0%)	15 (34.1%)	
Other	3 (5.4%)	2 (4.5%)	

find a significant relationship between overall case volume, spine case volume, or the number of cases performed annually/daily, and CTS symptoms, this may be related to the highly specialized nature of the study population. The literature suggests a dose-dependent relationship between vibration exposure and CTS symptom development,[14] and indeed reported a high prevalence of CTS in populations utilizing electronic tools daily, like assembly line workers with a reported prevalence of 43%.[15] The spine surgeons assessed via the questionnaire may have a minimum case volume exceeding the vibration exposure or repetitive motion necessary to develop symptoms.

This is supported by a British study, which assessed exposure in orthopedic surgeons using a sagittal saw and concluded that 23 min of exposure daily to this equipment daily exceeded the exposure limit value (EVL), the level l beyond which it is recommended that vibrating equipment be avoided for the remainder of the day.[16] The literature regarding repetitive motion thresholds for the development of CTS needs to be more specific. One study found that operative gloves increased carpal tunnel pressures in a cadaver model[16]; however, whether the increased pressure contributes to CTS symptom development has yet to be evaluated.

A meta-analysis of musculoskeletal disorders in surgeons and interventionalists found a rate of 9% for CTS in that population.[17] This is higher than the general population but well below the prevalence seen in our survey of spine-focused neurosurgeons. Other studies have evaluated CTS within the medical community in groups exposed to both vibration-producing equipment and repetitive motion, including dentists (prevalence: 9%) and plastic surgeons (prevalence: 15.1%).[11]

The importance of vibration exposure in increasing the risk of developing CTS is highlighted by studies evaluating the prevalence of CTS among motorcyclists - where vibration exposure is present, but repetitive motion is less likely. One study found a prevalence of 42%,[18] while another found that vibration exposure from 4 h daily of driving a low-powered motorbike was enough to induce CTS.[19]

The neurosurgeons surveyed who reported CTS were significantly more likely to work in a nonteaching setting, although the rate in both nonteaching and teaching positions reported a high rate of CTS symptoms when compared to the general population. No respondents reported taking time off of work, and the majority of respondents did not take any measures to address their symptoms. The presence of resident trainees who can operate semi-independently for portions of cases requiring surgical drill use or repetitive motion with rongeurs and curettes (i.e. laminectomies) may be an essential component of why neurosurgeons at academic teaching institutions were less likely to report CTS symptoms. Non-teaching institutions may have wide variations in the role of physician extenders in the operating room. Given the nature of licensure and scope of practice, neurosurgeon involvement may be more hands-on during portions of the case requiring vibration exposure or repetitive motion.

The self-reported nature of the questionnaire and the low response rate within the DSPN limits this study. Neurosurgeons rely on manual dexterity for their occupation, and respondents may have been unwilling to report CTS symptoms despite the anonymous survey link provided. Both vibration exposure and repetitive motion with rongeurs likely contribute to the development of CTS in spine surgeons; however, assessing the relative use of surgical drill versus rongeur for each respondent was beyond the scope of our survey. Some preliminary cadaver studies have demonstrated that exposure to surgical drill vibrations exceeds the EVL.[20] The short survey was designed to minimize the time required to respond, with the primary goal of demonstrating the prevalence of CTS among spine-focused neurosurgeons, but limits conclusions that may be drawn from this study. This survey assessed symptoms of CTS, rather than the self-reported diagnosis of carpal tunnel syndrome, although previous studies have demonstrated the reliability, and validity of CTS questionnaires.[21–24] Further research may include more detailed studies, such as assessing the daily duration of surgeons' exposure to hand-held vibration producing drills aimed at parsing the relative contributions of vibration versus repetitive motion in symptom development, in addition to other factors that may contribute to CTS symptoms such as hobbies (woodworking, gardening, etc.) that may lead to repetitive motions.

Other fields with occupational exposures that increase the risk of developing CTS have introduced work-specific interventions to minimize the risk. This includes vibration-dampening gloves worn by workers,[8,17,25–27] and vibration-dampening grips that attach to the equipment before use. These interventions may reduce the risk of vibration exposure and subsequent development of CTS symptoms; however, they may not be the most practical solutions within a surgical practice, although design of instruments with ergonomic handles may be able to decrease peak force exerted by surgeons.[28] Occupational exposures associated with the development of CTS include both vibration exposure and repetitive motion. This survey addresses only the prevalence of CTS amongst spine-focused neurosurgeons; further research is

Table 2
Respondents reporting specific symptoms of CTS, as well as interventions used for symptom management.

	Any CTS Symptom	Numbness/Tingling	Nocturnal Paresthesias	Symptoms that resolve with hand shaking	Hand Numbness	Thenar Atrophy
	n = 44	*n* = 33	*n* = 37	*n* = 33	N = S	N = S
Nocturnal Bracing						
Yes	10 (23.3%)	9 (28.1%)	9 (25.0%)	10 (31.3%)	1 (14.3%)	2 (50.0%)
No	33 (76.7%)	23 (71.9%)	27 (75.0%)	22 (68.8%)	6 (85.7%)	2 (50.0%
Steroid Injections						
Yes	3 (6.8%)	3 (9.1%)	3 (8.1%)	3 (9.1%)	2 (25.0%)	1 (20.0%)
No	41 (93.2%)	30 (90.9%)	34 (91.9%)	30 (90.9%)	6 (75.0%)	4 (80.8%)
Long-term NSAID Use						
Yes	3 (6.8%)	3 (9.4%)	3 (8.3%)	2 (6.3%)	1 (14.3%)	2 (40.0%)
No	40 (93.0%)	29 (90.6%)	33 (91.7%)	30 (93.8%)	6 (85.7%)	3 (60.0%)
Carpal Tunnel Release						
Yes	5 (11.6%)	5 (15.6%)	5 (13.9%)	4 (12.5%)	1 (14.3%)	2 (40.0%)
No	38 (88.4%)	27 (84.4%)	31 (86.1%)	28 (87.5%)	6 (85.7%)	3 (60.0%)
Other Treatments						
Yes	1 (4.0%)	1 (5.3%)	1 (5.0%)	1 (5.3%)	0 (0.0%)	0 (0.0%)
No	24 (96.0%)	18 (94.7%)	19 (95.0%)	18 (94.7%)	4 (100%)	2 (100%)

necessary to determine the root cause for the high prevalence of CTS and to devise methods for reducing exposures.

Source of funding

No sources of funding

CRediT authorship contribution statement

Courtney Pendleton: Data curation, Formal analysis, Investigation, Methodology, Writing - original draft, Writing - review & editing. **Karina Lenartowicz:** Formal analysis, Writing - review & editing. **Mohamad Bydon:** Formal analysis, Investigation, Methodology, Writing - original draft, Writing - review & editing. **Robert J. Spinner:** Data curation, Investigation, Methodology, Supervision, Writing - original draft, Writing - review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

Katherine A. Bews, Andrew Johnson-Lally.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.wnsx.2023.100237.

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