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Neck Symptoms and Associated Clinical Outcomes in Patients Following Concussion

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Objective: To examine the frequency and association of neck pain symptoms in patients with a concussion. **Study Setting and Participants:** Three-hundred and thirty-one consecutively enrolled patients aged 9 to 68 years with a diagnosed concussion 1 to 384 days post-injury were enrolled at a concussion clinic from a single integrated healthcare system in Western Pennsylvania between 2019 and 2021. **Design:** Retrospective cohort analysis of prospectively collected concussion screening tool intake survey responses and clinical outcomes data. The primary outcome was self-reported neck pain or difficulty with neck movement on the Concussion Clinical Profiles Screening (CP Screen) tool, recovery time, and incidence of treatment referral. Immediate Post-concussion Assessment and Cognitive Testing (ImPACT) composite scores, Vestibular/Ocular Motor Screening (VOMS) item scores, type and severity of neck symptoms, mechanism of injury, time from injury to clinic presentation, medical history, and concussion symptom profile were secondary outcomes. **Results:** Of the 306 consecutively enrolled eligible patients in the registry, 145 (47%) reported neck pain, 68 (22.2%) reported difficulty moving their neck, and 146 (47.7%) reported either symptom. A total of 47 (15.4%) participants reported more severe neck symptoms, and this group took longer to recover (40 ± 27 days) than those not reporting neck symptoms (30 ± 28 days; $U = 8316$, $P < .001$). Stepwise logistic regression predicting more severe neck symptoms was significant (Nagelkerke $R^2 = 0.174$, $\chi^2 = 9.315$, $P = .316$) with older age ($P = .019$) and mechanism of injury including motor vehicle collisions (MVCs) ($P = .047$) and falls ($P = .044$) as risk factors. MVCs and falls were associated with over 4 times and 2 times greater risk, respectively, for reporting more severe neck symptoms. **Conclusion:** Neck pain and stiffness symptoms are common in patients with a concussion following high-energy mechanisms of injury including MVCs or falls from height. These symptoms are associated with prolonged recovery. Providers should evaluate neck symptoms and consider targeted treatment strategies to limit their effects in patients with a concussion. **Key words:** *concussion*, *CP Screen*, *neck*, *symptoms*

MILD TRAUMATIC BRAIN INJURY, frequently termed "concussion," is an underdiagnosed condition that affects people of all ages, including the athletic population.[1] Concussions are frequently associated with violent movements in the head and neck, leading to whiplash-associated injury and neck pain.[2–4] It is vital to recognize concussion-related neck pain as a highly prevalent cause of disability and a significant economic burden within the general population.[5] Further, there is evidence that cervicovestibular rehabilitation may improve recovery from concussions.[6,7] Neck symptoms have been gaining attention in the concussion population, with some authors advocating for the description of "cervical spine disorder" as a clinical profile of patients with concussions.[8] The Concussion Clinical Profiles Screening (CP Screen) tool[9] is a 29-item self-reported clinical profile-based symptom inventory that assesses both neck pain and stiffness and scores them as modifiers of overall concussion severity.

Despite some understanding of the etiology, classification, potential treatments, and new interest in neck pain assessment for patients with concussions, limited literature has assessed the prevalence and overall clinical

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impact of neck pain on recovery. Approximately 13.8% of patients diagnosed with a concussion in a pediatric level 1 trauma center emergency department (ED) reported neck pain, which was most associated with acceleration/deceleration injury and motor vehicle collisions (MVCs).[10] In a related study, among patients presenting to the ED with symptoms of a concussion, the frequency of any reported neck pain was between 68.4% and 41.9% at 72 and 45 days, respectively.[11] In a prospective clinical registry study, Provance et al[12] found that 54% of concussed youth athletes reported experiencing neck or shoulder pain, which was associated with longer median symptom time, longer median return to play time, and greater initial symptom burden. No studies to date have assessed the frequency or clinical impact of reported neck symptoms within the adult concussion specialty clinic population.

The purpose of this study was to expand on prior research on neck-related symptoms among patients following concussion by expanding the age range to include adults and examining additional injury characteristics (eg, posttraumatic amnesia, ongoing workers' compensation case, ongoing litigation, and sports-specific mechanisms of injury) and related clinical outcomes (eg, clinical referral rate, Immediate Post-concussion Assessment and Cognitive Testing [ImPACT] score, and Vestibular/Ocular Motor Screening [VOMS] score). The primary aim was to describe the frequency, severity, and association of self-reported neck symptoms with demographic (eg, age and gender) and injury (eg, mechanism of injury and medical history) variables, as well as commonly used clinical outcomes (eg, cognitive, vestibular, and recovery time) in patients from a concussion specialty clinic population. The hypothesis was that neck symptoms would be commonly (ie, greater than one-third of patients) reported by patients following concussion. Furthermore, it was expected that neck symptom severity would be associated with prolonged concussion recovery and that high-energy mechanisms of injury would be more likely associated with more severe neck symptoms.

PARTICIPANTS/METHODS

Participants and design

This study was designed as a level III evidenced retrospective analysis of a prospectively collected cohort. All consented research registry patients aged 9 to 80 years presenting to a Western Pennsylvania single integrated healthcare system concussion specialty clinic between January 2019 and January 2021 with a diagnosed concussion per current consensus guidelines (ie, clear mechanism of injury, initial signs/symptoms, and currently symptomatic or impaired) were eligible for study inclusion.[13] Exclusion criteria included prior brain surgery, moderate to severe traumatic brain injury, neurological disorder, treatment for substance abuse, and delayed presentation (>30 days from initial injury to clinic presentation). Patients presenting to the clinic voluntarily completed concussion screening tool assessments including neck symptom inventory at their first clinical appointment as part of the standard of care. Patients were approached after their clinic visit for recruitment.

Measures

Demographic and sample data

Demographic data and medical history information were obtained from the electronic medical record and included age, gender, concussion history, medical history (attention deficit hyperactivity disorder [ADHD], migraines, undiagnosed migraines, motion sickness, ocular disorder, anxiety, depression, ongoing workers' compensation case, or ongoing litigation case), concussive symptom profile, mechanism of injury, concussion screening tool scores, and clinical outcomes, including time from injury to clinic presentation, duration of symptoms, and referral rate (see Table 1).

Concussion symptoms

The CP Screen tool was used to assess self-reported concussion symptoms across multiple domains. The CP Screen is a 29-item, self-report, clinical profile-based symptom inventory. Reliability in patients with concussions includes Cronbach's α of 0.92 and an intraclass correlation coefficient (ICC) of 0.91.[9] The items represent the following 5 concussion clinical profiles: (1) anxiety/mood (5 items), (2) cognitive/fatigue (3 items), (3) migraine (5 items), (4) ocular (5 items), and (5) vestibular (5 items); and the following 2 modifiers: (1) sleep (4 items) and (2) neck (cervical) (2 items) (see Figure 1, Supplemental Digital Content 1, available at: http://links.lww.com/JHTR/A668, which demonstrates CP Screening questions and Likert-scale rating of symptoms). Question 16 inquiries regarding "neck pain or stiffness" and question 25 inquiries regarding "difficulty moving your neck." Patients respond to each item that they are "currently experiencing" on a 0 (none) to 3 (severe) Likert-type scale. The CP Screen total score ranges from 0 to 87. Individual subscale scores range from 0 to 15 for anxiety/mood, migraine, ocular, and vestibular; 0 to 9 for cognitive/fatigue; 0 to 12 for sleep; and 0 to 6 for the neck (see Figure 2, Supplemental Digital Content 2, available at: http://links.lww.com/JHTR/A669, which demonstrates CP Screen Score Sheet). Raw scores for profile scores and modifiers may be averaged. The CP Screen takes 4 to 6 minutes to complete.

TABLE 1 *Injury characteristics and clinical outcomes*

	More severe neck symptoms ($n = 47$)	Mild to no neck symptoms ($n = 259$)	All patients ($n = 306$)
Days from initial injury to clinic presentation, average ± SD (range)	8.3 ± 6.5 d (2-28 d)	7.2 ± 6.0 d (1-30 d)	7 ± 6 d (1-30 d)
Days from initial injury to concussion recovery/clearance, average ± SD (range)	40.3 ± 26.9 d[a] (11-136 d)	30.2 ± 27.9 d[a] (4-156 d)	32 ± 28 d (4-156 d)
Vestibular referrals, *n* (%)	17 (36.2%)	70 (27%)	87 (28.4%)
Psychiatric referrals, *n* (%)	0 (0%)	0 (0%)	0 (0.0%)
Ocular referrals, *n* (%)	4 (8.5%)	1 (0.4%)	2 (0.7%)
Exertion/PT referrals, *n* (%)	1 (2.1%)	13 (5%)	14 (4.6%)
Any referral, *n* (%)	19 (40.4%)	79 (30.5%)	98 (32.0 %)
Loss of consciousness, *n* (%)	6 (12.8%)	26 (10.0%)	32 (10.5%)
Posttraumatic amnesia, *n* (%)	10 (21.3%)[a]	34 (13.1%)[a]	44 (14.4%)
Disorientation, *n* (%)	4 (8.5%)	31 (12.0%)	35 (11.4%)
Confusion, *n* (%)	3 (6.4%)	30 (11.6%)	33 (10.8%)
CP score raw total, average ± SD (range)	34.5 ± 12.5[a] (8-61)	18.7 ± 13.7[a] (0-63)	21.1 ± 14.6 (0-63)
VOMS total score, average ± SD (range)	53.0 ± 36.1[a] (0-149)	34.1 ± 33.2[a] (0-162)	36.9 ± 34.3 (0-162)
ImPACT symptom score, average ± SD (range)	40.2 ± 19.9[a] (5-85)	24.8 ± 19.8[a] (0-100)	27.2 ± 20.6 (0-100)
CP Q 16—neck pain, *n* (%)	47 (100%)[a]	98 (37.8%)[a]	145 (47%)
CP Q 25—neck movement difficulty, *n* (%)	47 (100%)[a]	21 (8.1%)[a]	68 (22.2%)

Abbreviations: CP, Concussion Clinical Profiles Screening; ImPACT, Immediate Post-concussion Assessment and Cognitive Testing; VOMS, Vestibular/Ocular Motor Screening.
[a] $P < .05$.

Cognitive testing

The ImPACT tool was used to evaluate neurocognitive function. The ImPACT tool is commonly used computer-based screening developed predominantly for use in athletics.[9,10,14–20] The tool is used at baseline and in the postinjury period. The reported ICC for preseason baseline testing is 0.36 to 0.68.[21] The ImPACT tool evaluates domains including verbal memory, visual memory, visual motor speed, reaction time, and impulse control. The ImPACT tool presents patients with a list of 22 common postconcussive symptoms including headache, dizziness, and nausea. Patients rate the severity of each symptom on a 1 (minor) to 6 (severe) Likert-type scale. The tool was designed with 5 validity thresholds, which can indicate an invalid protocol for factors such as lack of effort. The ImPACT tool takes 20 minutes to complete.

Vestibular/ocular testing

The VOMS tool was used to evaluate vestibular and ocular motor impairments. This tool is used in the postinjury patients to identify patients with a concussion.[9,22,23] Reliability in patients with concussions includes Cronbach's α of 0.92 and an ICC of 0.44 to 0.88.[9] The VOMS tool includes 5 domains: smooth pursuit, horizontal and vertical saccades, near point of convergence distance, horizontal vestibular ocular reflex, and visual motion sensitivity. Patients self-report changes in symptoms (eg, headache, dizziness, nausea, or fogginess) compared with their immediate preassessment state on a 0 (none) to 10 (severe) Likert-type scale after each VOMS item. The VOMS takes approximately 5 minutes to complete.

Recovery time

Recovery time in days was determined by subtracting the date of medical clearance for full return to activities from the date of injury. Medical clearance was determined per current standard of care[13] involving each of the following: being asymptomatic at rest, returning to baseline or normative values on cognitive and vestibular/ocular testing, and being symptom free following exertion testing.

Procedures

This study was approved by the University of Pittsburgh's Institutional Review Board. Patients completed the measure during their first clinical visit as part of

a comprehensive multidomain clinical examination, interview, and evaluation. The measures were completed in the following order: demographics/medical history/injury information, CP Screen, ImPACT, and VOMS. All measures were administered by trained clinicians. Recovery time was assessed after patients were medically cleared for full return to activity per current consensus criteria.[13]

Statistical analysis

The study power was set to 80% with an $\alpha = .05$. To determine the frequency of reported neck symptoms in patients with a concussion, summations with proportions of patients reporting symptoms in CP Screen questions 16 or 25 were recorded. To compare neck symptoms between mechanisms of injury including sports and non-sports-related concussion, we used χ^2 or Fisher's exact test analysis for categorical variables and independent *t* tests or the Mann-Whitney *U* test for quantitative variables. To determine differences in quantitative variable clinical outcomes including concussion recovery time, ImPACT scores, and VOMS scores, independent *t* tests or the Mann-Whitney U test was used to compare the grouping variable of no/mild neck symptoms versus more severe neck symptoms. To determine whether patients with more severe neck symptoms would be more likely to be referred to physical or psychiatric therapy, χ^2 or Fisher's exact tests were used to evaluate proportional differences in incidence of referral. χ^2 or Fisher's exact tests were also used to determine whether the no/mild neck symptoms and more severe neck symptoms groups differed by demographic variables, including gender or presence of medical history risk factors (see Table 1). Logistic regression analyses were used to identify predictors of more severe neck symptoms from demographic characteristics, injury factors, and medical risk factors. All demographic, injury, and medical risk factors with statistically significant mean or proportional difference in the no/mild neck symptoms group versus the more severe neck symptoms group were included in the logistic regression model. Days from initial injury to clinic presentation were included in the model as a potential confounding variable. Male gender and sports-related mechanism of injury were used as reference groups. For this study, a clinically significant level of reported neck symptoms termed "more severe" neck symptoms averaged 1.5 or more for CP neck symptoms (see Figure 2, Supplemental Digital Content 2, available at: http://links.lww.com/JHTR/A669, which demonstrates CP Screen Score Sheet). Patients with "no to mild" neck symptoms averaged less than 1.5 CP neck symptoms. Statistical analyses were performed using SPSS software version 27 (SPSS Inc, Chicago, Illinois).

RESULTS

Sample characteristics

A total of 306 of 363 (84.3% response rate) consecutively enrolled eligible patients from the clinical research registry were 117 (38.2%) females and 189 (61.8%) males, with an average age of 16 ± 4 years. See Table 2 for a summary of demographics and medical risk factor history. Patients with more severe neck symptoms

TABLE 2 *Demographics and medical risk factor history*

	More severe neck symptoms ($n = 47$)	Mild to no neck symptoms ($n = 259$)	All patients ($n = 306$)
Age, average ± SD (range)	18 ± 7 y[a] (11-51 y)	15 ± 3 y[a] (9-33 y)	16 ± 4 y (9-51 y)
Gender, *n* (%)			
Female	20 (42.6%)	97 (37.5%)	117 (38.2%)
Male	27 (57.4%)	162 (62.5%)	189 (61.8%)
Concussion history, *n* (%)	18 (38.3%)	76 (29.3%)	94 (30.7%)
ADHD history, *n* (%)	11 (23.4%)[a]	31 (12.1%)[a]	42 (13.8%)
Migraine history, *n* (%)	8 (17.0%)	51 (19.7%)	59 (19.3%)
Undiagnosed migraine history, *n* (%)	0 (0%)	7 (2.7%)	7 (2.3%)
Motion sickness history, *n* (%)	15 (31.9%)[a]	48 (18.8%)[a]	63 (20.9%)
Ocular disorder history, *n* (%)	4 (8.5%)	21 (8.1%)	25 (8.2%)
Anxiety history, *n* (%)	11 (23.4%)	51 (19.7%)	62 (20.5%)
Depression history, *n* (%)	4 (8.7%)	21 (8.4%)	25 (8.4%)
Workers' compensation case ongoing, *n* (%)	2 (4.3%)[a]	1 (0.4%)[a]	3 (1.0%)
Litigation case ongoing, *n* (%)	0 (0.0%)	1 (0.4%)	1 (0.3%)

Abbreviation: ADHD, attention deficit hyperactivity disorder.
[a] $P < .05$.

($n = 47$, 15.4%) were older (18 ± 7 years vs 15 ± 3 years; $P = .009$), more often had a history of motion sickness ($\chi^2 = 4.12$, $P = .042$), more frequently had a history of ADHD ($\chi^2 = 4.29$, $P = .038$), and a greater proportion had an ongoing workers' compensation case (likelihood ratio = 4.069, $P = .044$) when compared with the mild to no neck symptoms ($n = 259$) group. Sports injury was the most common mechanism of injury in 231 (75.5%) patients, followed by falls ($n = 47$, 15.4%), MVCs ($n = 12$, 3.9%), and assault ($n = 6$, 2.0%). Football was the most common sports-related concussion ($n = 65$, 21.2%), followed by hockey ($n = 45$, 14.7%) and soccer ($n = 39$, 12.7%).

Frequency and severity of neck symptoms

Among all patients, 145 (47%) reported neck pain, 68 (22.2%) reported difficulty moving their neck, and 146 (47.7%) reported either symptom. More severe neck symptoms (average CP neck symptoms ≥ 1.5) were reported by 47 (15.4%) patients. Among sports-related patients with concussions, 100 (43.3%) reported neck pain, 45 (19.5%) reported difficulty moving their neck, and 101 (43.7%) reported either symptom. More severe neck symptoms were reported in 28 (12.1%) patients with sports concussion. Among non-sports-related patients with concussions, 45 (60.0%) reported neck pain, 23 (30.7%) reported difficulty moving their neck, and 45 (60.0%) reported either symptom. Patients with sports-related concussions had a lower frequency of reported neck pain ($\chi^2 = 6.342$, $P = .012$), difficulty moving their neck ($\chi^2 = 4.099$, $P = .043$), and either symptom ($\chi^2 = 6.013$, $P = .014$) as compared with non-sports-related patients with concussions.

Association of neck symptoms with other clinical outcomes

Patients reporting more severe neck symptoms as compared with patients with no/mild neck symptoms experienced prolonged time to concussion recovery (40 ± 27 days vs 30 ± 28 days; $U = 8316$, $P < .001$) (Table 1). Patients reporting more severe neck symptoms were more likely to experience posttraumatic amnesia ($\chi^2 = 6.515$, $P = .038$), greater proportion had ongoing workers' compensation cases (likelihood ratio = 4.069, $P = .044$), were older ($P = .009$), and more frequently had a history of motion sickness ($\chi^2 = 4.120$, $P = .042$). There were no statistically significant differences in exertional PT (likelihood ratio = 0.762, $P = .340$), psychiatric ($P = 1$), vestibular ($\chi^2 = 1.634$, $P = .201$), or ocular referrals ($P = .251$) among patients with more severe neck symptoms compared with those without. The more severe neck symptom cohort had higher CP raw total scores ($P < .001$), VOMS total scores ($P < .001$), and ImPACT symptom scores ($P < .001$).

Results from a stepwise logistic regression to predict more severe neck symptoms using age, gender, days from initial injury to clinic presentation, mechanism of injury, posttraumatic amnesia with concussion, history of motion sickness, history of ADHD, and active workers' compensation case were significant (Nagelkerke $R^2 = 0.174$, $\chi^2 = 9.315$, $P = .316$). The significant predictors in the model were increased age ($P = .019$) and mechanism of injury with MVCs ($P = .036$) and falls ($P = .026$) as risk factors for more severe neck symptoms (see Table 3). Patients reporting MVCs or falls were at 4 times and 2 times greater risk, respectively, for reporting more severe neck symptoms.

DISCUSSION

This study sought to report the frequency of neck-related symptoms in patients following concussion from a specialty clinic population and expand on prior research by recruiting a broader age range and examining additional injury characteristics and clinical outcomes. The primary finding was that neck symptoms occurred in 48% of all patients, with 60% of patients in the non-sports category reporting neck symptoms and 44% of athletes. Demographic and medical factors associated with more severe neck symptoms included older age, history of motion sickness, history of ADHD, and those with workers' compensation cases. Injury factors associated with more severe neck symptoms included presence of posttraumatic amnesia at time of injury. When examining a stepwise logistic regression model, older age and specific mechanisms of injury–MVC and fall–were associated with more severe neck symptoms, but no other demographic, injury, or medical history risk factors were. Results also suggested patients with more severe neck symptoms had longer recovery time and universally had more symptoms across all self-report symptom measures, including the Post-Concussion Symptom Scale, the CP Screen, and vestibular screening, compared with patients with no or mild neck symptoms. However, the presence of more severe neck symptoms was associated with no differences in the rate of referrals for all types of therapies or treatments.

The findings provide new epidemiologic data on the incidence of neck symptoms in patients with concussions from a specialty clinic in the acute, subacute, and chronic injury phases. Consistent with prior literature in pediatric and ED acute concussion populations, the present evaluation found that neck pain and/or stiffness was common in the sample, occurring in nearly half of patients following concussion. Previously investigators reported the frequency of reported neck pain in patients

TABLE 3 *Logistic regression analysis for risk for presence of more severe neck symptoms*

Risk factor	Univariate odds ratio[a]	Adjusted odds ratio[a]	Adjusted *P* value
Age	1.15[b] (1.07-1.24)	1.13 (1.02-1.25)	*.019*
Gender, male (reference)	...	...	...
Gender, female	0.81 (0.43-1.52)	1.13 (0.55-2.33)	.739
Days from initial injury to clinic presentation	1.03 (0.98-1.08)	0.97 (0.82-1.03)	.394
Mechanism of injury, sports (reference)	...	...	...
Mechanism of injury, motor vehicle accident	7.25[b] (2.19-24.04)	4.14 (1.02-16.82)	*.047*
Mechanism of injury, falls	2.49[b] (1.16-5.34)	2.44 (1.02-5.81)	*.044*
Mechanism of injury, assault	1.45 (0.16-12.87)	0.79 (0.08-8.38)	.847
Mechanism of injury, other	0.52 (0.02-7.16)	...	1.000
Posttraumatic amnesia	1.94 (0.89-4.30)	1.59 (0.66-3.84)	.303
History of motion sickness	2.02[b] (1.02-4.03)	2.09 (0.97-4.50)	.060
History of ADHD	2.23[b] (1.03-4.82)	2.09 (0.90-4.88)	.87
Workers' compensation	11.48[b] (1.02-129.11)	0.66 (0.04-12.41)	.78

Abbreviation: ADHD, attention deficit hyperactivity disorder.
[a]Values presented as odds ratios with the 95% CI in parentheses, predicting the presence of more severe neck symptoms. The stepwise logistic regression model controlled for age, gender, days from initial injury to clinic presentation, mechanism of injury, posttraumatic amnesia with concussion, history of motion sickness, history of ADHD, and active workers' compensation case.
[b]Values were significant at $P < .05$ in the unadjusted analysis.

with acute concussion in the ED was between 68.4 at 72 hours and 41.9% at 45 days of follow up.[11] In a study of youth athletes with concussion, Provance et al[12] reported that 54% of athletes endorsed neck or shoulder pain on a health intake questionnaire upon presentation to a children's hospital sports medicine clinic. Consistent with the present evaluation, the investigators reported neck pain was associated with prolonged median return to play time and more severe initial concussion symptoms.[12] This report contrasts prior findings in a pediatric ED population, which reported only 13.8% of patients reporting neck pain associated with their concussion.[10] This discrepancy may be because the King et al study only assessed neck pain at acute presentation and lacked clinical follow-up data including neck pain, which may have developed after the initial ED visit. However, consistent with the present findings, the previous studies by King et al indicated that MVC mechanism of injury was associated with a higher rate of primary neck pain.[10,11]

The clinical associations of concussions with severe neck symptoms presented in this study are supported by previously described associations in the whiplash literature. Whiplash-associated disorder (WAD) describes a spectrum of head and neck symptoms triggered by an accident with an acceleration-deceleration energy transfer including MVCs.[24] Consistent with the present findings, nonrecovery after whiplash injury has been associated with cervical degeneration seen in patients of older age,[25,26] ongoing litigation including worker's compensation cases,[27–29] and psychological factors such as ADHD.[30] Unique to this investigation, identified patients with severe neck symptoms and concussions had a higher incidence of reported motion sickness history and scored higher on concussion indices (CP screen, VOMS, and ImPACT). The concussion indices data may implicate a higher-energy mechanism of injury as is seen in WAD.[31] Meanwhile, the association of motion sickness history with severe neck system may implicate a disturbance to the vestibular system that may be best addressed with case-specific interventions including cervicovestibular rehabilitation to promote recovery.[7]

Clinical implications

The association of neck symptoms with prolonged time to recovery and increased symptom burden supports the inclusion of neck symptom evaluations such as the CP Screening tool. Despite the association with prolonged recovery, there was underutilization of available treatment resources evidenced by the referral rate analysis. Patients with neck symptoms took longer to recover, suggesting earlier and more targeted evaluation and treatment by a physical therapist may be warranted. Patients with cervical spine symptoms without radiographic anomalies should be considered for additional cervical assessment and rehabilitation. Most of these symptoms will resolve with conservative treatment consisting of targeted exercise therapy and oral anti-inflammatory medication.[32,33] Radicular-type arm symptoms or a failure of a supervised exercise program greater than 6 weeks would warrant referral to a specialist and an MRI.[34,35]

Although this study cannot establish a causal link between neck pain and stiffness with concussion severity, the findings suggest that neck symptoms are associated with potential markers for injury severity, including posttraumatic amnesia, higher overall symptom burden, and longer recovery.[16,36–41] Evidence for this also comes from Schneider et al,[7] who found that a combination of cervical and vestibular physiotherapy decreased time to medical clearance in patients with neck pain and/or headaches following a sports-related concussion. Further, previous research has indicated that patients with neck pain following concussion often present to clinic later, which is associated with prolonged recovery.[42] As such, providers should be aware of neck symptoms for prognostic purposes postconcussion, in addition to making early referral to physical therapy for neck symptoms.

Strengths and limitations

Strengths of this study include the use of a large database of patients completing concussion clinical assessments representing multiple domains including symptoms, cognitive, vestibular, and ocular. Limited or missing data in eligible patients were minimal, thereby increasing the representativeness of the sample. Limitations include a retrospective analysis of a prospectively collected cohort and the generalizability of results due to outliers. The cohort was delimited to patients presenting to a concussion specialty clinic, with a proportionally large representation of patient with sports-related concussion. This study was limited by self-report of neck-related symptoms and potential recall and other reporting bias. Future research should include objective examination of neck function and range of motion. The true incidence of cervical spine injury in patients following concussion, which may also include fractures, dislocation, or spinal cord injury, should also be considered in future research.

CONCLUSION

Neck pain and stiffness are commonly reported symptoms following concussion and are associated with mechanism of injury and prolonged recovery. Concussions from MVCs and falls are more likely to involve reported neck symptoms than other mechanisms of injury such as sports-related. The findings provide new data on the prevalence of neck symptoms in patients following concussion. Providers should evaluate neck symptoms and consider early referral to physical therapy for evaluation and targeted rehabilitation to mitigate their potential influence on prolonged recovery in affected patients.

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