Directional preference constructs for patients' neck pain in the absence of centralization

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ABSTRACT

Objectives: We conducted a secondary analysis of a prospective, observational cohort study to (1) report the prevalence of Directional Preference (DP) constructs at first examination for patients with cervical spine challenges, and (2) determine the association between DP constructs and clinical outcomes at discharge from physical therapy.

Methods: We analyzed data collected from 718 consecutive patients who presented to outpatient, private practice clinics with primary complaints of non-specific neck pain; 200 patients met the inclusion criteria and completed first examination and discharge data. Statistical analysis determined the association between DP constructs at first examination and clinical outcomes at discharge.

Results: The findings in this investigation were that (1) the most prevalent DP constructs at first examination were related to ROM and pain intensity including Patient Reported Improvement in ROM (79.5%), Increase in Spine ROM (32.5%), and Pain Intensity Change (15.0%), (2) all DP groups improved and met the MCID for disability and pain intensity change at discharge except for the group that did not exhibit Increase in Spine ROM for pain intensity, (3) no clinically significant differences in pain intensity or disability existed between DP groups at discharge, and (4) 28.5% and 6.5% of patients exhibited a relative increase in cervical spine extension and flexion ROM, respectively, post-repeated movement testing on the first examination.

Discussion: The most prevalent DP constructs at first examination were related to ROM and pain intensity, and each was associated with a comparable clinical trajectory in terms of pain and disability outcomes at discharge. The findings of this study help Mechanical Diagnosis and Therapy (MDT) providers understand the common DP constructs encountered in routine clinical practice and their relation to pain and disability outcomes for patients with cervical spine challenges.

Level of Evidence: 2b

KEYWORDS

Cervical spine; neck pain; directional preference; McKenzie; centralization; practice-based evidence; orthopedic; musculoskeletal

Introduction

A recent review concluded that investigating Centralization (CEN) and Directional Preference (DP) was a top research priority for neck pain stakeholders [1]. The review was undertaken at the request of the Patient-Centered Research Institute (PCORI) to identify future research gaps in the conservative management of patients with neck pain disorders. Clinical practice guidelines and systematic reviews to date have shown little support for Mechanical Diagnosis and Therapy (MDT) in the cervical spine due to the limited quality and number of studies [2–5]. A systematic review by Takasaki and May [5] included five randomized controlled trials that did not demonstrate statistically significant differences in favor of MDT intervention; however, the authors contend that the findings may reflect suboptimal training of the treating therapists in MDT. In another review that examined CEN and DP [4], only 10 studies out of the 62 that were included in the

review investigated patients with cervical spine challenges. Further MDT research for patients with cervical spine disorders is clearly needed.

New research opportunities exist in regard to understanding DP assessment and management for patients with cervical spine disorders. The difference between DP and CEN is often misunderstood [6]. DP is a clinical finding that exhibits a characteristic change in signs and symptoms during an MDT evaluation. CEN is one of the many criteria used to determine the presence of DP and results in the systematic abolition of symptoms in a distal to proximal direction toward the spine. A DP can exist in the absence of CEN. However, the criteria used to establish the existence of DP has not been examined and many studies have not delineated between DP and CEN; the misunderstanding between DP and CEN are likely due to these reasons. Several studies analyzed the classification of patients' cervical spine disorders via CEN rather than DP in the absence of CEN [7–9] or did not provide a detailed description of

how DP was assessed [10,11]. In a study by Edmond et al [12], change in pain intensity and amount of ROM were the only two constructs examined for DP in the absence of CEN, and no additional information was provided on what cervical spine ROM directions were assessed or how much change in ROM was required to designate inclusion. Many different types of DP exist, and it is common for MDT providers to use DP criteria related to the assessment of changes in the patient's pain intensity of the distal-most relevant symptom, amount and quality of ROM, neurological signs and symptoms, and functional performance [13–15].

The aim of this investigation was to examine the DP assessment framework used by providers with advanced training in MDT for patients with cervical spine challenges during routine clinical practice. Spinal DP in the absence of CEN and spinal DP in the presence of CEN represent distinct diagnostic categories and have been shown to exhibit differences in prevalence and prognostic validity [5,12,16–20], yet no studies have examined the criteria used to establish a spinal DP in the absence of CEN and its subsequent association with outcome. We specifically sought to understand the prevalence of DP constructs and their relation to outcome for patients with cervical spine challenges that did not exhibit CEN at the

first examination. The primary objectives of this study were to (1) report the prevalence of DP constructs at first examination for patients with cervical spine challenges and (2) determine the association between DP constructs and clinical outcomes at discharge from physical therapy.

Methodology

Design

We conducted a secondary analysis of data from a prospective, observational cohort study which examined the association between Pain Pattern Classification (PPC), DP, and clinical outcomes [20]. The current study analyzed data collected from consecutive patients with non-specific neck pain who presented to outpatient clinics and exhibited DP at the first examination in the absence of CEN (see Figure 1). The TBD and TBD Institutional Review Boards for Protection of Human Subjects approved the project. Patient-informed consent was not required for the analysis and reporting of data as this study did not include any change in typical physical therapy practice.

Patients were included in this analysis if they presented with complaints of non-specific neck pain with

Figure 1. Flow of patients.

or without radiation into the upper extremities and their cervical spine challenge was classified as DP Non-CEN or DP NC (Non-Classifiable) at first examination; the PPC and DP framework have been described elsewhere [20]. Patients were excluded from the study if they had cervical spine surgery within the preceding 12 months. The managing providers were responsible for determining and reporting inclusion, exclusion, and discharge status. Ten providers participated throughout five Certified McKenzie Clinics in Florida, Alabama, Oklahoma, South Carolina, and New York. Six providers were certified in MDT and four held diplomas in MDT.

Outcome measures

Patient-reported outcomes were administered to patients by the managing provider immediately before the first examination, at regular intervals determined by the managing provider immediately after follow-up examinations, and then at discharge. The following two primary patient-reported outcomes were assessed via the Numeric Pain Rating Scale (NPRS) and the Neck Disability Index (NDI), respectively: pain intensity and patient self-reported disability. Pain intensity reported by the patient within 'the last few days' was assessed using an 11-point NPRS ranging from 0 ('No pain') to 10 ('Worst Pain Imaginable'). The NPRS has been shown to be reliable and valid [21,22] with a minimal detectable improvement between 1.3 and 4.1 points in patients with cervical spine disorders [21–23]; we considered 2 points of NPRS change as a somewhat conservative estimate of clinically significant improvement. The NDI is a patient self-report questionnaire for neck pain and is scored by initially calculating the score of each item (0–5-point scale) and then summing all 10 items. The score ranges from 0 to 50 with a higher number indicating greater levels of disability. Stratford et al. reported a minimally important change in the NDI score of 5 points (out of 50) [24]. The NDI has been shown to be an acceptable clinical measure for patients with non-specific neck pain [21].

DP classification and physical examination variables

DP was considered present at first examination if the patient's neck pain exhibited any of the following: (1) a decrease in the patient's most relevant distal pain by at least two pain intensity units, (2) an increase in cervical spine ROM via a bubble inclinometer as described by Hole et al [25], (3) patient reported improvement in his/her spinal ROM (e.g. patients often stated 'it feels better'), (4) improvement in the patient's neurological signs (i.e. improvement in abnormal hypotonic or hypertonic upper extremity

reflexes by $\geq$ one grade, upper extremity myotomes by $\geq$ one manual muscle test grade, sitting and/or supine upper limb tension tests, and/or upper extremity dermatomes by $\geq$ one grade), and (5) improvement in a patient's reported pain with a specific functional task by at least two pain intensity units (e.g. turning head to look over shoulder, reaching overhead, or other functional-based cervical spine, and/or upper extremity movement). For convenience, we, respectively, labeled these constructs as (1) Pain Intensity Change, (2) Increase in Spine ROM, (3) Patient Reported Improvement in ROM, (4) Improved Neurological Signs, and (5) Patient Reported Improvement in Functional Task.

A bubble inclinometer was used for measurement of cervical spine range of motion in flexion and extension. The inclinometer was placed on top of the patient's head aligned with external auditory meatus and then zeroed. Before and after repeated movement testing, the patient was asked to flex the head as far as possible, bringing the chin to the chest. The amount of cervical spine flexion was recorded. The patient was then asked to extend their head backward as far as possible. The amount of cervical spine extension was then recorded. If relevant to the patient's clinical presentation, a standard neurological examination was conducted. Upper extremity myotomes, dermatomes, reflexes, and tension tests were assessed before and after repeated movement testing. Myotomes and dermatomes were graded via the criteria set by the American Spinal Injury Association (ASIA) [26] and reflex testing was graded via 0 = no response (always abnormal), 1+ = a slight but definitely present response (may or may not be normal), 2+ = a brisk response (normal), 3+ = a very brisk response (may or may not be normal), and 4+ = a tap elicits a repeating reflex or clonus (always abnormal) [27].

The following upper extremity myotomes were assessed: C5 – Elbow flexors (Biceps, Brachialis), C6 – Wrist extensors (Extensor Carpi Radialis Longus and Brevis), C7 – Elbow extensors (Triceps), C8 – Finger flexors (Flexor Digitorum Profundus) to the middle finger, and T1 – Small finger abductors (Abductor Digiti Minimi). The following upper extremity dermatomes were assessed via light touch: C2 – At least 1 cm lateral to the occipital protuberance (alternatively 3 cm behind the ear), C3 – Supraclavicular Fossa (posterior to the Clavicle) and at the midclavicular line, C4 – Over the Acromioclavicular Joint, C5 – Lateral (radial) side of the Antecubital Fossa (just proximal to elbow crease), C6 – Thumb, dorsal surface, Proximal Phalanx, C7 – Middle finger, dorsal surface, Proximal Phalanx, C8 – Little finger, dorsal surface, Proximal Phalanx, and T1 – Medial (ulnar) side of the Antecubital Fossa, just proximal to the Medial Epicondyle of the Humerus. The following

upper extremity reflexes were assessed via a standard reflex hammer: Muscle stretch reflexes of the Biceps (C5–C6), Brachioradialis (C5–C6), and Triceps (C7). Upper limb tension was assessed via Elvey's Upper Limb Tension Test with a median nerve bias [28].

Data analysis

Statistical analyses were performed using R version 3.4.3. Our primary aim was to report the prevalence of DP constructs at first examination and determine the association between DP constructs and clinical outcomes (i.e. pain intensity and NDI score) at discharge for patients with neck pain. To assist in clinical interpretation of the results, we converted the following continuous variables to categories: Age – <45y, 45–65y, and >65y; Symptom Acuity – Acute (0–2 weeks), Sub-Acute (3–11 weeks), and Chronic (≥ 12 weeks); Surgical History – None and 1 or More; Medication for Condition – None and 1 or More; Number of Comorbid Conditions – None, 1, 2 or 3, and 4 or More; Imaging – None, 1, and 2 or More. To study the relationship between DP constructs at first examination, we created 2×2 contingency tables and used a Fischer Exact Test. The Fischer Exact Test was used to examine the significance of the association (i.e. contingency) between two given DP constructs. A significant association was considered present if the p -value was less than 0.05. To determine the association between DP constructs and clinical outcomes, we conducted a Wilcoxon Test and calculated p -values. Based on a report by Cleland et al. [29] regarding the minimal detectable change of cervical spine ROM, we used a 13-degree change in cervical spine extension ROM and a 19-degree change in cervical spine flexion ROM as a cut-point for DP inclusion for the construct Increase in Spine ROM. We categorized change in cervical spine extension and cervical spine flexion ROM into two categories each: cervical spine extension ROM greater than or equal to a 13-degree change (Extension ≥ 13 degrees) and less than a 13-degree change (Extension < 13 degrees) and cervical spine flexion ROM greater than or equal to a 19-degree change (Flexion ≥ 19 degrees) and less than a 19-degree change (Flexion < 19 degrees). We analyzed both cervical spine flexion and cervical spine extension ROM and calculated the prevalence of change in ROM for each category at first examination by determining the total number of patients within each category and then divided by the total number of patients in the sample; we then converted these numbers to percentages.

Results

A total of 718 consecutive patients with neck pain entered the clinic (Figure 1) during the study period.

Totally, 384 patients exhibited a DP and a PPC of Non-CEN and/or NC at first examination and 371 patients completed first examination data collection resulting in a participation rate of 97%. Reasons for not commencing data collection are found in Figure 1, and the characteristics of the patients are displayed in Table 1.

Compared to patients with first examination and discharge data ($n = 200$; 54% completion rate), patients with first examination data only ($n = 171$) were younger ($t = -2.38$, $df = 360$, p -value = 0.02) and had less PPO health insurance ($\chi^2 = 40.31$, $df = 4$, p -value = 0.00). No significant differences existed based on NDI score at first examination ($t = 1.74$, $df = 335$, p -value = 0.08), NPRS score at first examination ($t = -1.41$, $df = 363$, p -value = 0.16), gender ($\chi^2 = 1.57$, $df = 1$, p -value = 0.21), Acuity ($\chi^2 = 0.49$, $df = 2$, p -value = 0.78), number of surgeries ($\chi^2 = 1.05$, $df = 1$, p -value = 0.31), number of medications ($\chi^2 = 0.00$, $df = 1$, p -value = 0.97), number of images ($\chi^2 = 1.59$, $df = 2$, p -value = 0.45), exercise history ($\chi^2 = 0.52$, $df = 2$, p -value = 0.77), referral type ($\chi^2 = 2.00$, $df = 3$, p -value = 0.57), and number of comorbidities ($\chi^2 = 2.67$, $df = 3$, p -value = 0.44). Reasons for not completing discharge data collection are found in Figure 1.

The following prevalence of DP constructs (Table 2) was found at first examination for patients with first examination and discharge data: Pain Intensity Change (15.0%), Increase in Spine ROM (32.5 %), Patient Reported Improvement in ROM (79.5%), Improved Neurological Signs (6.0%), and Patient Reported Improvement in Functional Task (5.0%).

We excluded the following DP constructs from further analysis due to an unexpectedly low number of observations: Improved Neurological Signs ($n = 12$) and Patient Reported Improvement in Functional Task ($n = 10$). We examined the association among the remaining DP constructs at first examination. All combinations of DP constructs at first examination did not show a statistically significant association with one another relative to prevalence. We then analyzed the effect of DP constructs on disability and pain intensity at discharge (Table 2). For the disability analysis, all groups improved and met the MCID for disability change. No statistically significant difference in disability change was observed between the groups. For the pain intensity analysis, all groups improved and met the MCID for pain intensity change except for the group that did not exhibit Increase in Spine ROM. No statistically significant difference in pain intensity change was observed between the groups.

For the cervical spine ROM analysis (Table 3), 28.5% exhibited at least a 13-degree increase in cervical spine extension ROM post-repeated movement testing on the first examination. In total, 6.5% of patients exhibited at least a 19-degree increase in cervical spine flexion ROM post-repeated

Table 1. Patient characteristics.

Characteristics	First examination only (n = 171)	First examination and discharge data (n = 200)
Age (y)	40.5 ± 16.5 (3–82)	44.6 ± 16.4 (8–81)
Missing	0.0%	0.0%
Gender		
Male	35.1%	42.0%
Female	64.9%	58.0%
Missing	0.0%	0.0%
Symptom Acuity		
Acute (0–2 weeks)	17.0%	19%
Sub-Acute (3–11 weeks)	31.6%	28.5%
Chronic (≥12 weeks)	50.9%	50.5%
Missing	0.6%	2.0%
Surgical History		
None	95.3%	95.0%
1 or More	2.3%	5.0%
Missing	2.3%	0.0%
Medication for Condition		
None	48.0%	49.0%
1 or More	50.9%	50.5%
Missing	1.2%	0.5%
Imaging		
None	49.7%	45.0%
1	39.8%	40.5%
2 or More	10.5%	14.5%
Missing	0.0%	0.0%
Exercise History		
1 or 2 Times per Week	28.7%	28.5%
At least 3 Times per Week	39.8%	37.5%
Seldom or Not at All	29.2%	33.0%
Missing	2.3%	1.0%
Referral Type		
Primary Care	55.6%	60.5%
Specialist	18.7%	13.5%
Self	5.8%	5.5%
Other	19.9%	20.5%
Missing	0.0%	0.0%
Number of Comorbid Conditions		
None	29.8%	24.0%
1	20.5%	23.5%
2 or 3	33.3%	35.0%
4 or more	12.3%	16.5%
Missing	4.1%	1.0%
Payer		
Auto	2.9%	9.5%
Health Maintenance Organization (HMO)	83.0%	54.5%
Medicaid	0.6%	0.0%
Medicare Part B	3.5%	6.0%
Preferred Provider Organization (PPO)	7.6%	28.5%
Workers' Compensation	0.0%	1.0%
Other	1.2%	0.5%
Missing	1.2%	0.0%
NDI First Examination	14.8 ± 7.3 (1–35)	13.3 ± 8.1 (0–43)
Missing	9.4%	8.5%
Pain Intensity First Examination	4.7 ± 2.2 (0–9)	5.0 ± 2.4 (0–10)
Missing	1.2%	0.0%

NDI = Neck Disability Index; NPRS = Numeric Pain Rating Scale.

movement testing on the first examination. A statistically significant difference was exhibited between the cervical spine extension groups for differences in pain as well as the cervical spine flexion groups for differences in disability. However, results should be interpreted with caution for the cervical spine flexion groups due to the low number of observations for the Flexion ≥19 degrees group ($n = 13$). The average time to discharge was 35.0 days ($SD = 21.4$; range = 1–100).

Discussion

Our primary findings in this investigation were that (1) the most prevalent DP constructs at first examination were related to ROM and pain intensity including Patient Reported Improvement in ROM (79.5%), Increase in Spine ROM (32.5%), and Pain Intensity Change (15.0%), (2) all DP groups improved and met the MCID for disability and pain intensity change at discharge except for the group that did not exhibit Increase in Spine ROM for pain intensity, (3) no clinically significant differences in pain intensity or disability existed between DP groups at discharge, and (4) 28.5% and 6.5% of patients exhibited a relative increase in cervical spine extension and flexion ROM, respectively, post-repeated movement testing on the first examination.

To the best of the authors' knowledge in this study, no other MDT studies for patients with cervical spine challenges have investigated the prevalence of DP constructs and their subsequent association with outcome. The ROM and pain intensity constructs in this study closely align with the MDT paradigm [13–15,30], which states DP is associated with changes in the patient's mechanical presentation and reductions in the distal-most relevant pain intensity; a favorable change in the mechanical presentation not only includes an improvement in the quantity of ROM but also a reduction in the pain felt during cervical spine movement. In our investigation, patients' reports of improvement in the quality of movement were found to be an important determinant (79.5% prevalence) for assigning a DP. Further studies are needed to verify these findings.

We analyzed the association between DP constructs at first examination and pain and disability outcomes at discharge. All groups improved relative to pain intensity and disability changes, however no DP construct showed a clinically significant difference in pain intensity or disability at discharge. These findings indicate that each DP construct is associated with a comparable clinical trajectory in terms of pain and disability outcomes and exhibits equally favorable outcomes at discharge in the absence of CEN. Certain DP constructs might, however, be associated with more rapid and substantial improvements in pain intensity and disability at certain time points, but our study design disallowed us from assessing those relationships. Additional studies are needed to evaluate the association between DP constructs at first examination and clinical outcomes at various time points including the first few days, 1 week, 2 weeks, and at discharge from physical therapy.

Cervical spine flexion and extension ROM were measured via an inclinometer before and after repeated movement testing. We used a 13- and 19-

Table 2. First examination DP constructs and discharge disability and pain intensity comparison (n = 200).

	Status	Counts	Frequency	Mean Pain at Intake	Mean Pain at Discharge	Pain Difference	Test for Pain Difference (p-value)	Mean Disability at Intake	Mean Disability at Discharge	Disability Difference	Test for Disability Difference (p-value)
Pain Intensity Change	Present	30	15.0%	5.85	2.33	3.52	0.23	15.96	9.08	6.88	0.71
	Absent	170	85.0%	4.86	1.89	2.97		12.85	6.52	6.34	
	Missing	0	0.0%								
Increase in Spine ROM	Present	65	32.5%	5.09	1.90	3.19	0.22	14.59	7.54	7.05	0.32
	Absent	104	52.0%	4.84	2.98	1.86		13.18	7.07	6.11	
	Missing	31	15.5%								
Patient Reported Improvement in ROM	Present	159	79.5%	4.98	1.90	3.08	0.90	13.26	7.02	6.24	0.55
	Absent	41	20.5%	5.15	2.18	2.96		13.41	6.30	7.11	
	Missing	0	0.0%								

Values are proportions (percent) or prevalence rates of the DP construct of interest. Level of disability was determined by the Neck Disability Index (NDI). Level of pain intensity was determined by the Numeric Pain Rating Scale (NPRS). Difference scores were calculated by subtracting the mean value (i.e. NPRS or NDI score) at first examination from the mean value at discharge.

Table 3. Cervical spine ROM, NDI and pain analysis (n = 200).

ROM	Counts	Frequency	Mean Pain at Intake	Mean Pain at Discharge	Pain Difference	Test for Pain Difference (p-value)	Mean Disability at Intake	Mean Disability at Discharge	Disability Difference	Test for Disability Difference (p-value)
Extension ≥13 degrees	57	28.5%	4.90	1.60	3.30	0.05*	13.76	7.19	6.57	0.81
Extension <13 degrees	110	55.0%	4.99	2.42	2.57		13.56	7.23	6.33	
Missing	33	16.5%								
Flexion ≥19 degrees	13	6.5%	6.34	2.92	3.42	0.56	19.0	8.15	10.85	0.01*
Flexion <19 degrees	153	76.5%	4.83	2.62	2.21		13.26	7.17	6.09	
Missing	34	17.0%								

ROM = range of motion; NDI = Neck Disability Index; NPRS = Numeric Pain Rating Scale. Values are proportions (percent) or prevalence rates for the ROM related Directional Preference (DP) constructs. Level of disability was determined by the NDI. Level of pain intensity was determined by the NPRS. Difference scores were calculated by subtracting the mean value (i.e. NPRS or NDI score) at first examination from the mean value at discharge. Extension ≥13 degrees corresponds with ROM change that meets or exceeds the minimal detectable change for cervical spine extension ROM. Extension <13 degrees corresponds with ROM change that does not meet or exceed the minimal detectable change for cervical spine extension ROM. Flexion ≥19 degrees corresponds with ROM change that meets or exceeds the minimal detectable change for cervical spine flexion ROM. Flexion <19 degrees corresponds with ROM change that does not meet or exceed the minimal detectable change for cervical spine flexion ROM. *Statistically significant

degree cut-point as a basis for determining an increase in cervical spine extension and flexion ROM, respectively [29]. The data from our investigation indicate that a relative increase in cervical spine extension ROM was more common (28.5%) than an increase in cervical spine flexion ROM (6.5%). This finding is consistent with prior cervical spine prevalence research regarding common directions of preference and loading strategies. An extension DP has been shown to be pervasive, typically exhibiting an 80% prevalence or higher [10,12,31,32]. In a recent report by Otero and Bonnet [31], 297 patients with neck pain were examined via MDT methods. A 92% prevalence of derangement was found and 84% had a DP of extension [31]. Although individual interventions were not recorded in our investigation, based on the previously reported prevalence data mentioned, providers in this study likely had most patients performing extension-based movements, which could explain why improvements in extension ROM were more common. In addition, an increase in cervical spine extension ROM was associated with a statistically, but not clinically, significant difference in pain intensity at discharge. This finding could be explained by the early analgesic effect associated with DP management [16]. An increase in

cervical spine flexion ROM was associated with a statistically, but not clinically significant difference in disability at discharge, however these data should be interpreted with caution due to the small sample size within the Flexion ≥19 degrees group (n = 13). Further studies are needed to verify these findings.

There are several opportunities for improvement and further research in this area. Although the participating clinicians were instructed to collect data on all patients, the completion rate (54%) was unexpectedly low and is a potential source of selection bias. However, patients with first examination data only and patients with first examination and discharge data differed only by age (patients with first examination data had an average age of 40.5, whereas patients with first examination data and discharge had an average age of 44.6) and type of health insurance (83.0% of patients with first examination data only had an HMO insurance type versus 54.5% of patients with first examination data and discharge data). The overall aim of this study disallowed us from gaining an understanding of the comprehensiveness of the DP assessment framework used in this investigation. We developed the DP constructs used in this study through focus group meetings

with diploma and certified providers in MDT who all worked in Certified McKenzie Clinics. The framework for the DP constructs was adopted from McKenzie [14,15]. Further studies are needed to reach consensus on what constitutes a comprehensive set of DP tests and measures, which can be examined through the use of additional focus group meetings and Delphi studies. Research with larger sample sizes is needed to confirm the data presented in this study, especially the low occurrence of the DP constructs related to functional improvement and neurological signs, as these are reported as components of an MDT evaluation [13–15]. Furthermore, clinically significant differences in DP constructs may exist at different time points than those assessed in this investigation. Further studies should consider assessing pain and disability outcomes across various time points to attempt to expose clinically significant differences between DP categories.

Differences in provider practice patterns might influence the selection of physical examination tests during DP assessment. The providers in our study had advanced levels of training in MDT, and, in order to maximize generalizability, we allowed the provider to use his or her professional expertise and discretion when selecting the appropriate set of physical examination tests to determine the presence of DP within a standard MDT evaluation framework; we did not require that every DP construct be assessed in a given patient encounter since the clinical decision-making process for the selection of these tests and measures are patient-specific and highly individualized. Requiring excessive research documentation as well as the collection of every DP construct for each patient would deindividualize care, cause operational inefficiencies, and disrupt research to practice translation. We chose only to measure cervical spine flexion and extension via inclinometer measurement; however, the MDT providers in this study reported a high degree of burden performing these measurements as this was not part of their routine practice. We encouraged providers to use their clinical judgment to allow for a naturalistic approach to the patient encounter, minimize disruptions in workflows, and reflect actual MDT practice. The design and scope of our study prohibited us from determining why providers chose to use the tests and measures they did. We suspect that other factors influenced the selection of certain sets of clinical tests and could help explain the DP construct findings in this study. Further research is needed to assess how patient, provider, and clinical-level factors influence practice patterns relative to DP assessment of patients with cervical spine challenges including patient characteristics (e.g. comorbidities, condition type, severity of illness, and patient expectations), provider characteristics (e.g. bias, training levels, familiarity and confidence with tests and measures), and facility standards.

Conclusion

Our primary findings in this investigation were that (1) the most prevalent DP constructs at first examination were related to ROM and pain intensity (2) all DP groups improved and met the MCID for disability and pain intensity change at discharge except for the group that did not exhibit Increase in Spine ROM for pain intensity, (3) no clinically significant differences in pain intensity or disability existed between DP groups at discharge, and (4) 28.5% and 6.5% of patients exhibited a relative increase in cervical spine extension and flexion ROM, respectively, post-repeated movement testing on the first examination. These findings help MDT providers understand the common DP constructs encountered and their relation to pain and disability outcomes for patients with cervical spine challenges. Our investigation offers insight for further research to explore the DP assessment framework as part of a standard MDT evaluation.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

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