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Relationship between pain characteristics and pain adaptation type in persons with SCI

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Abstract—After a spinal cord injury (SCI), people commonly experience several types of persistent pain. Unfortunately, individuals who experience unremitting pain despite various treatments have no choice but to adapt to their pain. Although people may possess different styles of pain adaptation, one can hypothesize that the specific types of pain a person experiences are also important. The present study determined the association between pain characteristics and specific adaptational patterns to pain after SCI. Participants (N = 182) were interviewed regarding pain characteristics and the impact of pain on their psychosocial status. Based on the SCI version of the Multidimensional Pain Inventory (MPI-SCI), they were classified as Dysfunctional, with higher pain severity (PS) and life interference (LI); Interpersonally Supported, with moderately high PS, high social support levels, and less LI; or Adaptive Coper, with lower PS and LI levels. A multinomial logistic regression analysis indicated a robust model fit (chi-square = 63.6, p < 0.0005), predicting MPI-SCI subgroup membership based on a combination of pain intensity (p < 0.0005), extent of pain aggravation (p < 0.01), electric quality of pain (p < 0.01), constancy of pain (p < 0.01), and distribution of pain (p < 0.05). The results of the present study support the biopsychosocial model of pain.

Key words: adaptation, biopsychosocial, chronic pain, Multidimensional Pain Inventory, neuropathic pain, pain aggravation, pain history, psychosocial impact, rehabilitation, spinal cord injury.

INTRODUCTION

After a spinal cord injury (SCI), people often experience several types of persistent pain problems simultaneously [1–2]. Persistent and severe pain is a well-recognized problem that can significantly reduce quality of life of persons with SCI [3] and significantly affect them psychosocially after SCI [4–5]. Although two recent pharmacological trials showed some success in alleviating pain [6–7], most of the pain problems associated with SCI are not relieved by available treatments [8–9]. Indeed, pain relief, together with issues related to occupation and

Abbreviations: AC = Adaptive Coper, AD = affective distress, ANOVA = analysis of variance, CI = confidence interval, DR = distracting response, DYS = Dysfunctional, GA = general activity, ID = Interpersonally Distressed, IS = Interpersonally Supported, LC = life control, LI = life interference, MPI = Multidimensional Pain Inventory, MPI-SCI = spinal cord injury version of the MPI, NR = negative response, NRS = numerical rating scale, OR = odds ratio, PS = pain severity, S = support from significant others, SCI = spinal cord injury, SR = solicitous response, VA = Department of Veterans Affairs.

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sexual activity, was recently identified in a large European multicenter study as an area of significant and unmet needs [10]. Consequently, those individuals who experience pain that is refractory to treatments after their SCI have no choice but to adapt.

In contrast to most other chronic pain populations, people with SCI-related pain often experience several types of pain with specific clinical characteristics [11–12]. For example, the combination of sharp, continuous, and intense pain interfering with daily living and exacerbated by multiple factors and situations was significantly associated with a specific pain being perceived as the "most disturbing" compared with the other pains experienced [13]. Identifying the aspects that make SCI-related pain disturbing may help focus treatment efforts and may increase our understanding of how these aspects of pain affect adaptation to chronic pain.

The Multidimensional Pain Inventory (MPI) (version 2) includes nine subscales that measure pain severity (PS); life interference (LI); affective distress (AD); life control (LC); support from significant others (S); negative responses (NRs), distracting responses (DRs), and solicitous responses (SRs) by significant others; and participation in general activities (GAs) [14]. Subgroup analyses of the MPI scales have identified three adaptational subgroups:

1. Dysfunctional (DYS) with high levels of PS, AD, and perceived LI and low levels of perceived LC and GA.
2. Adaptive Coper (AC) with lower levels of PS, AD, and LI and a higher sense of LC and GA.
3. Interpersonally Distressed (ID) with high levels of PS and low levels of social support.

These particular subgroups have been replicated in several chronic pain populations, e.g., headache [15–16], back pain [17–18], orofacial pain [17,19], whiplash injuries [20], fibromyalgia syndrome [21], and cancer pain [22]. However, adjustment to pain after SCI seems to differ partly from what has been observed in other chronic pain populations [23]. This finding may be because individuals who have sustained SCI have had to adapt to several concomitant pains with different characteristics [1–2] as well as to the physical impairments and limitations associated with SCI.

Based on the biopsychosocial perspective on pain [24–25], one can hypothesize that adaptation to pain after SCI not only depends on psychosocial factors but also involves adaption to specific pain types, some of which may have characteristics that are more difficult to deal with and adapt to than other pain types. A previous study in SCI demonstrated that a DYS classification was associated with burning pain and allodynia (i.e., pain in response to a stimulus that would normally not provoke pain, such as light touch) [23], suggesting that pain types with neuropathic characteristics were associated with a more dysfunctional adaptational pattern. However, in that study, only two subgroups were identified: DYS, which had higher PS and LI scores, and AC, which had significantly lower PS and LI scores than DYS. A subgroup corresponding to the ID, with higher PS and lower perceived social support, which has been observed in other pain populations, was not identified in that study. However, in a recent study that included a larger sample of persons with SCI and chronic pain [26], a new adaptational subgroup was identified: the Interpersonally Supported (IS), which was characterized by moderately high PS and high LC, S, DR, SR, and GA scores. Compared with DYS, IS reported significantly greater perceived social support and life satisfaction and less pain disability and emotional distress, despite experiencing moderately high PS.

The present study determined to what extent pain characteristics can predict specific patterns of adaptation to persistent pain after SCI. We hypothesized that membership in the DYS and IS subgroups would be predicted by greater extent of neuropathic pain characteristics compared with the subgroup with the lowest PS, i.e., the AC. In addition, we hypothesized that membership in the IS subgroup would be predicted by significantly less aggravation of pain caused by daily factors and situations and more pain breaks than the DYS subgroup. This hypothesis was based on the fact that persons characterized as IS have more interpersonal support that may be associated with better coping.

METHODS

Sample Characteristics

All participants were ≥18 years old, had experienced a traumatic SCI at least 1 year before the study, and had experienced pain for a minimum of 6 months. The participants (N = 182) were recruited through advertisements posted at the Miami Department of Veterans Affairs (VA) Medical Center and the University of Miami Leonard M. Miller School of Medicine, including The Miami Project to Cure Paralysis, and by word of mouth. The data presented in the present study are part of a larger project

regarding pain after SCI. After giving written informed consent, each participant took part in a 3-hour face-to-face session consisting of completing several interview-based questionnaires and a neurological examination based on the American Spinal Injury Association impairment scale, specifically, the Standards for Neurological Classification of SCI [27]. The participants also provided information regarding sex, age, time since injury, completeness of injury, and duration of their pain problem. The Miami VA Medical Center and the University of Miami Institutional Review Boards approved this study.

Measures

SCI Version of Multidimensional Pain Inventory

The MPI (version 2) is a revision of the original West Haven-Yale MPI questionnaire [14]. It is a 60-item (56 scored) comprehensive instrument based on cognitive-behavioral theory and is designed to assess the severity and impact of chronic pain, emotional and physical adaptation to persistent pain, and social support. Answers are given on a numerical rating scale (NRS) ranging from 0 to 6. The psychometric properties of the MPI are excellent, and the factor structure has been confirmed in a number of studies [28–30]. Based on exploratory and confirmatory factor analyses, Widerström-Noga and colleagues revised the MPI for use in the SCI chronic pain population [31]. In the SCI version of the MPI (MPI-SCI), three questions from the LI subscale, one question from the LC subscale, and two questions concerning the responses by significant others were removed to improve the factor structure. Additionally, in the GA subscale, each item was supplemented with a question addressing the degree to which a specific activity may have been decreased specifically because of pain, as opposed to the physical impairment. The internal consistency, stability, and validity of the MPI-SCI were recently demonstrated in a sample of individuals with SCI and chronic pain [32].

In a previous study [26], DYS, AC, and IS (three distinct adaptational subgroups of the MPI-SCI of nearly equal proportions) were identified. The subgroups were based on a subgroup analysis, a statistical method in which the within-group variability is minimized (i.e., individuals within a subgroup share as many characteristics as possible) and between-group variability is maximized (i.e., individuals of different subgroups share as few characteristics as possible). The subgroup analysis scans the scores from each of the nine subscales one by one and decides whether the current record should merge with the previously formed subgroups or start a new subgroup based on the distance criterion. In a second step, these pre-subgroups are grouped with use of the hierarchical cluster procedure. The cluster procedure accounts for all subscales when subgroup membership is assigned. We used the cluster assignment derived in the previous study [26] as the dependent variable in the present analyses to assess the relationship between specific pain characteristics and pain adaptation type.

Pain History

In a face-to-face interview, participants provided details concerning all pain problems that had been present for >6 months. The interview was based on a questionnaire developed and previously used by our laboratory [33]. Participants were first asked to define the areas in which they felt persistent pain. If more than one pain problem was experienced, each pain was evaluated separately by an interviewer who was instructed to ensure that the person being interviewed was referring to the specific pain in question. Specific characteristics were defined for each distinct pain problem regarding location, quality, intensity, temporal characteristics, and aggravating factors (i.e., factors and situations that elicit or aggravate pain).

General Pain

Pain Location. Location of pain was indicated on a drawing of the human body (front and back), divided into eight areas: head, neck and shoulders, arms and hands, frontal torso and genitalia, back, buttocks, thighs and legs, and feet [33]. For the present analyses, the number of painful body areas (between 1 and 8) was used as a general measure of pain distribution.

Overall Pain Intensity. In this study, we used an 11-point NRS to assess an individual's overall average pain intensity [34], with anchors of "0" to indicate "no pain" and "10" to indicate "the most intense pain imaginable." Subjects were asked to provide one overall pain rating for all their pains. This rating was used as an external validation of the MPI-SCI subgroup assignment that used the PS subscale, which is made up of three questions: (1) level of pain at the present moment, (2) severity of pain during the past week, and (3) suffering experienced. The PS subscale is different from pain intensity, which deals only with the perceived intensity of a particular pain. Thus, significantly higher pain intensity ratings

were expected in the DYS and IS subgroups than in the AC subgroup.

Most Disturbing Pain

Participants were asked whether they experienced several pain problems that they felt were distinctly different from one another. If so, they were asked to differentiate between these pain problems and determine which one was the "most disturbing." To determine how well specific pain characteristics predict subgroup membership, we used only the pain characteristics considered most disturbing for further analysis. The most disturbing pain was selected for use since previous research has shown that the probability of a pain being regarded as most disturbing is significantly related to higher levels of perceived LI and pain intensity [13]. Therefore, pain regarded as most disturbing can be assumed more likely to influence adaptation to pain than other pains with less disturbing characteristics. For those cases in which no specific pain was considered more disturbing than any other pain problem the person experienced, one pain was randomly selected by the SPSS random numbers procedure (SPSS Inc; Chicago, Illinois) to be analyzed as the most disturbing for that subject. If only one pain was present, it was regarded as the most disturbing pain.

Pain Intensity. We assessed the intensity of the most disturbing pain by using an NRS ranging from 0 (no pain) to 10 (most intense pain imaginable) [34].

Constancy of Pain. To define the temporal characteristics of the most disturbing pain problem, we asked the participants two questions: (1) "How often do you have pain?" with possible answers of "no predictable pattern," "1 to 3 days per month," "1 to 2 days per week," "3 to 6 days per week," or "every day"; and (2) "Do you have breaks from pain?" with possible answers of "no predictable pattern," "week-long breaks," "breaks of 1 day to several days," "breaks of several hours," "breaks of 5 minutes to 1 hour," "short breaks (<5 minutes)," or "no breaks." Answers were assigned a value of "0" for the lowest frequencies ("1 to 3 days per month" and "week-long breaks"), and successive integers were assigned for each increase in pain frequency or constancy. We calculated the "constancy of pain" score by summing the values for these two questions so that higher scores indicated more constant pain (i.e., more frequent episodes and shorter pain-free periods).

Quality of Pain. The participants described the qualities specific to their most disturbing pain problem by choosing from a list of 24 descriptors and/or by adding their own descriptors. The list consisted of the following words: aching, biting, burning, cold, cramping, crushing, cutting, dull, electric, flashing, lacerating, lancinating, penetrating, pinching, pressing, pricking, pulsating, radiating, sharp, shocking, shooting, stabbing, stinging, and throbbing. The frequencies for the 10 most commonly selected descriptors were used for analysis.

Pain Aggravation. Various physical and emotional circumstances, activities, or situations may affect a person's pain experience. The participant was presented a list of 27 factors and was asked, for the most disturbing pain problem, whether each factor "has no effect on the pain," "makes the pain worse," "makes the pain considerably worse," or whether they "did not know." The factors were chosen based on interviews with individuals with SCI and on previous studies [33]. The factors included infections, full bladder, constipation, muscle spasms, fatigue, anger, anxiety, sadness, prolonged sitting, change of position, lying down, getting out of bed, going outside, sudden movements, coughing or sneezing, exercise, sexual activity, touch, noise, music, hot weather, cold weather, and wet weather; and the use of substances such as alcohol, cigarettes, caffeine, and recreational drugs. To assess the impact of the aggravation of "most disturbing" pain due to these factors, we coded each of the 27 factors as follows: "0" was assigned for the answer "has no effect on the pain," "1" for "makes the pain worse," and "2" for "makes the pain considerably worse." We calculated a pain aggravation score for the most disturbing pain by summing the values across all factors. If a participant did not know a factor's effect on the most disturbing pain, the factor was excluded from the analysis.

Statistical Methods

Statistical analyses were performed with SPSS 15 for Windows. To determine differences between the subgroups, we conducted parametric and nonparametric analyses, depending on whether the variables met the normality and homoscedasticity assumptions. We conducted one-way analyses of variance (ANOVAs) and Student *t*-tests to analyze normally distributed data and analyzed categorical data by performing Kruskal-Wallis and χ^2 tests. All *t*-tests were two-tailed, and we used Bonferroni correction to adjust for multiple comparisons [35], unless otherwise stated. We performed a multinomial logistic regression analysis to predict subgroup membership. The multinomial logistic regression command fits the maximum likelihood

regression model, which allows for multiple comparisons across all outcomes. The forward stepwise procedure starts with no variables in the model and enters the most significant variable at each step. The procedure examines the variables included for entry until all variables in the model fulfill the criteria set for retention (in this case an α level of 0.05). A valuable estimate in a logistic regression model is the odds ratio (OR) for each of the predictors with its 95 percent confidence interval (CI) relative to a reference group. The OR indicates the odds of belonging to one subgroup compared with a specified reference subgroup for each variable included in the final model. A >1 OR indicates that the odds of belonging to one subgroup are greater than belonging to a reference subgroup. Conversely, a <1 OR indicates that the odds of belonging to one subgroup are less than belonging to a reference subgroup. Because no model for prediction of subgroup membership exists in the literature to guide variable selection and because sample size is relatively small in comparison to the possible number of predictor variables [36], only the variables that were found to be significantly different in the univariate relationship analyses were included as independent variables in the logistic regression analysis.

RESULTS

SCI Version of Multidimensional Pain Inventory Subgroups

The subjects of the present study were part of a larger data set including 190 persons with SCI and chronic pain, who participated in a study aimed at defining adaptational subgroups to SCI-related pain. In that study [26], three equally sized but distinctly different subgroups were identified (i.e., the DYS, IS, and AC) based on the MPI-SCI. Out of the 190 subjects, 182 completed both the MPI-SCI and a differentiated pain history interview and therefore only their data were used in the present study. The data subset was similarly distributed across the subgroups, i.e., DYS, IS, and AC (**Figure**), and as observed previously [26], individuals classified into the AC subgroup were significantly younger and had been injured significantly longer than individuals classified as either DYS or IS ($p < 0.05$) [26]. Sample characteristics of this subset of subjects are summarized in **Table 1**.

General Pain

Pain Location

When we asked participants to differentiate between their pains, the majority of participants (78.0%) reported more than one pain. In total, 463 pains were reported by the 182 participants of the present study. Of the 463 pains reported, the most common pain locations were back (30.2%), neck/shoulders (22.7%), and legs/feet (22.5%). Most participants marked several areas in the pain drawing, and the mean number of areas was 3.1 (**Table 2**). Pain in persons classified as DYS was significantly more widespread, as indicated by pain covering more body areas, than in both the IS and the AC subgroups.

Overall Pain Intensity

Ratings of overall pain intensity were significantly different among the three subgroups (**Table 2**). Notably, the average pain intensities were not significantly different between the DYS subgroup and the IS subgroup, although individuals in the AC subgroup reported significantly less intense pain than individuals in the other subgroups.

Most Disturbing Pain

To determine the role of pain characteristics (associated with specific types of pain) in predicting subgroup membership, we used the data from the pain considered most disturbing for further in-depth analysis.

Pain Intensity

The intensity of the most disturbing pain was significantly different among the subgroups (**Table 2**). However, similar to pain intensity ratings of overall pain, no significant differences between DYS and IS were found, although they both scored significantly higher than the AC. Both the DYS and IS subgroups reported pain intensities for the most disturbing pains in the severe range, 7.6 and 7.8, respectively, whereas the AC subgroup reported pain intensity in the moderate range, 6.3. The pain intensity ratings for the most disturbing pains were significantly higher than the average overall pain intensities.

Constancy of Pain

When the constancy of pain (i.e., the combined score of reported frequency of pain and the duration of pain-free periods) was compared among subgroups (**Table 2**), participants in the DYS subgroup (8.1) reported a significantly

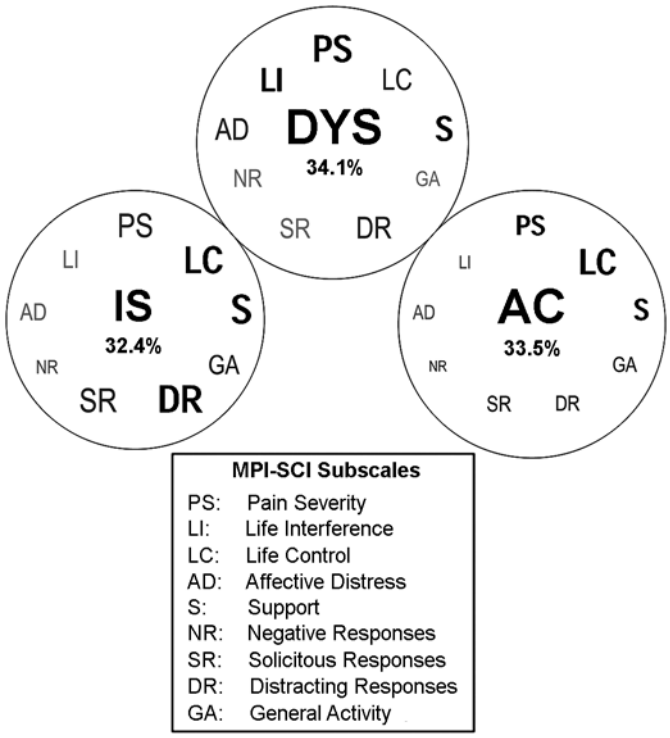

Figure.
Based on 9 subscales (shown in legend) of the spinal cord injury version of the Multidimensional Pain Inventory (MPI-SCI), participants (N = 182) were divided into 3 adaptational subgroups: Interpersonally Supported (IS) (32.4%) with higher LC, S, and DR levels and lower LI, AD, and NR levels; Dysfunctional (DYS) (34.1%) with higher LI, PS, and S levels and lower NR, SR, and GA levels; and Adaptive Coper (AC) (33.5%) with higher PS, LC, and S levels and lower LI, AD, and NR levels.

higher degree of constant pain than the IS (6.4) and the AC subgroups (7.0).

Quality of Pain

The 10 most frequently chosen pain descriptors were compared among the subgroups (**Table 3**). These were (in order of descending frequency) sharp, burning, aching, stabbing, throbbing, penetrating, electric, stinging, shooting, and pinching. Overall, the number of pain descriptors chosen was significantly different among the subgroups. The pain qualities that significantly differed among subgroups were electric and sharp, while the other descriptors did not significantly differ among subgroups. Although no significant differences were found between the DYS and the IS subgroups with respect to sharp pain, the AC subgroup members reported sharp pain significantly less often than the IS. Similarly, the IS subgroup members more often chose electric pain than the DYS and AC members.

Pain Aggravation

The extent of factors and situations reported to aggravate pain (i.e., the pain aggravation score) was significantly different among the three subgroups (**Table 4**). Post hoc comparisons revealed significantly higher pain aggravation scores for the DYS than for the IS and the AC subgroups. Of the 27 factors, only 8 were reported to aggravate pain in more than 25 percent of the sample. These factors were (in descending order) prolonged sitting, cold weather, wet weather, spasms, fatigue, sudden movements, touch, and infections. Comparison among the three subgroups also revealed significant differences among the subgroups with respect to pain aggravation due to prolonged sitting, spasms, and fatigue. While no significant differences were found between the DYS and the IS subgroups regarding individual factors, greater pain aggravation due to prolonged sitting, spasms, and fatigue was reported by the DYS subgroup than by the AC subgroup.

Prediction of Subgroup Membership

To determine which combined factors predicted subgroup membership, we entered the following independent variables in the stepwise logistic regression model: (1) extent of pain distribution, i.e., number of body areas with pain; (2) presence of sharp pain; (3) presence of electric pain; (4) pain intensity; (5) constancy of pain; and (6) pain aggravation score. All variables concerned the most disturbing pain, except for the total number of body areas with pain. Variance inflation factors and tolerance were examined for each variable, indicating no substantial multicollinearity among the predictors in the model. The final model included five variables that significantly predicted subgroup membership when combined. The final model, along with ORs and 95 percent CIs for the predictors, is shown in **Table 5**. We used likelihood ratio tests to assess the effect of each independent variable across all possible outcomes (i.e., subgroups) simultaneously. The model included (1) pain intensity, (2) pain aggravation score, (3) electric pain, (4) constancy of pain, and (5) extent of pain distribution. Although pain intensity was not significantly different between the DYS and the IS subgroups, individuals experiencing higher pain intensities had greater odds of belonging to the DYS and IS

Table 1.
Characteristics of persons with spinal cord injury (SCI) and chronic pain by adaptational subgroups Dysfunctional, Interpersonally Supported, and Adaptive Coper.

Characteristic	Overall (*N* = 182)	Dysfunctional (*n* = 62)	Interpersonally Supported (*n* = 59)	Adaptive Coper (*n* = 61)
Age (yr, mean ± SD)*	41.7 ± 13.6	43.9 ± 12.4	43.2 ± 14.1	37.9 ± 13.6
Time Since Injury (yr, mean ± SD)†	9.3 ± 8.8	7.3 ± 7.2	8.7 ± 8.1	12.2 ± 10.6
Sex‡ (%)				
Men	85.2	82.3	83.1	90.2
Women	14.8	17.7	16.9	9.8
ASIA Classification (%)¶				
A	53.8	43.5	54.2	63.9
B	9.3	6.5	15.3	6.6
C	10.4	16.1	3.4	11.5
D	17.0	25.8	13.6	11.5
E	0.5	0.0	1.7	0.0
Not Available	8.8	8.1	11.9	6.6
Pain Duration (yr, mean ± SD)§	8.2 ± 7.9	7.8 ± 7.7	7.5 ± 7.5	9.2 ± 8.4

*$F = 3.6$, $p < 0.05$.
†$F = 3.2$, $p < 0.05$.
‡$\chi^2 = 1.8$, not significant.
¶$\chi^2 = 17.9$, not significant.
§$F = 0.7$, not significant.
ASIA = American Spinal Injury Association (Standards for Neurological and Functional Classification of SCI), SD = standard deviation.

Table 2.
Characteristics of general and most disturbing pains for persons with spinal cord injury (SCI) and chronic pain by adaptational subgroups Dysfunctional (DYS), Interpersonally Supported (IS), and Adaptive Coper (AC).

Measure	Mean ± SD				F-Statistic, *p*-Value	DYS-IS*	DYS-AC*	IS-AC*
	All (*N* = 182)	DYS (*n* = 62)	IS (*n* = 59)	AC (*n* = 61)				
General Pain								
Number of Pain Locations	3.1 ± 1.5	3.7 ± 1.5	2.9 ± 1.5	2.8 ± 1.4	6.2, <0.01	<0.05	<0.01	NS
Pain Intensity NRS	6.1 ± 2.1	7.0 ± 1.9	6.3 ± 2.3	5.0 ± 1.7	15.9, <0.0005	NS	<0.0005	<0.001
Most Disturbing Pain								
Pain Intensity NRS	7.2 ± 2.0	7.6 ± 1.8	7.8 ± 2.0	6.3 ± 1.9	10.5, <0.0005	NS	<0.001	<0.0005
Constancy of Pain Score	7.2 ± 2.6	8.1 ± 2.1	6.4 ± 2.7	7.0 ± 2.8	6.6, <0.01	<0.001	<0.05	NS

**p*-values for Bonferroni corrected post hoc comparisons.
NRS = numerical rating scale, NS = not significant, SD = standard deviation.

subgroups than the AC subgroup. Furthermore, individuals reporting a greater extent of pain aggravation, a greater number of painful areas, and pain that was more constant had greater odds of belonging to the DYS subgroup than either of the other two subgroups. In contrast, individuals experiencing electric pain had greater odds of belonging to the IS subgroup than the DYS subgroup when the other variables were held constant in the model.

DISCUSSION

The results of the present study show that adaptational patterns derived from the MPI-SCI can be partly predicted by specific clinical characteristics of the pain a person experiences after an SCI. Thus, the present study supports the biopsychosocial model of pain, which suggests substantial interplay between biological, psychological, and social factors [24].

Table 3.
Aggravating factor score and aggravation (%) of most disturbing pain caused by factors and situations for persons with spinal cord injury and chronic pain by adaptational subgroups Dysfunctional (DYS), Interpersonally Supported (IS), and Adaptive Coper (AC).

Factor/Situation	Overall (*N* = 182)	DYS (*n* = 62)	IS (*n* = 59)	AC (*n* = 61)	Statistic, *p*-Value	DYS-IS*	DYS-AC*	IS-AC*
Aggravation of Pain Score (mean ± SD)	9.3 ± 6.1	11.7 ± 5.0	9.1 ± 5.5	7.2 ± 5.0	F = 9.0, <0.0005	<0.05	<0.0005	NS
Prolonged Sitting (%)	73.1	78.7	81.3	62.7	H = 9.3, <0.01	NS	<0.05	<0.05
Cold Weather (%)	68.7	69.4	71.2	65.6	H = 1.7, NS	NT	NT	NS
Wet Weather (%)	48.9	59.7	44.1	42.6	H = 4.1, NS	NT	NT	NT
Spasms (%)	42.3	54.8	33.9	37.7	H = 7.7, <0.05	NS	<0.01	NS
Fatigue (%)	44.5	54.8	40.7	37.7	H = 6.6, <0.05	NS	<0.05	NS
Sudden Movements (%)	42.3	54.8	35.6	36.1	H = 5.9, NS	NT	NT	NT
Touch (%)	39.0	41.9	30.5	44.3	H = 3.6, NS	NT	NT	NT
Infections (%)	35.7	41.9	30.5	34.4	H = 2.4, NS	NT	NT	NT

*p-Values for Bonferroni-corrected post hoc comparisons.
Note: Values are frequencies (%) of subjects reporting pain aggravation due to specific factor or situation. One-way analysis of variance was performed for aggravation of pain scores; all other comparisons were analyzed with use of Kruskal-Wallis tests.
NS = not significant, NT = not tested, SD = standard deviation.

Table 4.
Number of pain descriptors and frequency (%) of 10 most commonly selected pain descriptors of most disturbing pain for persons with spinal cord injury and chronic pain by adaptational subgroups Dysfunctional (DYS), Interpersonally Supported (IS), and Adaptive Coper (AC).

Pain Descriptor	Overall (*N* = 182)	DYS (*n* = 62)	IS (*n* = 59)	AC (*n* = 61)	Statistic, *p*-Value	DYS-IS*	DYS-AC*	IS-AC*
Number (mean ± SD)	4.6 ± 3.8	5.1 ± 4.4	5.2 ± 3.7	3.5 ± 2.9	F = 3.9, <0.05	NS	NS	<0.05
Sharp (%)	50.5	53.2	61.0	37.8	χ^2 = 6.8, <0.05	NS	NS	<0.01
Burning (%)	46.7	53.2	52.5	34.4	χ^2 = 5.6, NS	NT	NT	NT
Aching (%)	45.1	48.4	45.8	41.0	χ^2 = 0.7, NS	NT	NT	NT
Stabbing (%)	30.2	35.5	32.2	23.0	χ^2 = 2.4, NS	NT	NT	NT
Throbbing (%)	27.5	30.6	32.2	19.7	χ^2 = 2.8, NS	NT	NT	NT
Penetrating (%)	25.8	21.0	30.5	26.2	χ^2 = 1.4, NS	NT	NT	NT
Electric (%)	22.5	16.1	34.0	18.0	χ^2 = 6.5, <0.05	<0.05	NS	<0.05
Stinging (%)	20.9	29.0	13.6	19.7	χ^2 = 4.5, NS	NT	NT	NT
Shooting (%)	20.3	16.1	25.4	19.7	χ^2 = 1.6, NS	NT	NT	NT
Pinching (%)	19.2	21.0	25.4	11.5	χ^2 = 3.9, NS	NT	NT	NT

*p-Values for Bonferroni-corrected post hoc comparisons.
NS = not significant, NT = not tested, SD = standard deviation.

Psychosocial Factors

Previous research has identified three different adaptational subgroups in persons with SCI and chronic pain based on the MPI-SCI [26]. That study indicated that perceived social support may significantly moderate the impact of pain in those who experience severe pain after their SCI. However, the role of social support in chronic disease and pain is not fully elucidated. For example, while positive effects of social support may include decreased stress [37], depression [38], and functional disability [39], SRs and NRs from significant others have been shown to be related to both higher PS and increased disability [40–44]. After SCI, social support may increase participation [45], improve mental health [46], and moderate the relationship between stress and AD [47]. However, while social support has been shown to be inversely related to chronicity of pain after SCI [47], another study showed that high levels of DRs and SRs were associated with both higher levels of depressive symptoms and pain interference after SCI [48]. The discrepancy between studies indicates that the role of social support in the experience of pain after SCI is complex and not fully elucidated.

Table 5.
Multinomial logistic regression analysis predicting adaptational subgroup Dysfunctional (DYS), Interpersonally Supported (IS), and Adaptive Coper (AC) membership for persons with spinal cord injury and chronic pain.

Pain Characteristic	χ^2	*p*-Value	DYS-IS*	DYS-AC*	IS-AC*
Intensity	16.4	<0.0005	NS	1.3 (1.1–1.6)	1.5 (1.2–1.9)
Aggravation	13.0	<0.01	1.1 (1.0–1.2)	1.1 (1.1–1.2)	NS
Electric	12.3	<0.01	0.16 (0.06–0.50)	0.31 (0.10–0.98)	NS
Constancy	10.9	<0.01	1.3 (1.1–1.5)	1.1 (0.94–1.3)	0.85 (0.73–1.0)
Number of Pain Locations	8.5	<0.05	1.4 (1.1–1.8)	1.4 (1.1–1.9)	NS

*Specific differences between subgroups expressed as odds ratio (95% confidence interval) with second subgroup named in each pair as reference group.
Note: Overall $\chi^2 = 63.6$; degrees of freedom = 10; $p < 0.0005$.
NS = not significant statistically by Wald's test statistic.

Role of Pain Characteristics

MPI-SCI subgroup membership was significantly predicted by a combination of pain intensity, extent of pain aggravation, presence of electric pain (quality of pain), temporal pattern of pain, and extent of pain distribution. The role of each of these factors is discussed in the following subsections.

Pain Intensity

Although no significant differences were obtained between the DYS and IS subgroups regarding the overall pain intensity ratings and the intensity of the most disturbing pain, the DYS and IS subgroups scored significantly higher than the AC subgroup. However, the intensity of the most disturbing pain was significantly higher than the ratings for the overall pain intensity, i.e., most disturbing pains were rated in the severe range (pain intensities ≥7 on an NRS [49]). This result confirms the previous finding that pain intensity is one of the primary determinants for pain being regarded as most disturbing [13]. Other studies in the population with SCI and chronic pain have also identified the intensity or severity of pain as a significant determinant of high impact of pain. For example, intense or severe pain has been found to be significantly related to difficulty in dealing with pain [50–51]. Furthermore, intense pain significantly contributes to both decreased emotional and physical function [52]. Similarly, another study found pain intensity to be higher in pain regarded as "worst" than "second worst" [53].

Aggravation of Pain

Clinical signs of neuropathic pain include allodynia (i.e., pain in response to a stimulus that would normally not provoke pain, such as light touch) and hyperalgesia (i.e., an exaggerated response to a painful stimulus) [54]. Research has suggested that evaluation of these sensory abnormalities may provide important information concerning potential pain-generating mechanisms after SCI [55–58]. In the clinic, aggravation of pain by common factors, such as touch and cold, is frequently reported by persons who experience chronic neuropathic pain after their SCI [59]. These sensory abnormalities may be caused by the activation of sensitized mechanoreceptors in skin, muscles, or joints [60–62] and by central sensitization [57,63]. The participants in the present study reported aggravation of pain was caused by multiple factors and situations. The most commonly reported reasons for pain aggravation were either mechanical- (prolonged sitting, spasms, sudden movements, and touch) or temperature-related (cold or wet weather), but also fatigue and infections were included. A greater extent of pain aggravation was a significant predictor of assignment to the DYS subgroup. This result is consistent with previous research in SCI [64] in which people classified as DYS reported significantly more pain aggravators than those classified as AC. Interestingly, the present study also revealed a significant difference between the DYS and IS subgroups regarding extent of pain aggravation. Although pain intensity did not significantly differ between these two subgroups, both the ANOVA and the multinomial regression analysis showed significantly higher extent of pain aggravation in the DYS than the IS subgroup. Specific causes of pain aggravation, i.e., prolonged sitting, muscle spasms, and fatigue, also differed significantly among the subgroups. Although individuals classified as DYS more commonly reported aggravation by these three factors than IS individuals, the differences between these two subgroups did not reach statistical significance. In contrast, the AC subgroup reporting significantly lower extent of aggravation than the IS and DYS subgroups was consistent with the previous study [23].

Quality of Pain

The multinomial regression analysis indicated that pain perceived as having an electric quality was significantly associated with the participant being classified as IS rather than DYS or AC. Pain qualities such as burning, electric, or shooting are frequently associated with neuropathic pain after SCI [65]. Although research shows that pain qualities alone are insufficient for neuropathic pain to be adequately classified [66], burning spontaneous pain combined with evoked pain significantly predicted DYS membership in a previous study [23]. Contrary to that study and to our original hypothesis, burning pain was not significantly different among the three subgroups. However, the significantly higher frequency of electric pain in the IS subgroup suggests a relationship between the presence of neuropathic pain and higher pain intensity [59,67–68].

Temporal Pattern

The present study also showed that constant pain is more common in individuals classified as DYS compared with IS. This relationship was indicated both by the univariable and multivariable analyses. Research regarding the influence of pain that has a continuous temporal pattern compared with pain that is interrupted by breaks is sparse. However, a recent study by Felix et al. showed that among persons with SCI who experienced multiple pains [13], the pain that was present with no or minimal breaks was significantly associated with pain regarded as the most disturbing pain.

Pain Distribution

Pain distribution significantly predicted subgroup membership, suggesting that pain is more widespread in persons belonging to the DYS group than in the other two subgroups. Forman-Hoffman et al. [69], who found that widespread pain in veterans was associated with higher healthcare use and more comorbidities and lower health-related quality of life, have provided further support for a relationship between widespread pain and greater psychosocial distress and other comorbidities. Similarly, Carnes et al. found that widespread pain in patients with chronic musculoskeletal pain was significantly predicted by older age, psychological distress, and higher pain intensity [70]. Another study suggested that widespread pain after whiplash injury was associated with multiple negative consequences [71], such as increased pain intensity, depressive symptoms, maladaptive coping strategies, and decreased life satisfaction and general health. In summary, results from studies in populations of diverse chronic pain support the results of the present study in which widespread pain significantly predicted a DYS profile.

Biopsychosocial Perspective on Adapting to Pain Associated with SCI

Chronic pain is a serious consequence of SCI that has repeatedly been shown to be associated with perceptions of lower general health and well-being and with higher levels of depression than those who have an SCI but do not experience pain [51]. According to the biopsychosocial perspective, there is dynamic interaction among biological factors, psychological status, and social and cultural factors. While biological mechanisms may initiate, maintain, and modulate pain after SCI, psychological factors may influence the appraisal and perception of pain and social factors may modulate the individual's behavior in response to these perceptions [24].

The results of the present study suggest that neuropathic pain is more likely experienced by those who experience intense pain and are classified as DYS and IS rather than AC. Despite life satisfaction being reported as significantly lower in persons classified as DYS than in persons classified as IS [32], no significant differences in PS were found. Although both subgroups reported features that indicate neuropathic pain (e.g., greater extent of pain aggravation, presence of electric pain, and more constant temporal pattern), the DYS subgroup reported significantly greater extent of pain aggravation and constant pain and more widespread pain than the IS subgroup. This finding may partly explain the greater psychosocial impact perceived by the individuals classified as DYS. While no causality can be determined based on these data, one can assume that pains that are aggravated by a variety of daily and common factors and situations and pain that is constant and widespread with neuropathic-like characteristics are more difficult to cope with. In summary, the results of the present study suggest that the adaptational patterns to pain after SCI are determined not only by factors related to inherent and learned coping skills and social support but also by specific characteristics of pain.

Study Limitations

This study describes adaptational patterns in a group of individuals with SCI and chronic pain. Some of the measures used in the present study, such as the aggravating factors score and the temporal constancy score, were based on variables from a standardized pain history questionnaire. Although the reliability and internal consistencies for these

scales were adequate [13,72], not all psychometric information for these measures is available. In addition, the inclusion of only the pain perceived by each individual as being most disturbing excludes many additional pain types that may or may not significantly influence subgroup membership. Finally, contamination between the subgrouping variables and the predictors of subgroup membership may be expected because the PS subscale is significantly correlated with a numerical rating of pain intensity after SCI [32]. However, the PS subscale is only 3 out of 50 variables and 1 subscore out of 9 used in the subgroup analysis.

CONCLUSIONS

Chronic pain after SCI clearly depends on not only multiple pathophysiological mechanisms expressed as clinical signs and symptoms but also psychological factors such as AD and psychosocial factors, including social support. Therefore, treatments targeting the pathophysiological mechanisms of pain combined with treatments to reduce psychosocial distress [73–74] may more effectively reduce PS and impact than a single type of therapy. Ideally, each individual with SCI who seeks pain treatment should undergo a comprehensive pain evaluation that includes classifying the pain type and identifying the psychological and psychosocial factors that contribute to the pain problem so that the healthcare provider can design the most effective, tailored treatment strategy for that individual.

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