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Musculoskeletal pain in ambulatory patients with spinal cord injury who walking with or without walking devices: Prevalence and impact on walking speed

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ABSTRACT

Background: Musculoskeletal pain in spinal cord injury (SCI) is a common problem. However, not much research exists on the prevalence of pain in ambulatory patients with SCI walking either with or without ambulatory assistive devices (AAD).

Objectives: This study aimed to explore the prevalence of musculoskeletal pain and to investigate the impact of pain on walking speed in ambulatory patients with SCI walking with or without AAD.

Materials and methods: There were 86 patients with SCI who were able to walk independently with or without AAD. All the patients were evaluated for musculoskeletal pain using a visual analogue scale (VAS). Then their walking speed was assessed using a 10-meter walk test (10MWT).

Results: The proportion of patients with pain was high in both groups (63% in patients using AAD and 55% in patients not using AAD). For those with AAD, the fastest walking speed was significantly different in patients with mild, moderate, and severe pain compared to patients with no pain while for those without AAD, the fastest speed was significantly different in patients with moderate and severe pain compared to patients with no pain (p<0.05).

Conclusion: Musculoskeletal pain was commonly found in ambulatory patients with SCI walking with or without AAD, and this pain impacted their walking speeds. The finding of musculoskeletal pain in both patients walking with or without AAD could raise healthcare professionals' awareness of the debilitating impact of musculoskeletal pain. Thus, the development of improved therapeutic approaches for reducing this impact is needed.

Introduction

Musculoskeletal pain is defined as an aching, dull sensation that increases with limb movements and arises from the musculoskeletal structure.[1] When musculoskeletal pain occurs, it can potentially interfere with the ability to perform daily activities-especially walking, the improvement of which is a primary rehabilitation goal in patients with neurological deficits.[2-4] Spinal cord injury (SCI) commonly distorts sensorimotor or autonomic functions and-depending on the severity and levels of the injury-results in various degrees of diminished functional ambulation.[3-5] After SCI, 80% of patients can regain walking ability after participation in rehabilitation.[5] Among patients with SCI who regained walking ability, a previous study reported that 64% of those walked with assistive walking devices including walker crutches or cane, and 34% walked without AAD.[6] Moreover, patients with SCI who had regained walking function also

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walked non-functional e.g., household ambulation, slow gait speed, abnormal gait pattern, and compensatory movement that subsequently increase the risk of musculoskeletal pain.[5,6] The prevalence of musculoskeletal pain in SCI patients has been reported to be approximately 68-71.1%.[2,7] Although several studies have reported problems with musculoskeletal pain in patients with SCI, most of the patients featured were wheelchair users and placed in the same category as overall ambulatory patients with SCI.[2,5,8,9] In addition, patients who walk with AAD have remaining muscle weakness and walking asymmetry after SCI.[10] Therefore, the upper extremities are used to aid in locomotion. Barbetta *et al*. (2016) reported that the increased use of upper extremities has been associated with a higher occurrence of musculoskeletal pain among individuals with SCI who walk with AAD.[11] In contrast to AAD patients, non-AAD patients can walk independently, but the ability to walk is diminished and asymmetrical patterns emerge.[10] Therefore, when non-ADD patients walk, the increased strain on their lower extremities may lead to musculoskeletal pain. However, there was no evidence of musculoskeletal pain in ambulatory patients with SCI walking with or without AAD. Therefore, we hypothesized that patients with SCI walking with or without AAD might experience musculoskeletal pain and that the areas of musculoskeletal pain in each group would differ. Therefore, the objectives of this study were to investigate the extent of musculoskeletal pain in ambulatory patients with SCI walking with or without AAD and to determine the areas of pain in those patients. Moreover, this study investigated the impact of musculoskeletal pain on walking speeds in these patients.

Materials and methods

Participants

One hundred and twelve SCI patients were enrolled from a tertiary rehabilitation centre and community in the northeast area of Thailand during January 2017 and October 2018. The sample size calculation (using proportion of prevalence musculoskeletal pain from pilot study in 54 participants with SCI=0.66 with precision of estimation =0.1, levels of significant level at 0.05, and power of test at 0.80) indicated that the study required 86 participants.

The participants were ambulatory patients at least 18-years old with SCI stemming from both traumatic and non-traumatic causes who scored from A to D on the American Spinal Injury Association [ASIA] Impairment Scale (AIS).[12] The exclusion criteria included inability to understand and follow commands, leg-length discrepancy, pregnancy, brain involvement and any underlying disease that caused pain. The study was approved by the Khon Kaen University Ethics Committee for Human Research (HE551077), and eligible participants provided their written informed consent before participating in the study.

Protocol

Eligible patients were interviewed and assessed for baseline demographic and SCI characteristics, including the cause of the injury, the severity of SCI according to the AIS criteria, the time of injury, the level and completeness of the injury (using the ASIA motor and sensory score) and the walking devices used.[12] Pain intensity was assessed with a visual analogue scale (VAS), and areas of pain were determined using a body chart diagram.[13-15]

For this study, the reasons for musculoskeletal pain caused by problems with the muscles, joints or bones were injury, overuse or strain, arthritic changes or wear and tear. Musculoskeletal pain usually gets worse with movement and better with rest.[1,15] We collected VAS data using visuals analog scale from interviews with the participants. When participants had multiple areas with different VAS scales, we confirmed pain data in those areas using palpation and active and passive movement; in such cases, we selected the area of most severe pain as the measure of the patient's severity of pain. Patients with SCI who had a VAS scale >1 were classified into the pain group, whereas those with a VAS <1 was assigned to the no-pain group.[16] To differentiate musculoskeletal pain from neurological pain in this study, active, passive, and accessory movement tests were used.[1]

After the patients were interviewed and assessed for their baseline demographics and the SCI characteristics and musculoskeletal pain analyses were completed, the patients were divided into four groups according to the severity of their pain: no pain (VAS=0), mild pain (VAS=1-3), moderate pain (VAS=4-6) and severe pain (VAS=7-10).[16] Patients were assessed for their walking speed using a 10-metre walk test (10MWT).[17]

The 10-metre walk test (10MWT)

Patients walked at both their preferred and fastest gait speeds along a 10-metre walkway. The time required during the middle four metres of the walkway was recorded to minimise the inclusion of acceleration and deceleration effects.[17] Patients performed three trials at each speed, and average times in the seconds were recorded.[17] When assessing preferred walking speed and fastest gait speed, all participants were given time to rest between each test for 5 minutes or until their tired disappear. We observed no decline in the walking speed of patients asked to walk at a fast speed.

Statistical analysis

Descriptive statistics were applied to explain the baseline demographics, SCI characteristics and the prevalence of musculoskeletal pain. Findings among groups were compared using nonparametric Mann-Whitney U tests when the data were not normally distributed for continuous data. For variables were categorized data, chi-square test was used to compare differences between groups. The one-way analysis of variance (ANOVA) was used to compare walking speeds among groups of patients who had no pain, mild pain, moderate pain and severe pain, with a p-value of less than 0.05.

Results

There were 112 patients with SCI who were interested in participating in this study. However, 26 patients were excluded due to osteoarthritis of the knee (n=7) brain involvement (n=3) and inability to ambulate (n=16). There were ultimately 86 ambulatory patients with SCI who participated in this study.

The patients' demographic and SCI characteristics are presented in Table 1. There were no significant differences among the groups in terms of demographic data or SCI characteristics, except for the motor score and gender (Table 1). In addition, the average duration of AAD use was 24 months. The severity of pain ranged from no pain to severe pain in both the AAD (no pain=21, mild pain=8, moderate pain=19, and severe pain=9) and the non-AAD groups (no pain=13, mild pain=4, moderate pain=8, and sever pain=4).

Table 1 Demographic and spinal cord injury (SCI) characteristics of patients with SCI who walked with or without assistive devices (AAD).

Variable	AAD group (n = 57)			Non-AAD group (n = 29)		
	Pain (n=35)	No pain (n=21)	*p* value	Pain (n=16)	No pain (n=13)	*p* value
Age (years)[a]	49.0 (36.0 – 67.5)	61.0 (48.0 - 67.0)	0.312	51.0 (41.0 – 57.0)	55.0 (32.0–58.0)	0.812
Body mass index (kg/m2)[a]	20.9 (18.6 – 24.0)	21.90 (20.1 - 25.7)	0.227	20.3 (18.7 – 23.7)	22.5 (19.1–24.4)	0.682
Post-injury time (months)[a]	48.01 (24.0 – 99.0)	48.04 (25.0 - 98.0)	0.921	57.5 (29.0 – 111.0)	63.5 (48.0–180.0)	0.215
Gender:						
- Male, n (%)[b]	24 (67)	17 (80)	0.726	15 (94)	8 (61)	0.033*
- Female, n (%)[b]	12 (33)	4 (20)		1 (6)	5 (39)	
Motor score:						
- Upper motor scores (scale)[a]	32.50 (18.6–23.7)	40.0 (19.1–25.1)	0.017*	37.0 (33.0 – 44.5)	46.0 (44.0–48.0)	0.004***
- Lower motor scores (scale)[a]	34.0 (19.5–40.0)	38.0 (27.0–43.0)	0.097	37.40 (34.0 – 44.5)	46.03 (44.6–48.0)	0.008**
Sensory scores (scale)[a]	180.0 (164.0–196.0)	188.0 (160.0 –99.0)	0.697	197.0 (189.0 – 204.0)	208.0 (188.0–216.0)	0.308
Cause of injury:						
- traumatic, n (%)[b]	23 (64)	13 (62)	0.582	7 (44)	6 (46)	0.377
- non-traumatic, n (%)[b]	13(36)	8(38)		9 (56)	7 (54)	
Severity of injury:						
- AIS A and B, n (%)	6 (17)	2 (9)	0.836	-	-	-
- AIS C, n (%)	10 (28)	5 (24)		-	-	-
- AIS D, n (%)	20 (55)	14 (67)		16	13	0.310

Abbreviations*: AIS: American Spinal Injury Association (ASIA) Impairment Scales, AIS A: No sensory or motor function is preserved in the sacral segments S4–S5, AIS B: Sensory but not motor function is preserved below the neurological level and extends through the sacral segments S4–S5, AIS C: Motor function is preserved below the neurological level, and most key muscles below the neurological level have a muscle grade less than three, AIS D: Motor function is preserved below the neurological level, and most key muscles below the neurological level have a muscle grade greater than or equal to three.*

Note*: [a]Data were presented in terms of median (interquartile range: Q1–Q3). The findings between the groups were compared using the Mann–Whitney U test. [b]These variables were categorised data, and a chi-square test was used to compare differences between groups. * Indicates a significant difference between groups (p<0.05). ** Indicates a significant difference between groups (p<0.01). *** Indicates a significant difference between groups (p<0.001).*

The proportion of patients who experienced pain was high for both the AAD (63%) and the non-AAD groups (55%); however, the areas where pain was experienced varied. Moderate severity of upper limb (36%) pain was more common in the AAD group, moderate severity pain of trunk (59%) and lower limb (36%) pain was more common in the non AAD group (Figure 1).

We examined walking speed and reported pain in patients in the AAD and non-AAD groups separately. Within the AAD group, a significantly faster gait speed was observed in patients with no pain than in those with mild, moderate, and severe pain (p<0.05, Figure 2A). In the non-AAD group, there was no significant difference in gait speed between those with mild and no pain and no significant difference in gait speed between those with severe and moderate pain (Figure 2B). In addition, there were no differences found in the preferred walking speed, both AAD and non-AAD group.

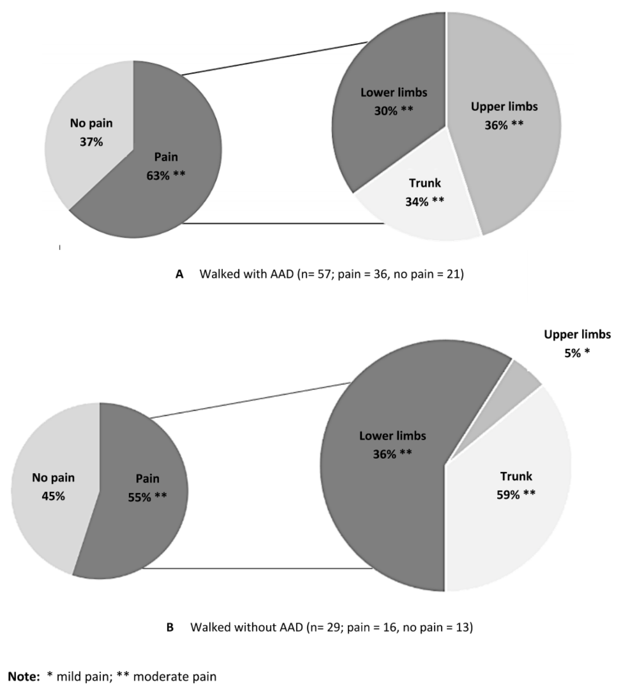

Figure 1*. Prevalence, severity, and area of pain in ambulatory patients with SCI who walked with or without AAD. A: walked with AAD, B: walked without AAD.*

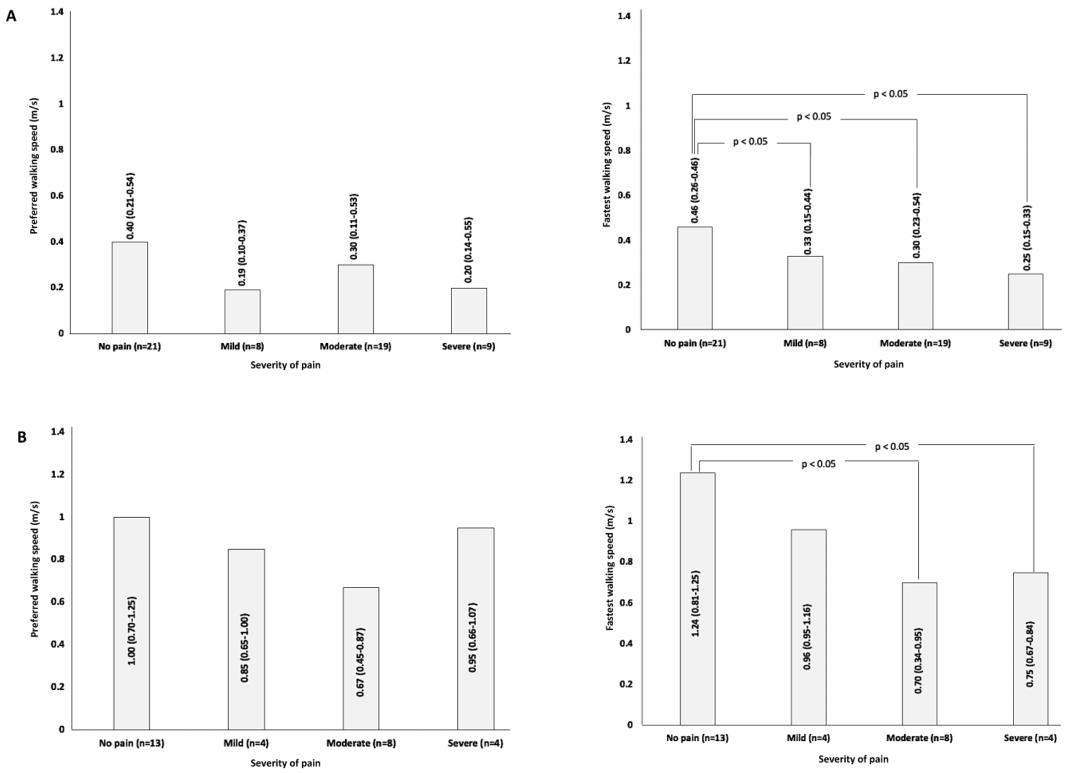

***Figure 2**. Comparison of walking speeds associated with different pain severities among patients with SCI who walked with and without AAD. A: AAD group, B: non- AAD group.*

Discussion

Musculoskeletal pain is a serious problem and is commonly found in those with neurological conditions, especially in patients with SCI. A previous study reported that patients with SCI had the highest prevalence of chronic pain when compared with other patients with neurological deficits.[18]

The present study has shown that SCI patients with or without an AAD who participated in this study had problems with musculoskeletal pain. An important finding of the present study is the high prevalence of pain in the non-AAD group (55%, Figure. 1). We found that the areas of pain in this group were mostly reported in the lower limbs and trunk. This may be explained by the fact that patients with SCI have sensorimotor deficits as indicated by the data showing significantly lower upper and lower motor scores in patients who had pain than those who had none (Table 1). Although these patients can walk independently, their sensorimotor impairments are likely to cause them to walk asymmetrically and with an abnormal gait pattern. Kumprou *et al*. reported that different degrees of impairment between the limbs is one important cause of asymmetrical walking in those with neurological disorders whereas the levels of asymmetrical walking in ambulatory participants with SCI who had bilateral sensorimotor impairments were reported around 78–94%.[10] Asymmetrical walking can increase the risk of injury to the musculoskeletal structures and ultimately result in lower limb pain in SCI patients who walk without AAD.[10] In addition, the SCI patients experience lingering muscle weakness. Walking in non-AAD patients seems to increase the demand on lower-extremity muscles. Therefore, walking with an abnormal gait pattern and walking asymmetrically while there is still muscle weakness after SCI could-especially in the case of ambulatory patients with SCI who walk without AAD-lead to chronic arthritis causing by repetitive abnormal movements and putting direct strain on musculoskeletal structures.

In addition, the present study found a high prevalence of pain in the AAD group (63%, Figure 1A). The AAD group showed a high prevalence of upper limb pain. This may be explained by the fact that SCI patients who walk with an AAD are more likely to have impaired lower limb functions, which can increase their dependence on the upper extremity functions for mobility.[19] The muscles of the upper limbs are primarily composed of small muscle fibre groups, whereas lower limb muscles primarily consist of large muscle fibre groups.[2,19] Thus, the extra work of the upper limbs that compensates for loss of strength and/or mobility in lower limbs might induce an injury to the upper limbs structures.[19] Previous studies reported that repetitive compressive forces on the upper limbs in chronic arthritis patients could be caused by long-term use of a walker or cane.[19-21] These repetitive forces can, in turn, contribute to pathologies, such as osteoarthritis, carpal tunnel syndrome and tendonitis.[19] Another study reported the prevalence of upper limb musculoskeletal pain in patients with poliomyelitis, which prolonged the use of AAD.[22] Therefore, medical care and prevention of musculoskeletal pain should be of concern to patients who walk with and without AAD.

Walking speed is considered a measurement of the overall quality of a person's gait.[17] Furthermore, adequate velocity is only one criterion that should be met for independent community ambulation to be considered safe for patients with SCI.[23] However, a previous study showed no evidence of a link between musculoskeletal pain and walking speed in ambulatory SCI patients.[2,4] Therefore, this study considers the effects of musculoskeletal pain on walking speed in SCI patients walking with or without AAD. The results indicate that mild-to-severe musculoskeletal pain may influence the fastest gait speed in ambulatory patients with SCI who walk with AAD ($p<0.05$, Figure 2A). In non-AAD group, moderate to severe pain influenced fastest gait speed ($p<0.05$, Figure. 2B). Musculoskeletal pain, especially in parts of the lower limbs, influences walking abilities in patients with SCI.[4] Sawa *et al*. reported that people with pain commonly alter their gait pattern to avoid pain.[24] Furthermore, individuals with musculoskeletal pain typically limit the range of joint movement during walking to minimise pain severity, which could cause a decrease in gait speed. One study has reported that problems with musculoskeletal pain affect patients who pay more attention to the pain side, which could distract the patient during walking. These individuals have been shown to walk more slowly when performing other tasks or encountering challenging walking conditions.[25] Patients using AAD and suffering mild-to-severe pain exhibited a pain-related decline in walking speed ($p<0.05$, Figure 2A). The impact of musculoskeletal pain on the fastest gait speed in patients with AAD might be attributed to upper limb, trunk, and lower limb pain (Figure 1A). Furthermore, the patients using AAD required more work from the upper limbs rather than the lower limbs for walking.[19] Therefore, the impact of musculoskeletal pain on the fastest gait speed in patients with AAD was probably due to both upper limb and lower limb pain (Figure 1) which since upper and lower limbs are both important in controlling walking functions in these patients. The reduction in fastest gait speed suffered by SCI patients with musculoskeletal pain could result in limited community ambulation skills-such as difficulties crossing streets with traffic lights-in addition to producing other detrimental effects in these patients.[23]

There are some potential concerns regarding this study's data collection and interpretation methods. For instance, the small sample size for comparing walking speeds may have contributed to the fact that no significant difference was found in terms of the preferred gait speed of patients. Further studies should use a larger sample to confirm the effects of musculoskeletal pain on walking speed. Therefore, the results could not be generalised to the entire population of SCI patients. Further research involving longitudinal study is required to explain the causes of musculoskeletal pain. In addition, this study did not report AAD types and the different types of AAD could affect whole-body control while walking. Future study could consider the different types of AAD.

Conclusion

The findings of this study show a high prevalence of musculoskeletal pain in ambulatory patients with SCI who walk with and without AAD. Upper limb pain was more common in those using AAD, whereas patients in non-AAD group experienced more lower limb pain. Moreover, this study finds that musculoskeletal pain might be the cause of difficulty in changing walking speeds, which is related to walking ability in SCI patients. With greater awareness of problems related to musculoskeletal pain, healthcare professionals will be able to more effectively prevent this pain and ensure that it does not interfere with these patients' improvement in walking ability.

Conflicts of interest

The authors declare no conflict of interest.

Ethical approval

The participants gave their informed consent before enrolling in the study. The study was approved by the Khon Kaen University Ethics Committee for Human Research (no. HE551077).

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