Characteristics of neuropathic pain in individuals with chronic spinal cord injury

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ABSTRACT

Objectives: To present the characteristics of neuropathic pain in individuals with chronic spinal cord injury (SCI).

Methods: We recruited all individuals with chronic SCI referred to the Brain and Spine Injury Research center with a diagnosis of neuropathic pain from April 2013 to September 2015 into this historical cohort study.

Results: Forty individuals with chronic SCI-induced neuropathic pain entered this study with a mean age of 43.67±13.12 years and a majority of who were male (n=30, 75%). Motor vehicle collision (n=25, 62.5%) and fall (n=7, 17.5%) were the most common causes of SCI in our participants. There were 13 (32.5%) cervical, twenty (50%) thoracic, and 7 (17.5%) lumbosacral SCI. The mean ‘maximal pain intensity’, ‘overall pain intensity during the past week’, and ‘the pain intensity at the initial consultation in pain clinic’ measured by numerical rating scale (NRS) in this cohort were 8.71±1.73, 6.32±1.60, and 6.11±2.48, respectively. Burning pain was the most frequently used description of pain reported by our participants. Pain intensity significantly decreased after six months of treatment for all three above categories.

Conclusion: This study provides characteristics of neuropathic pain in a group of individuals with chronic SCI. Further large prospective studies are needed to determine the association between lesion level, completeness of injury, and region of pain.
**Methodology. Ethics.** This study was ethically approved by Sina Trauma and Surgery Research Center, Tehran University of Medical Sciences. The information of individuals with chronic SCI remained confidential and was used only for research purposes and the authors are obliged to the principles of Helsinki Declaration.

**Disclosure.** This study was approved and financially funded by the Sina Trauma and Surgery Research Center, Tehran University of Medical Sciences, Tehran, Iran.
evaluated the following four criteria for each participant:

1. Pain with a distinct neuroanatomically plausible distribution. 2. A history suggestive of a relevant lesion or disease affecting the peripheral or central somatosensory system. 3. Demonstration of the distinct neuroanatomically plausible distribution by at least one confirmatory test. 4. Demonstration of the relevant lesion or disease by at least one confirmatory test.

We considered a participant to have a definite neuropathic pain when all (1 to 4) criteria were met. Probable neuropathic pain was defined when criteria 1 and 2 were met, plus either 3 or 4; and possible

Table 1 - The anatomical distribution of pain throughout the body assessed in the initial consultation.

| Pain throughout the body     | n |
|------------------------------|---|
| Head                         | 0 |
| Face                         | 0 |
| Mouth and throat             | 0 |
| Shoulder                     | 10|
| Arms                         | 9 |
| Elbows                       | 6 |
| Forearms                     | 7 |
| Wrist                        | 6 |
| Hands                        | 9 |
| Chest                        | 5 |
| Abdomen                      | 11|
| Multiple joints              | 7 |
| Groin                        | 10|
| High back                    | 10|
| Middle back                  | 10|
| Low back                     | 11|
| Buttock                      | 18|
| Thighs                       | 15|
| Knees                        | 14|
| Legs                         | 15|
| Ankles                       | 12|
| Urogenital area              | 5 |
| Bones                        | 6 |
| Different muscles            | 5 |

Table 2 - Frequency of pain quality descriptors evaluated in the first consultation.

| Pain quality descriptors     | n |
|------------------------------|---|
| Burning                      | 30|
| Pins & needles               | 26|
| Electric shock               | 22|
| Numbness                     | 18|
| Shooting                     | 16|
| Stabbing                     | 16|
| Pressure                     | 10|
| Spontaneous pain             | 16|
| Throbbing (pulsate)          | 13|
| Allodynia                    | 9 |
| Sharp pain                   | 8 |
| Dysesthesia                  | 6 |
| Evoked pain                  | 5 |
| Hyperalgesia                 | 5 |
| Hyperesthesia                | 5 |
| Hypoesthesia                 | 5 |
| Itching                      | 5 |
| Aching                       | 2 |

Table 3 - Frequency of exacerbating and alleviating factors for pain assessed in the initial consultation.

| Intensifying factors        | n | Relieving factors      | n |
|-----------------------------|---|-----------------------|---|
| Cold                        | 20| Warmth                | 18|
| Activity                    | 18| Resting               | 16|
| Emotional stress            | 17| Massage               | 15|
| Coughing/sneezing           | 9 | Mental relaxation      | 10|
| Bending forward             | 9 | Activity              | 3 |
| Bending backward            | 5 | Travelling            | 4 |
| Bending                     | 8 | Bending forward        | 3 |
| Rotation the body           | 5 | Cold                   | 1 |
| Sleeplessness               | 8 | Bending backward       | 0 |
| Warmth                      | 4 | Bending to the parties | 0 |
| Walking*                    | 2 | Rotation to the parties| 0 |
| Resting                     | 2 | Walking*              | 0 |
| Oversleeping                | 1 |                       |   |
| Urination**                 | 2 |                       |   |
| Defecation**                | 2 |                       |   |
| Sexual intercourse**        | 4 |                       |   |

*Participants who could walk, **Related to pelvic pains

Table 4 - Non-pharmacological treatments used by individuals with chronic SCI prior to their initial visit.

| Non-pharmacological treatments     | n |
|------------------------------------|---|
| Massage therapy                    | 10|
| Exercising                         | 7 |
| Nerve block injections             | 5 |
| TENS                               | 5 |
| Acupuncture                        | 4 |
| Traction                           | 4 |
| Movement therapy                   | 3 |
| Thermotherapy                      | 2 |
| Psychotherapy                      | 2 |
| Hypnotism                          | 0 |
| Ultrasound                         | 0 |
| Biofeedback                        | 0 |
| Others                             | 6 |

*Transcutaneous electric nerve stimulation
neuropathic pain was considered when criteria 1 and 2 were met, without confirmatory evidence from 3 or 4.

We used the 11-point numerical rating scale (NRS) to measure the severity of pain, scoring from 0 to 10 for no pain to worst pain imaginable. Scales 1-3 refer to mild pain, 4-6 were moderate pain, and 7-10 refer to severe pain.\(^\text{11}\) We evaluated the pain intensity (measured by NRS) experienced by the participants using on 3 scales including ‘maximal pain intensity’, ‘overall pain intensity during the past week’, and ‘the pain intensity at the time of consultation’, at follow-up in the pain clinic and over the telephone.

A trained psychologist called the participants for a telephone follow-up in order to fill out a brief pain evaluation form based on the validated Persian version of the Brief Pain Inventory (BPI).\(^\text{12}\) Brief Pain Inventory asks about the ‘maximal pain intensity’, ‘overall pain intensity during the past week’, and ‘the pain intensity at the time of consultation’, in addition to questions about how pain interferes with the patient’s daily activities.

Table 5 - Treatments administered for the individuals with chronic SCI by the pain clinic evaluated after 6-month of treatment.

| Treatments                | n  |
|---------------------------|----|
| Amitriptyline             | 25 |
| Gabapentin                | 24 |
| Capsaicin+ Lidocaine      | 23 |
| Lidocaine perfusion       | 17 |
| Ketorolac                 | 16 |
| Baclofen                  | 16 |
| Venlafaxine               | 11 |
| Ketamine perfusion        |  8 |
| Pregabalin                |  8 |
| Nitroglycerin ointment    |  8 |
| Acetaminophen             |  6 |
| TENS*                     |  5 |
| Duloxetine                |  4 |
| Diclofenac sodium         |  4 |
| Nortriptyline             |  3 |
| All the other pharmacological treatments | 20 |

*Transcutaneous electric nerve stimulation

Figure 1 - Pain diagrams demonstrating the distribution and severity of neuropathic pain for each individual.
Telephone follow-up at our center is performed at one, 3, 6, and 12 months and then every year thereafter. In order to report more homogenous data, we reported the 6-month post-initial consultation data for all participants.

An electronic search of PubMed literature for neuropathic pain in SCI was performed (1946 to 1 January 2017), in order to find prior related research using the following conditions: spinal cord injury (MeSH Terms) AND neuropathic pain (MeSH Terms).

**Statistical analysis.** All statistical analyses were performed using Statistical Package for the Social Science software version 18 (SPSS Inc, Chicago, Illinois, USA). Descriptive analysis was expressed as frequency, mean, and standard deviation (SD). Wilcoxon test was used to compare the mean difference of NRS pain scaling before and after treatment. P-values less than 0.05 were considered statistically significant.

### Results

**Patient-related data.** Forty individuals with chronic SCI with a mean age of 43.67±13.12 years (ranging from 18 to 76 years old) were included in the study. Of the forty patients 75% (n=30) were male. The most common causes of SCI were motor vehicle collision (n=25, 62.5%) and falls (n=7, 17.5%). Detailed causes of SCI are further provided in Appendix 1.

There were 13 (32.5%) cervical (3 upper cervical, 10 lower cervical), 12 (50%) thoracic (4 upper thoracic, 16 lower thoracic), and 7 (17.5%) lumbosacral SCI. The mean time duration after injury was 5.65±7.89 years. Thirty-four participants (85%) had instrumented spinal fixation surgery after their injury (Appendix 1).

In terms of living status, 27 participants (67.5%) were married, 24 were living with their wife/husband, and 11 participants were living with their parents. Twenty-three participants used wheelchair, 4 used walker, and 9 were bedridden. With regards to other social factors, 5 participants (12.5%) were employed and the average number of years of education was 9. Seven participants had the history of admission to the hospital due to pain. Three participants were smokers with less than 1 pack/day and eight were former-smokers.

**Pain-related data.** The mean ‘maximal pain intensity’, ‘overall pain intensity during the past week’ and ‘the pain intensity at the initial consultation in pain clinic’ were 8.71±1.73, 6.32±1.60, and 6.11±2.48, respectively.

In terms of International SCI Pain (ISCIP) classification, 24 participants (60%) had only neuropathic pain in tier 1 while 16 participants (40%) had both neuropathic and nociceptive pains. In tier 2, 21 participants had below-level neuropathic pain (10 participants had both nociceptive musculoskeletal pain and below-level NP) and 19 participants had at-level neuropathic pain (6 participants had both nociceptive musculoskeletal pain and at-level NP). Finally, spinal cord compression (n=29), muscular pain (n=11) and cauda equina compression (n=7) were the most common types of ISCID classification tier 3. Detailed ISCID classification data is further provided in Appendix 1.

The pain diagrams demonstrating the distribution and severity of neuropathic pain for each individual are demonstrated in Figure 1. Table 1 also provides the distribution of neuropathic pain for the entire cohort. Buttocks, thighs, and legs were the most commonly reported areas of pain. Seven individuals with chronic SCI reported their pain to be most severe on the right side, 5 on the left side, 3 in the middle part, and 21 participants (52%) reported the severity of the pain to be the same on both sides of the body.

### Appendix 1

Table 6 - Mean difference of ‘maximal pain intensity’, ‘overall pain intensity during the past week’ and ‘the pain intensity at the initial consultation in pain clinic’ in pain clinic and after 6 months of treatment (measured by NRS) in the individuals with chronic SCI.

| Variables                              | Initial consultation | After 6-month of follow-up | Mean difference | P-value |
|----------------------------------------|----------------------|-----------------------------|-----------------|---------|
| Maximal pain intensity                 | 8.71±1.73            | 7.65±1.73                   | -1.06           | 0.01    |
| Overall pain intensity during the past week | 6.32±1.60           | 5.30±1.79                   | -1.02           | 0.01    |
| The pain intensity at the time of consultation | 6.11±2.48           | 4.59±2.46                   | -1.52           | 0.01    |
all. Table 4 shows the non-pharmacological treatments used by participants prior to their initial visit to the pain clinic. Gabapentin, amitriptyline, and capsaicin-lidocaine were the most commonly administered treatments in the pain clinic. Table 5 shows the distribution of different treatments administered for the participants. The more frequently used medications, i.e. amitriptyline, gabapentin, capsaicin and lidocaine (locally administered or IV infusion) were the most effective treatments that remained in the list of the medications during the long course of the treatment (Table 5).

**Telephone follow-up.** One patient expired and 10 were missed during the six-month follow-up period. On average, participants reported a 20.4%±20.8 relief in pain after using the treatments. The mean ‘maximal pain intensity’, ‘overall pain intensity during the past week’, and ‘the pain intensity at the time of telephone follow-up consultation’ were 7.65±1.73, 5.30±1.79 and 4.59±2.46, respectively. Pain intensity significantly decreased for ‘maximal pain intensity’, ‘overall pain intensity during the past week’, and ‘the pain intensity at the time of consultation’ after six months of treatment (Table 6).

**Discussion.** In our study, more than half of the individuals with chronic SCI had only neuropathic pain while the rest had both neuropathic and nociceptive pains. Below-level and at-level pain were detected almost equally in our participants. Buttocks, thighs, and legs were the most commonly reported areas of pain in the body, and burning pain was the most frequently reported description of pain.

There was an improvement in all three pain scales after 6 months of treatment. Mean ‘maximal pain intensity’, ‘overall pain intensity during the past week’, and ‘the pain intensity at the time of the consultation’ were all categorized as severe at the initial visit (8.71, 6.32, and 6.11, respectively). At the six-month follow-up, their pain was severe (7.65), moderate (5.30), and moderate (4.59) for each respective category. Failed medical therapy has been reported as a common outcome for individuals with chronic SCI-induced neuropathic pain and perhaps learning to live with the pain seems to facilitate the adjustment and acceptance of the pain. However, several recent studies have identified promising therapies to treat chronic neuropathic pain, including botulinum toxin A and neurostimulation therapies. In our study, the lower limbs (buttock, thighs, knees, legs) were the most common areas of pain. In a descriptive study by Nakipoglu-Yuzer et al including 69 individuals with chronic traumatic SCI in Turkey, pain was reported in the hip and leg areas in 52.2% of their participants. Burning pain was the most common descriptor used in our study, followed by pins and needles, electric shock, and numbness. Meanwhile, pain was described as burning, aching, sharp, and stinging in the aforementioned study by Nakipoglu-Yuzer et al. They also reported a significant association between level of injury and region of pain. However, we decided not to run a correlation analysis due to the small sample size. Nakipoglu-Yuzer et al did not find a significant association between demographic and SCI-related data with pain characteristics. Teixeira et al performed a retrospective study reported the clinical characteristics of 213 individuals with chronic SCI. However, they did not find any statistically significant association between incomplete SCI and more severe pain. In the study by Nakipoglu-Yuzer et al neuropathic pain localization was ‘below level’ in nearly all (97%) of the participants. In contrast to the finding of Nakipoglu-Yuzer et al. we showed a similar distribution for at-level and below-level SCI neuropathic pain. Werhagen et al retrospectively identified 402 individuals with chronic SCI in Sweden and also found no association between gender, level of SCI, or completeness of injury with the development of ‘at-level’ and ‘below-level’ neuropathic pain, except for ‘below-level’ pain which was associated with a complete injury. In a retrospective chart review and cross-sectional survey by Mann et al. sleep disturbance/insomnia (28.2%) was the most frequently reported comorbidities followed by depressive symptoms (25.2%) and anxiety (23.3%).

Determining the prevalence and characteristics of neuropathic pain and investigating its characteristics in individuals with chronic SCI may contribute to a better understanding to the underlying mechanism as to why some patients are refractory to certain treatments. It can also improve our understanding of the different characteristics of individuals with neuropathic pain and potentially improve the management of SCI-induced neuropathic pain.

**Limitations of the study.** Our center is in the public sector of the health care organizations; whereas, there is an active private sector in the country. Moreover, the center is a university and teaching hospital. Therefore, our patients do not represent the whole population and consequently our findings should be cautiously attributed to the all SCI patients. Due to serious physical disabilities, loss to follow-up is a significant limitation for any study evaluating patients with chronic SCI. Also, the small sample size limited the statistical analyses performed and a larger sample size would be required for correlation analyses.
Conclusion. This study provides demographic and pain-related data in a series of individuals with chronic SCI suffering from neuropathic pain. Our findings provide a better understanding of pain characteristics. Further studies with larger sample sizes are needed to determine the predictors of the development of the neuropathic pain in SCI patients and also the relationship between different variables such as SCI level, completeness of injury, and the region of pain.

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**Appendix 1 - Characteristics of individuals with spinal cord injury referring to our clinic based on International Spinal Cord Injury Pain (ISCIP) Classification.**

| No. | Age | Gender | Cause of SCI | Level of SCI | Time duration from SCI | Spine fixation surgery | ISCIP classification Tier 1 | ISCIP classification Tier 2 | ISCIP classification Tier 3 | Pain diagram |
|-----|-----|--------|--------------|--------------|------------------------|------------------------|-----------------------------|-----------------------------|-----------------------------|--------------|
| 1   | 45  | Male   | Fall         | Thoracic (T4) | 6 yrs                  | +                      | Neuropathic pain            | Below level SCI neuropathic pain | Spinal cord compression           | Figure1-A    |
| 2   | 19  | Female | MVC          | Lumbar (L1)   | 3 yrs                  | +                      | Neuropathic pain            | At level SCI neuropathic pain | Cauda equina compression | Figure1-B    |
| 3   | 54  | Male   | Fall         | Thoracic (T12) | 5 yrs                  | +                      | Neociceptive pain Neuropathic pain | Musculoskeletal pain At level SCI neuropathic pain | Spinal cord compression | Figure1-C    |
| 4   | 32  | Male   | MVC          | Thoracic (T6-T7) | 2 yrs                  | +                      | Neuropathic pain            | Below level SCI neuropathic pain | Spinal cord compression | Figure1-D    |
| 5   | 44  | Male   | MVC          | Cervical (C5-C6) | 3 yrs                  | +                      | Neuropathic pain            | Below level SCI neuropathic pain | Spinal cord compression | Figure1-E    |
| 6   | 51  | Female | MVC          | Cervical (C6)  | 1.5 yrs                | +                      | Neuropathic pain            | At level SCI neuropathic pain | Nerve root compression | Figure1-F    |
| 7   | 31  | Male   | MVC          | Thoracic (T4-T5) | 1 yr                   | +                      | Neuropathic pain            | At level SCI neuropathic pain | Spinal cord compression | Figure1-G    |
| 8   | 45  | Male   | Trauma (Heavy object falling on back) | Thoracic (T12) | 3.5 yrs                | +                      | Neuropathic pain            | At level SCI neuropathic pain | Cauda equina compression | Figure1-H    |
| 9   | 45  | Female | MVC          | Thoracic (T8)  | 2 yrs                  | +                      | Neociceptive pain Neuropathic pain | Musculoskeletal pain Below level SCI neuropathic pain | Glenohumeral arthritis, lateral epicondylitis Spinal cord compression | Figure1-I    |
| 10  | 36  | Female | MVC          | Thoracic (T5-T6) | 14 mo                  | +                      | Neociceptive pain Neuropathic pain | Musculoskeletal pain Below level SCI neuropathic pain | Muscular pain Spinal cord compression | Figure1-J    |
| 11  | 46  | Male   | MVC          | Cervical (C6-C7) | 2 yrs                  | +                      | Neuropathic pain            | At level SCI neuropathic pain | Spinal cord compression | Figure1-K    |
| 12  | 37  | Female | MVC          | Lumbar (L1-L2) | 14 yrs                 | +                      | Neuropathic pain            | At level SCI neuropathic pain | Spinal cord compression | Figure1-L    |
| 13  | 64  | Male   | MVC          | Cervical (C5-C6) | 42 yrs                 | +                      | Neuropathic pain            | At level SCI neuropathic pain | Spinal cord compression | Figure1-M    |
| 14  | 64  | Male   | Fall         | Lumbar (L1-L2) | 2.5 yrs                | +                      | Neuropathic pain            | At level SCI neuropathic pain | Cauda equina compression | Figure1-N    |
| 15  | 52  | Male   | MVC          | Thoracic (T12) | 3 yrs                  | +                      | Neociceptive pain Neuropathic pain | Other nociceptive pain Musculoskeletal pain At level SCI neuropathic pain | Surgical skin incision Muscular pain and spasm Spinal cord compression | Figure1-O    |
| 16  | 31  | Male   | MVC          | Cervical (C5-C6-C7) | 4 yrs                  | +                      | Neociceptive pain Neuropathic pain | Musculoskeletal pain Below level SCI neuropathic pain | Muscular pain and spasm Cauda equina compression | Figure1-P    |
| 17  | 76  | Male   | Spine dissection due to sudden bending | Lumbar (L4-L5) | 8 yrs                  | +                      | Neuropathic pain            | Below level SCI neuropathic pain | Spinal cord compression | Figure1-Q    |
| 18  | 27  | Male   | MVC          | Thoracic (T11-T12) | 1 yr                   | +                      | Neuropathic pain            | Below level SCI neuropathic pain | Spinal cord compression | Figure1-R    |
| 19  | 28  | Male   | MVC          | Thoracic (T10-T11) | 10 yrs                 | +                      | Neociceptive pain Neuropathic pain | Musculoskeletal pain At level SCI neuropathic pain | Muscular pain Spinal cord compression | Figure1-S    |
| 20  | 48  | Female | MVC          | Cervical (C5-C6) | 1 yr                   | +                      | Neuropathic pain            | Below level SCI neuropathic pain | Spinal cord compression | Figure1-T    |

MVC - Motor Vehicle Crash, SCI - Spinal Cord Injury, ISCIP - International Spinal Cord Injury Pain, + - Spine fixation surgery was carried out
### Appendix 1 - Characteristics of individuals with spinal cord injury referring to our clinic based on International Spinal Cord Injury Pain (ISCIP) Classification.

| No. | Age | Gender | Cause of SCI | Level of SCI | Time duration from SCI | Spine fixation surgery | ISCIP classification Tier 1 | ISCIP classification Tier 2 | ISCIP classification Tier 3 | Pain diagram |
|-----|-----|--------|--------------|--------------|------------------------|------------------------|---------------------------|--------------------------|--------------------------|--------------|
| 21  | 50  | Male   | MVC          | Thoracic (T11) | 4 yrs                 | +                      | Neuropathic pain          | Musculoskeletal pain       | Lumbar facet syndrome     | Figure1-U     |
| 22  | 33  | Female | MVC          | Cervical (C3-C4) | 2 yrs                 | +                      | Neuropathic pain          | Musculoskeletal pain       | Lumbar facet syndrome     | Figure1-V     |
| 23  | 53  | Male   | MVC          | Lumbar (L1)     | 2 yrs                 | +                      | Neuropathic pain          | Musculoskeletal pain       | Ankle joint arthritis     | Figure1-W     |
| 24  | 54  | Male   | Fall         | Cervical (C4-C5) | 8 mo                  | +                      | Neuropathic pain          | Musculoskeletal pain       | Muscular pain             | Figure1-X     |
| 25  | 51  | Male   | Trauma (Heavy object falling on back) | Thoracic (T12) | 10 yrs                | +                      | Neuropathic pain          | Musculoskeletal pain       | Muscular pain             | Figure1-Y     |
| 26  | 31  | Male   | Fall         | Cervical (C6)   | 4 yrs                 | +                      | Neuropathic pain          | Musculoskeletal pain       | Spinal cord compression   | Figure1-Z     |
| 27  | 34  | Male   | Trauma (gymnastics) | Cervical (C5-C6) | 10 yrs                | +                      | Neuropathic pain          | Musculoskeletal pain       | Spinal cord compression   | Figure1-a     |
| 28  | 39  | Male   | Fall         | Thoracic (T10-T11) | 3 yrs                 | +                      | Neuropathic pain          | Musculoskeletal pain       | Quadrates lumborum muscle spasm | Figure1-b     |
| 29  | 37  | Male   | T8 surgery screw malposition | Thoracic (T8) | 15 mo                 | +                      | Neuropathic pain          | Musculoskeletal pain       | Spinal cord compression   | Figure1-c     |
| 30  | 29  | Male   | MVC          | Thoracic (T5-T6) | 3 yrs                 | +                      | Neuropathic pain          | Musculoskeletal pain       | Muscular pain             | Figure1-d     |
| 31  | 31  | Male   | MVC          | Lumbar (L1)     | 12 yrs                | +                      | Neuropathic pain          | Musculoskeletal pain       | Cauda equina compression  | Figure1-e     |
| 32  | 60  | Male   | Trauma (slipping) | Thoracic (T12) and L1 | 7 yrs                 | +                      | Neuropathic pain          | Musculoskeletal pain       | Cauda equina compression  | Figure1-f     |
| 33  | 57  | Male   | MVC          | Cervical (C6-C7) | 15 mo                 | +                      | Neuropathic pain          | Musculoskeletal pain       | Bowel impaction            | Figure1-g     |
| 34  | 59  | Male   | MVC          | Thoracic (T12)  | 30 yrs                | +                      | Neuropathic pain          | Musculoskeletal pain       | Spinal cord compression   | Figure1-h     |
| 35  | 42  | Female | MVC          | Cervical (C5-C6) | 6 yrs                 | +                      | Neuropathic pain          | Musculoskeletal pain       | Spinal cord compression   | Figure1-i     |
| 36  | 58  | Male   | MVC          | Cervical (C4)   | 3 yrs                 | +                      | Neuropathic pain          | Musculoskeletal pain       | Spinal cord compression   | Figure1-j     |
| 37  | 18  | Female | Complicated LP | Lumbar (L2) | 5 yrs                 | +                      | Neuropathic pain          | Musculoskeletal pain (cauda equina syndrome) | Muscular spasm and pain Cauda equina injury | Figure1-k     |
| 38  | 44  | Male   | Fall         | Thoracic (T10-T11) | 2.5 yrs               | +                      | Neuropathic pain          | Musculoskeletal pain       | Spinal cord compression   | Figure1-l     |
| 39  | 57  | Male   | Angiography of thoracic arteries | Thoracic (T7-T8) | 3 mo                  | +                      | Neuropathic pain          | Musculoskeletal pain       | Muscular pain             | Figure1-m     |
| 40  | 35  | Female | MVC          | Thoracic (T6)   | 3 yrs                 | +                      | Neuropathic pain          | Musculoskeletal pain       | Thoracic facet syndrome   | Figure1-n     |

MVC - Motor Vehicle Crash, SCI - Spinal Cord Injury, ISCIP - International Spinal Cord Injury Pain, + - Spine fixation surgery was carried out.