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Light Touch Manual Therapy as a Potential Adjuvant for the Management of Mechanical Allodynia in Patients with Acute Spinal Cord Injury

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Abstract

Background: Allodynia is a symptom associated with many diseases, including spinal cord injury (SCI), and often worsens over time as crisscrossed neuronal synapses make stronger connections. What triggers a crossover between pain and pleasure during gentle touch processing remains to be fully revealed. Reduce mechanical allodynia (MA) after SCI may minimize its progress for a secondary neuropathic central pain.

Methods: The pre-post study investigated if MA intensity pf patients with acute SCI would improve after the association of manual therapy sessions with light touch as a non-pharmacological adjuvant modality to participant's analgesic drug strategy during the acute SCI stage. The light touch manual therapy was based on TOUCH'IN method, which consists of gently touching the MA area following predetermined steps.

Results: In all participants the MA was the main pain complain even though they were receiving pharmacological analgesic therapy. Right after the end of the first session with light touch manual therapy, MA significantly reduced from an intense (average 9/10) to a mild level (average 1/10) and the self-perception of health improvement increased. It took about 3 consecutive sessions to participants sustain the MA intensity at a mild level. Since the MA intensity reduction was achieved, it remained low for at least 180 days. The functionality and the self-perception of health improvement were also significantly improved after the association of manual therapy to drug therapy.

Conclusion: MA intensity was significantly reduced in patients with acute SCI, when light touch therapy based on TOUCH'IN method was associated as an adjuvant non-pharmacological strategy to participant's analgesic drug therapy.

Keywords: Light touch • C-tactile afferent • Manual therapy • Mechanical allodynia • Neuropathic pain • Spinal cord injury

Introduction

The first point of our body's contact with tactile stimuli (innocuous and noxious) is the epidermis, and when an innocuous stimulus, i.e. light touch or caress, is perceived as a painful sensation, the sensory distortion is known as mechanical allodynia (MA). The myelinated Aβ-fibers are the predominant class responsible for sensing light touch and a subpopulation of unmyelinated C-tactile afferents has been shown to be crucial for gentle touch [1,2]. Unmyelinated C-tactile afferents activation (e.g. slow brushing stimuli) may also have a role in pain inhibition and are thought to be a system for limbic touch that may underlie emotional, hormonal and affiliative responses to light touch [3-5]. What triggers a crossover between pain and pleasure during gentle touch processing remains to be fully revealed [6,7]. Potential mechanisms have been purposed, ranging from alterations in mechanotransduction and sensory neurons excitability to the actions of inflammatory mediators and wiring changes in the central nervous system [7,8]. Moreover, the presence of MA in persistent neuropathic pain may be associated with a shift of brain responses towards neural circuits that regulate the affective and motivational components of pain [9].

The vast majority (78%) of patients with spinal cord injury (SCI) initially report allodynia 2 weeks after the trauma, and the reports of pain gradually decrease over 6 months [10]. Importantly, the presence of MA in the shin and feet 1-2.5 months after SCI was the best biomarker for the risk of developing below-level central pain [11,12]. Epidemiological studies show that MA may be present in 20 to 55% of central or peripheral neuropathic syndromes [13,14]. Once the MA is detected, the main goal would be to reduce hyperexcitability by administering agents able to prevent or minimize its progress and possibly the development of a secondary below-level central pain 11. Drug therapy studies for allodynia in SCI population have shown that alfentanil, morphine and ketamine may be a short-term management option with limited effect over the pain 15. There is also evidence that pregabalin is more effective in reducing allodynia than oxcarbazepine [15,16].

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Even though studies on pharmacological treatment of SCI-related neuropathic pain clearly dominate the literature, non-pharmacological modalities are also under the interest of both researchers and patients [15,17]. The management of MA and hyperalgesia focused on the site of the pain (i.e. the skin, *via* interfering with keratinocyte-sensory neuron communication) would allow an easy and non-invasive therapeutic strategy for these conditions. Moreover, may also avoid the central nervous system-mediated side effects of most current pain treatments, including opioid analgesic drugs 8. In this context, we investigated if MA intensity would improve after the association of manual therapy sessions with light touch as a non-pharmacological adjuvant modality to participant's drug therapy.

Methods

This pre-post study aimed to prospectively investigate if MA intensity would change after the association of light touch manual therapy sessions as a non-pharmacological adjuvant therapy for pain relieve in patients with acute SCI.

Participants

This study included all conscious (Glasgow Coma Scale=15) patients with SCI and MA admitted in the João XXIII Emergency Hospital, Belo Horizonte - MG, Brazil, from august 2016 to august 2017. Patients were informed and oriented about the study and signed, themselves or caregivers, the Informed Consent Form. The study was approved by the Hospital Foundation of Minas Gerais State (FHEMIG) Research Ethics Committee under technical opinion 019B/2016, and by the Federal University of Minas Gerais (UFMG) Research Ethics Committee (CAAE 88980217.2.0000.5149).

Exclusion criteria included: (1) *Douleur Neuropatique* en 4 questions (DN4) score <4; (2) any possible cause of nociceptive pain near or over the MA area (e.g., chest drains, skin laceration, fractures); (3) cauda equina syndrome and (4) peripheral nerve injuries.

Evaluation procedures

The DN4 was used for discriminating neuropathic from nociceptive pain in participants [18,19]. The questionnaire consists of 10 items (7 related to symptoms and 3 related to clinical pain assessment) and a score > 4 suggests presence of neuropathic pain in SCI patients. DN4 is a reliable tool in clinical setting which prioritizes accurate diagnosis and facilitates the distinction between neuropathic and nociceptive pain.

Pain intensity was recorded before and after each session with light touch by using the Numeric Rating Scale (NRS), where 0='no pain' and 10='worst pain' [20]. A follow up after 60 and 180 days from the discharge from TOUCH'IN method intervention was performed and patient was contacted by a phone call to be asked about the MA intensity.

In order to measure a potential clinical improvement achieved with the intervention received, the Patients' Global Impression of Change Scale (PGICS) was applied. The scale is a one-dimensional measure in which individuals rate their improvement associated with intervention on a scale of 7 items, ranging from '1=No changes (or condition worsened)' to '7=Much better, and with a considerable improvement that made all the difference' [21]. The PGICS was applied before and after each session.

The Impairments and Functional Disabilities due Pain Scale (IFDS) has 12 items, however 6 of them were not appliable for the acute stage of SCI context in the emergency hospital. Items selected were sleep, appetite, personal hygiene; interpersonal relationships, concentration and humor, and they were classified as (1) 'no change', (2) 'partially committed' and (3) 'fully committed'. Data could be taken from patient's self-report or by examiner observation [22]. Clinical data such as neurological level, spinal syndromes and severity rating were obtained from medical records.

Intervention procedure

Mechanical Allodynia (MA): the medical team examined the presence of MA by gently touching the painful skin area with cotton and bed sheet for 1 second [11,23,24]. Neuropathic pain was classified into 'at-level' and 'below-level' pain [25]. After suspicion of MA the researcher/therapist started the light touch manual therapy based on TOUCH'IN method. Participants underwent up to 7 consecutive sessions. In case of hospital discharge or transfers, if the pain intensity remained low according to NRS for 2 or more consecutive sessions or if pain ceased, sessions were interrupted. No changes in drug therapy or other medical assistance (e.g., conventional physical therapy, nursing assistance) were done.

The TOUCH'IN method

The light touch therapy based on TOUCH'IN method consisted in 5 steps: (1) 'passed test'; (2) 2 fingers touch; (3) 3 fingers touch; (4) palm hand touch and (5) sweep touch.

The 1st step is the 'passed test', where the therapist gently touches the painful area with one finger and remains unmoved until the patient informed if the pain has passed or if it reduced for a light intensity. Patient may refer increase on MA right after touching the painful area, but after staying with the finger unmoved over the skin, MA starts to reduce. It is crucial to patient to be conscious about the answer regarding the touch stimuli of 'passed test'. The 'passed test' must be done all over the painful area, always starting from bords to the central area, and touch must be done one area after another, consecutively. Some patients may refer pain on the other body side while therapist stimulates the MA area. The 2nd step consists of touching the MA area, from the bords to the center, with 2 joined fingers and remaining unmoved. At this time, if the patient does not say 'passed' before 1.5 or 2 minutes you can progress through the side area. The 3rd step consists of touching the painful area with 3 joined fingers for about 3 to 8 seconds, then take fingers off and immediately return touching the same area again. The same area can be touched for 5-10 times before moving to the next. In the 4th step, therapist must touch the painful area with palm hand and adducted fingers and remain on skin for 3 to 8 seconds, then take the hand off and immediately return touching the same area again for 5-10 times. Finally, on the 5th step, the stimuli must be dynamic and slow, sweeping the entire painful area always on the same direction and rhythm (i.e. such as slow gentle caress). The sweep velocity and changes on rhythm should increase, according to patient's tolerance and feedback.

After performing the 5 basic steps of TOUCH'IN method, the physical therapist should gently and dynamically caress the painful and non-painful area. For example, if the MA area is located around the elbow and the cubital fossa, caress should be done in the entire arm for, at least, 2 minutes. After that, therapist should encourage patient to actively contract the muscles involved with MA area. If not possible because of the SCI deficit, passive mobilization of the segment should be performed. After mobilization, the segment aliened is left in a different position from that found in the beginning of session.

Statistical analyses

Statistical analysis was performed using the GraphPad Prism 5.0 statistical program (La Jolla, CA, USA) and the SPSS 17.0 program (SPSS Inc., Chicago, IL, USA). Data were reported descriptively using measures of mean central tendency and standard deviation and/or median and standard error. Results were analyzed for normal distribution by the Kolmogorov-Smirnov test. Variables with normal distribution were compared using t-student, One-way ANOVA statistical tests. Dunn's post-test was used when necessary for multiple comparisons. In cases of non-normal distribution, the variables were compared using the Mann-Whitney U or Kruskal-Wallis statistical tests. The correlation between the applied scales was performed using Pearson or Spearman tests for variables with normal or non-normal distribution, respectively. Significance level was set at $p < 0.05$.

Results

Seventeen patients were admitted with spinal trauma diagnosis, with or without spinal cord involvement, associated with MA complaint, and 11 were included. Six patients were excluded: 2 with a nociceptive pain cause near or over the MA area, 1 due to consciousness level alteration during treatment, 1

received other adjuvant manual therapy, 1 did not cooperate and 1 presented the cauda equina syndrome.

Demographical data and trauma mechanisms are provided in Table 1. Cervical spine was the most affected (45.4%), followed by the thoraco-lumbar transition (27.2%). In all cases, the neuropathic pain was at-level and the MA begun in up 24h after the trauma (Table 2). The most frequently prescribed medication was dipyrone (100%), opioids (81.8%) and ketoprofen (63.6%) (Table 2). Gabapentin and amitriptyline were prescribed for 36.3% and 27.2% of participants, respectively. None of patients used pregabalin (Table 2).

The elapsed time between patient admission to the emergency hospital and the 1st session with TOUCH'IN method was, on average, 6 days and all patients were receiving analgesics therapy during this period.

Table 1. Patients' socio-demographic and clinical profile.

Patients	Age (years)	Sex	Trauma Mechanism	Type of Injury	Surgical procedure	Impairment Classification	Tactile allodynia Classification	Mechanical Allodynia region
1	17	F	MVA	T12 fx with bone fragment into the spinal canal	Yes	AIS - D	at-level	Whole legs below knees and feet
2	73	F	Fall from the standing height	Cervical spinal stenosis	Yes	CCS tetraparesis	at-level	Right shoulder and humerus (C4-C5 dermatomes)
3	40	M	FOH (10m)	T12 and L3 fx with spinal canal stenosis	Yes	AIS - B	at-level	Whole legs below knees and feet
4	45	F	FOH (3m)	Cervical spinal stenosis + spinal cord contusion	Yes	CCS tetraparesis	at-level	-Right hand: dorsum from 2nd to 5th fingers -Left hand: dorsum from 2nd to 4th fingers
5	37	M	FOH (3m)	T12 body compression fx with retropulsion into the spinal canal.	conservative treatment	AIS - C	at-level	-RLL: knee (L3-L5 dermatomes), calcaneal tendon, tibia, foot dorsum. -LLL: knee (L3-L5 dermatomes)
6	23	M	FAP	FAP into T5 spinal canal	conservative treatment	AIS - A	at-level	below nipples on the left (T5-T6 dermatomes)
7	46	M	Run-over injury	Cervical spinal stenosis	conservative treatment	CCS upper paraparesis	at-level	Right and left hand: thenar region, dorsum of 1st and 2nd MPJ, region between the MPJ of 2nd and 3rd fingers
8	50	M	MVA	Cervical spinal stenosis	No	CCS -tetraparesis	at-level	LUL: deltoid insertion region, medial face of biceps (c5 dermatome) RUL: whole wrist
9	19	M	FAP	FAP into L2 spinal canal	conservative treatment	AIS - C	at-level	Whole right ankle
10	23	M	FAP	FAP into C2 vertebral body	conservative treatment	AIS - E	at-level	Left hemicrania: below the occipital tuberosity and behind auditory pavilion. Pain island regions along the sternocleidomastoid muscle and furcula.
11	23	M	FAP	FAP into T1 spinal canal	conservative treatment	AIS - A	at-level	RUL: anteromedial face of the arm (T1 dermatome), lateral face of the shoulder and elbow (C5-C6 dermatomes)

Caption: F: female; **M:** male; **FAP:** firearm projectile; **MVA:** motor vehicle accident; **FOH:** fall of height; **Fx:** fracture; **RLL:** right lower limb; **LLL:** left lower limb; **RUL:** right upper limb; **LUL:** left upper limb **MPJ:** metacarpal-phalanx joints; **CCS:** central cord syndrome

Table 2. Patients' mechanical allodynia profile before and after intervention with light touch manual therapy based on TOUCH'IN method.

Patients	Onset time of MA after trauma	Elapsed time between EH admission and D_1 of MT-AT	Pain NRS D_0	Pain NRS D_1	Pain NRS D_F	Drugs prescription	Number of sessions	Pain NRS D_{60}	Pain NRS D_{180}
1	Immediately	4 days	10	1	1	DIP, MOR, MET, CBMZ, CNZP, GBP	4	2	0
2	Immediately	18 days	10	2	0	DIP, MOR, HAL, DZP	2	0	0
3	First 12h	9 days	9	0	0	DIP, MOR, COD	7	missing	missing
4	Immediately	9 days	10	0	0	DIP, MOR, COD, KET, CBMZ, CNZP	6	1	4
5	First 6h	1 day	10	3	0	DIP, KET, CMZP	2	1	0
6	First 6h	0 day	10	0	0	DIP, MOR, NAL, KET, GBP	2	0	0
7	First 12h	4 days	7	0	0	DIP, COD, KET, CBMZ	3	4	0
8	First 6h	7 days	10	0	0	DIP, MOR, AMT, DZP	4	2	0
9	First 24h	9 days	10	1	0	DIP, COD, KET, AMT, GBP	1	missing	missing
10	First 6h	2 days	8	2	0	DIP, KET, CMZP, GBP	3	8	4
11	First 6h	4 days	10	3	0	DIP, COD, KET, AMT	3	0	0

Caption: MA: mechanical allodynia; **EH:** emergency hospital; **MT-AT:** manual therapy based on affective touch; **NRS:** numeric rating scale, D_0**:** before the 1st session; D_1**:** after the 1st session; D_F**:** discharge of TOUCH'IN intervention; D_{60}**:** follow up after 60 days, D_{180}**:** follow up after 180 days, **DIP:** dipyrone; **MOR:** morphine; **MET:** methadone; **CBMZ:** carbamazepine; **CNZP:** clonazepam; **GBP:** gabapentin; **HAL:** haloperidol; **DZP:** diazepam; **COD:** codeine; **KET:** ketoprofen; **NAL:** nalbuphine; **AMT:** amitriptyline.

Pain intensity – Numeric Rating Scale (NRS)

Mechanical allodynia was the main pain complaint of all participants at the time before the intervention with light touch manual therapy (Figure 1). The mean MA intensity before the intervention (NRS D_0) was 9.4/10 (SD +1.03), i.e., severe pain. Right after the end of the 1st session (NRS D_1) there was a significant MA reduction ($p < 0.01$), coming from an intense level (average 9/10) to a mild level (average 1/10). It took an average of 3 sessions to participants sustain the MA intensity at a mild level for 2 consecutive days and, consequently, were discharged from light touch manual therapy. Moreover, during the course of sessions the therapy duration was decreasing.

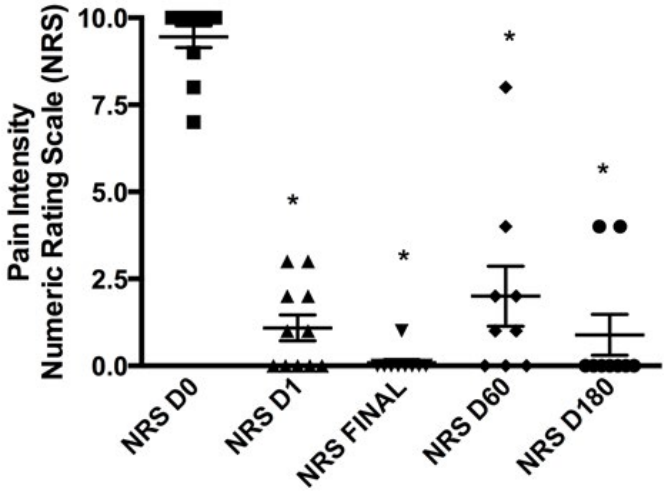
Follow up of 60 (D_{60}) and 180 (D_{180}) days after the discharge of light touch manual therapy based on TOUCH'IN method was performed in 9 participants. The others 2 participants were not available for contact. In both follow up times, MA intensity was kept at a mild level. The mean intensity at D_{60} was 2/10 and at D_{180} was 0.8/10. There were no statistical changes on MA intensity level between the moment of discharge from manual therapy intervention and D_{60} or D_{180} of follow up.

Patient's Global Impression of Change Scale (PGICS) and Impairments and Functional Disabilities due Pain Scale (IFDS)

Prior to the first intervention with light touch manual therapy, PGICS score had a mean of 2/7, i.e., the perception of improvement related to the treatment received so far for MA control were classified as "almost the same, with no visible change". After the end of the 1st session (D_1), the perception of health improvement and level of satisfaction with the treatment received significantly changed ($p < 0.001$) to an average of 6/7, i.e., classified as "better, and with improvements that made a real and useful difference" (Figure 2). The health improvement perception remained unchanged until the discharge of intervention using TOUCH'IN method.

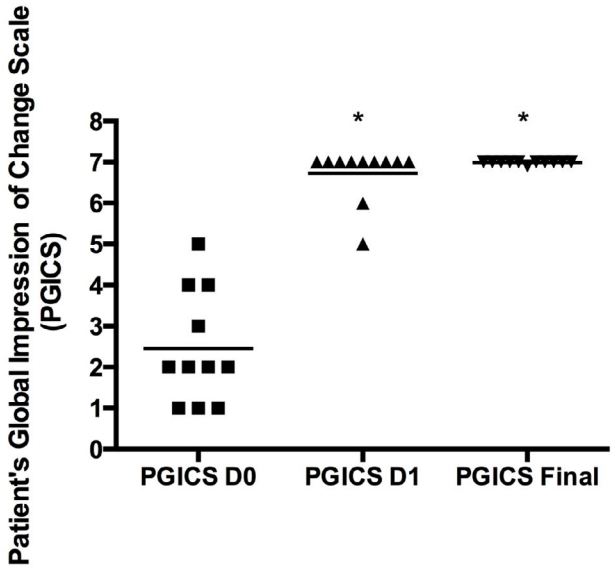
There was a significant improvement in all functional domains at the discharge of light touch manual therapy based on TOUCH'IN method (Table 3). A moderate positive significant (r 0.6453/p<0.03/) correlation were observed between MA intensity and IFDS total score, i.e., increases in MA intensity resulted in increases in functional impairments. When analyzing the IFDS domains separately, 'sleep' ($p < 0.01$; r 0.6995) and 'personal hygiene' ($p < 0.004$; r 0.7860) significantly correlated with MA intensity, in a positive way and with a moderate strength.

Discussion



Caption: NRS D0: pain intensity before intervention with *TOUCH'IN* method; **NRS D1:** pain intensity after the first session; **NRS FINAL:** pain intensity at the discharge of *TOUCH'IN* intervention; **NRS D60:** pain intensity follow up after 60 days of intervention discharge; **NRS D180:** pain intensity follow up after 180 days of intervention discharge. Data were analyzed using Kruskal-Wallis test with Dunn's post-test.

Figure 1. Pain intensity before and after intervention with TOUCH'IN method



Caption: PGICS D0: patient's health improvement perception before the first session with *TOUCH'IN* intervention; **PGICS D1:** patient's health improvement perception after the first session with *TOUCH'IN* intervention; **PGICS Final:** patient's health improvement perception after discharge of *TOUCH'IN* intervention. Data were analyzed using Kruskal-Wallis test with Dunn's post-test.

Figure 2. Patient's health improvement perception related to TOUCH'IN intervention.

Table 3. Mean domains' scores of Impairments and Functional Disabilities due Pain Scale (IFDS).

IFDS Domains	Total Score D_0	Total Score D_F	Mean Score D_0	Mean Score D_F	P value
Sleep	30/33	13/33	2.7 (+0.46)	1.1 (+0.40)	p< 0.0001
Appetite	20/33	Nov-33	1.8 (+0.87)	1.0 (+0.0)	p<0.01
Personal Hygiene	32/33	Nov-33	2.9 (+0.30)	1.0 (+0.0)	p<0.0001
Interpersonal Relationships	24/33	Nov-33	2.0 (+0.83)	1.0 (+0.0)	p<0.0014
Concentration	26/33	Nov-33	2.3 (+0.80)	1.0 (+0.0)	p<0.002
Humor	32/33	Nov-33	2.2 (+0.90)	1.0 (+0.0)	p<0.0009
Total Score	164/198	123/198			p<0.0001

Caption: D_0: functional status before the 1st session with TOUCH'IN method. **D_F:** functional status at discharge of TOUCH'IN intervention. Data were analyzed by employing t-test.

This study investigated the adjuvant clinical effects of light touch manual therapy based on TOUCH'IN method for MA control in patients during acute stage of SCI. Participants were under pharmacological treatment for neuropathic pain and our results revealed that the MA intensity and the self-perception of health improvement were significantly improved right after end of the first manual therapy with light touch session. The TOUCH'IN method consists of gently touching the MA area following predetermined steps. Because MA is evoked by non-painful stimuli, it is hypothesized that low-threshold primary afferent fibers convey touch-evoked pain *via* non-neuronal cells such as Merkel cells and keratinocytes 8. Merkel cells constitute a small percentage (roughly 3%–6% including fingertips, whisker hair follicles, and touch domes) of the cells in the epidermis [26]. These touch-sensitive cells express mechanosensory Piezo 2 ion channel, which has been documented to contribute to two-point tactile discrimination, brush, air puff, and vibration even after nerve injury or during chronic inflammation [27]. One direct implication is that blocking the Piezo 2 function would be expected to prevent MA [27]. In the present study, the action of gently touching the skin over the pain site was part

of the process, and even though the pain could increase in the first moment right after the touch, the pain intensity decreased or completely ceased over time.

Keratinocytes, which cover 95% of the epidermis, are intimately involved in communicating information about somatosensory stimuli that impact the skin to the nervous system [26]. These non-neuronal epidermal cells can release a variety of chemical factors such as calcitonin gene-related peptide β (CGRPβ), β-endorphins, endothelin-1, neurotrophins, and cytokines all of which can activate receptors on sensory nerve terminals 8. Furthermore, when an innocuous touch occurs over the non-injured skin, the adenosine triphosphate – ATP - released acts on P2X4 receptors on sensory neurons and possibly over other slowly adapting sensory cells such as Aβ, Aδ and C-fibers [8]. Keratinocytes [28] and Merkel cells [29] may modulate epidermal homeostasis through autocrine/paracrine signaling and may contribute to chronic pain under pathological conditions. It is important to highlight that, in the present study, participants had complete and incomplete SCI and the innocuous skin touch was done over the skin site of MA, with the clinical relieve of the pain being achieved immediately after the first session. It is tempted to hypothesize that the local stimuli induced by the light touch may interfered in Merkel cells and keratinocyte-sensory neuron communication and epidermal homeostasis, potentializing the analgesic effects of the pharmacological strategies.

The cutaneous stimulation given by TOUCH'IN method was designed to also target unmyelinated C-tactile afferents. The C-tactile afferents activation reduces physiological arousal, carries a positive affective value and, under healthy conditions, inhibits responses to painful stimuli [30]. Marshall AG, et al. [31] found that there was not a dedicated lamina I spinothalamic coding channel which was responsible for the perception of affective aspects of touch. These found lead the authors to the following question: how, and in what form, might C-tactile afferents impart their emotionally salient activity on the higher central nervous system? In the present study, even though the participants had different types of SCI, all of them had significant clinical MA relieve after intervention with gentle touch therapy, supporting Marshall and co-workers (2019) questioning.

Allodynia is a symptom associated with many diseases and often worsens over time as crisscrossed neuronal synapses make stronger connections, and the symptom can have a substantial negative impact on mental and emotional health, due to the distress caused by continual pain 32. Due to the complex nature of the neuropathic pain, there is no 'one size fits all' approach when it comes to treatment [17]. Researchers [32-36] have shown that pain report and associated neural responses can be attenuated in response to slow, light and affective touch. Furthermore, gentle touch affects pain in fundamental ways by directly reducing central nociception, as some brain regions are involved such as secondary somatosensory cortex and posterior insula, mid/anterior insula, dorsal anterior cingulate cortex, dorsal and ventral lateral prefrontal cortex, thalamus, dorsal caudate, periaqueductal gray matter, amygdala, and cerebellum [33-36].

Kim K, et al. [37] had positive results treating allodynia with ketamine, intravenously and subsequently perorally, in 13 patients with SCI in the acute stage. All patients failed on reducing allodynia intensity when treating with gabapentin, tricyclic antidepressants, and non-steroidal anti-inflammatory, and pain intensity persisted above 5/10 according to the visual analogue scale. After ketamine therapy, their results showed that the analgesic effect lasted for at least 2 weeks and decreased after 1 month. Side effects were observed in 38.4% participants. Our data showed that patients' clinical state regarding self-perception of health, functionality and MA intensity were significantly improved when light touch manual therapy with TOUCH'IN method was associated to drug therapy, and this improvement was achieved right after the first session and reduction of MA intensity lasted for 180 days. Literature about management of pain in SCI patients [11,12,38] alerts to continuously monitor acutely injured patients with signs of allodynia, which might allow for a timely and effective treatment of neuropathic pain and potentially minimize the likeliness of a chronic disease course.

Hatch MN, et al. [17] highlighted the difficulty in running clinical trials with SCI patients and neuropathic pain, partially because there are very few places with specialized SCI care, and the number of people with this condition for recruitment into trials is relatively small in comparison to other diseases. Even though this study was performed in a trauma emergency hospital, only 11 patients with SCI and MA were enrolled in the study. A reason for this low number of patients may rely on the fact that allodynia is a very peculiar condition, often misleads by uninformed health professionals as a type of conversion hysteria and therefore neglected. A survey carried out by the International Association for the Study of Pain - IASP - revealed that among its members in developing countries, few have received adequate education in understanding and treating pain during university graduation [39].

Patients with allodynia hope for complete and immediate resolution of their pain, which is rarely achievable, and the pain often becomes persistent no matter how much medical and alternative therapy a patient receives [32]. Many patients erroneously believe opioids are effective for chronic neuropathic pain, and the long-term use of allopathic medications often increases their potential for side effects and have high additive potential. Consequently, interest in non-pharmacologic interventions for neuropathic pain management increases [15,32]. Complementary treatments such as massage, exercise, osteopathy and transcranial magnetic stimulation have low-quality evidence of positive effects over neuropathic pain in SCI population 15. Recent analysis [15,17] revealed that many studies with non-pharmacologic treatments do not have strong evidence yet to support recommended use in SCI neuropathic pain. Soler MD, et al. [40] used Transcranial Direct Current Stimulation (tDCS) alone or associated with Visual Illusion (VI) in 26 patients with SCI and MA, which were already under medication for neuropathic pain. Treatment had 2 weeks of duration, lasting 20min each session. A significant improvement in MA was found only when both technics (tDCS + VI) were performed simultaneously. Moreover, the pain relief was observed on the last day of treatment and persisted for at least 2 weeks.

Conclusion

Mechanical allodynia intensity was significantly reduced in patients with acute SCI, when light touch manual therapy based on TOUCH'IN method was associated as a non-pharmacological adjuvant modality to participant's drug therapy. The MA intensity reduction from an intense to a mild level and the self-perception of health improvement increased right after the end of the first manual therapy session. Since MA intensity reduction was achieved, it remained low for at least 180 days.

Ethical Approval and Consent to Participate

The study adhered to the Declaration of Helsinki and was approved by the local ethics committees of the Hospital Foundation of Minas Gerais State - FHEMIG – (technical opinion 019B/2016) and Minas Gerais Federal University – UFMG – (CAAE 88980217.2.0000.5149); all the patients and their parents or guardians gave their written informed consent to use their clinical data in anonymized form.

Consent for Publication

I, Aline Duprat Ramos, give consent for the publication of identifiable details, which can include photograph(s) and/or videos and/or case history and/or details within the text to be published in the Neurological Research and Practice. I confirm that I have seen and been given the opportunity to read both the Material and the Article to be published by Neurological Research and Practice. I have discussed this consent form with Aline Silva de Miranda, who is an author of this paper.

Availability of Supporting Data

Raw data were generated at Hospital Foundation of Minas Gerais State -

FHEMIG. Derived data supporting the findings of this study are available from the corresponding author on request.

Competing Interests

All authors, Aline Duprat Ramos, Daniel Fernandes Martins, Rodolfo Borges Parreira, Aline Raulino Dutra and Aline Silva de Miranda, declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Authors' Contributions

All named authors meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship for this article, take responsibility for the integrity of the work as a whole, and have given their approval for this version to be published.

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