ORIGINAL ARTICLE

The effects of phenol neurolysis of the obturator nerve on the distribution of buttock-seat interface pressure in spinal cord injury patients with hip adductor spasticity

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Objectives: Hip adductor spasticity may adversely effect shear-force and pressure distribution on the buttocks, where ulcerations most frequently appear in patients with spinal cord injury (SCI). Phenol neurolysis of the obturator nerve (ON) is commonly used to manage hip adductor spasticity. This study aimed to determine the effects on the distribution of buttock-seat interface pressure (BSIP) in a group of SCI patients with adductor spasticity that underwent ON blockade with phenol.

Methods: We reviewed the records of SCI patients that were admitted to our clinic between January 2009 and December 2009. BSIP values (obtained with an X-sensor 48) and hip adductor spasticity levels of SCI patients with hip adductor spasticity that underwent ON blockade with phenol were collected. BSIP distributions of the patients were divided into two portions: first one is the BSIP distribution at the pressure ≤ 37 mm Hg, and the second one is at the pressure > 37 mm Hg.

Results: The study included 20 SCI patients (19 males and 1 female), with a mean age of 42.85 ± 13.24 years. Although the percentage of BSIP distribution at ≤ 37 mm Hg range increased significantly ($P < 0.001$), after ON neurolysis, BSIP distribution at > 37 mm Hg range decreased significantly ($P < 0.001$). In addition, mean hip adductor spasticity decreased significantly after ON neurolysis ($P < 0.001$).

Conclusion: Phenol neurolysis of the ON is a promising treatment for the management of hip adductor spasticity in SCI patients and also has positive effects on BSIP, which has a crucial function in the development of pressure ulcers.

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Introduction

Pressure ulcers are one of the most common complications in spinal cord injury (SCI) patients. An estimated 50–80% of SCI patients develop pressure ulcers.¹ The principal etiological factor in ulceration is improper pressure distribution.² Shear-force, age,³ hygiene,⁴ nutritional status,⁵ general health status,³ activity level,¹ tissue properties—including temperature,⁶ moisture,⁷ tissue viability⁸—posture, deformities, and physiological factors are other etiological factors associated with pressure ulcers. Furthermore, sensory disorders, spastic or flaccid paralysis, coma, edema, and overuse of sedative medications also contribute to the formation of pressure ulcers.⁹

Spasticity is another factor that can lead to pressure ulcers. The relationship between spasticity and pressure ulcers varies. Sustained elevated spasticity leads to impaired lymphatic circulation and hypoperfusion of the tissue, resulting in an accumulation of toxic intracellular materials.¹⁰ In addition, humidity and difficulty maintaining perineal hygiene in cases of hip adductor spasticity are other contributing factors. Moreover, increased shearing-forces due to adductor spasticity promote the formation of pressure ulcers. Nonetheless, hip adductor spasticity may adversely effect the distribution of pressure on the buttocks, which is where pressure ulceration most commonly appears. Although Henderson *et al.*¹¹ reported a safety range < 60 mm Hg for those in a wheelchair, 37 mm Hg is the maximum limit of external pressure for regular perfusion.¹²

Although it is known that spasticity can cause skin breakdown secondary to difficulty positioning and shearing pressure, the relationship between pressure ulcers and spastic

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hip adductors, as a seated-position risk factor in patients with SCI, remains to be clarified. Phenol neurolysis of the obturator nerve (ON) is commonly used to manage hip adductor spasticity.¹³ Phenol causes chemical denervation via denaturing proteins, which results in Wallerian denervation. Phenol typically induces a short-term anesthetic effect, followed by neuromuscular blockade of longer duration.¹⁴

To the best of our knowledge, this study is the first to examine the effects of ON neurolysis on buttock-seat interface pressure (BSIP). This study aimed to determine the effects of phenol ON blockade on the distribution of BSIP and spasticity in the adductor muscles in a group of SCI patients with adductor spasticity.

Materials and methods

In our hospital's SCI rehabilitation service, we generally use neurolytic phenol blockade of the ON for hip adductor spasticity in patients with chronic motor complete spinal injury [American Spinal Injury Association Impairment Scale (AIS-A or AIS-B)]. In addition, our clinical routine is to hospitalize patients with chronic SCI for 3 weeks to perform follow-up examinations. Among these examinations is the assessment of the BSIP. Written informed consent was obtained from all the participants before any interventions were performed. In addition, the patients were informed about the importance of doing push-ups for 20s every 20 min.

We reviewed the records of patients admitted to our clinic between January 2009 and December 2009. Inclusion criteria were as follows: onset of traumatic or non-traumatic SCI at least 12 months earlier, motor completeness (AIS-A or AIS-B), use of a manual wheelchair for at least 2 h a day for 6 months, and hip adductor spasticity. Exclusion criteria were as follows: pressure ulcers on the buttock region and history of surgery for pressure ulcers on the buttocks.

An X-Sensor 48 with a 36 × 36-capacitive sensor mat (each sensor, 1.6 cm²) interfaced with a PC sampling system at 50 Hz was used to measure BSIP (XSENSOR Technology Corporation, Calgary, Alberta, Canada).¹⁵ These sensors measure the pressure in a range of 5–232 mm Hg. The patients' own wheelchairs (without cushions) were used in the study.

Each subject was seated in their wheelchair with their back against the backrest, buttocks positioned in the back of the seat, feet on the adjustable footsteps with thighs making contact with the seat, and calves supported by the calf support. Hands were positioned on the thighs. The subjects remained in this test position for 10 min before measuring the pressure. Pressure measurements were obtained 1 day before ON neurolysis. The same procedures were performed by the same physiotherapist 2 weeks after neurolysis.

ON neurolysis was performed using the pubic approach method under peripheral nerve stimulator (Stimuplex S, B. Braun, Melsungen, Germany) guidance, using a 22G 100-mm Teon-coated needle (Stimuplex, B. Braun). The frequency of stimulation was 1 Hz for 0.1 ms and the initial intensity of stimulation was 3 mA. Accurate location was

usually obtained when adductor muscle twitch was observed in response to 0.2–0.7-mA stimulation. Then, recovery of the twitch response was observed and 10 ml of 5% phenol was administered. Neurolysis was performed to both ONs during the first to seventh day of hospitalization. Before nerve stimulation, 2 ml of 2% lidocaine was injected into the subcutaneous tissues for local analgesia, so as to reduce irritative physical or physiologic sensations. As the patients were awake and could observe the injection procedure, and even though some were AIS-A patients, they could have become agitated, which could have increased hip flexor spasticity, negatively affecting the injection procedure.

Clinical data of patients were collected. The percentages of BSIP of the patients were divided into two portions: first one is the BSIP distribution at the pressure ≤37 mm Hg, and the second one is at the pressure >37 mm Hg. In addition, hip adductor spasticity values were measured according to the Modified Ashworth Scale at the time of admission and discharge. SPSS v.13.0 for Windows was used for statistical analysis. Pre- and post-treatment evaluations were compared using the Wilcoxon test and the probable effect of AIS classification on differences between the evaluations were determined using the general linear model repeated measures analysis of variance (between-subject factors). A *P*-value <0.05 was considered to be significant.

Results

The study included 20 SCI patients (19 males and 1 female), with a mean age of 42.85 ± 13.24 years, mean weight of 80.3 ± 15.5 kg, and mean height of 175.2 ± 7.5 cm. In all, 3 subjects were tetraplegic and 17 were paraplegic; 13 patients were AIS-A and 7 were AIS-B. Mean duration after onset of SCI was 41.82 ± 47.21 months. Patient demographics are shown in the Table 1.

Before ON neurolysis, BSIP distribution between 0 and 37 mm Hg was 62.91%, and it was 37.08% over 37 mm Hg. Two weeks after ON neurolysis, BSIP distribution between 0 and 37 mm Hg was 71.16%, and it was 28.84% over 37 mm Hg. Although the percentage of BSIP distribution at ≤37 mm Hg range increased significantly (*P* < 0.001), it decreased significantly at >37 mm Hg range (*P* < 0.001).

Table 1 Demographics of patients

Age (years)	42.85 ± 13.24
Men (<i>n</i>)	19
Women (<i>n</i>)	1
Paraplegic (<i>n</i>)	17
Tetraplegic (<i>n</i>)	3
Cervical neurologic level (<i>n</i>)	3
Thoracic neurologic level (<i>n</i>)	17
Lumbar neurologic level (<i>n</i>)	0
AIS-A (<i>n</i>)	13
AIS-B (<i>n</i>)	7
Mean weight (kg)	80.3 ± 15.5
Mean height (cm)	175.2 ± 7.5
Mean SCI duration (months)	41.82 ± 47.21

Abbreviations: AIS, American Spinal Injury Association Impairment Scale; SCI, spinal cord injury.

Figure 1 Buttock-seat interface pressure distribution at ≤ 37 mm Hg range and at > 37 mm Hg range. ON, obturator nerve. ** $P < 0.001$.

Figure 2 The hip adductor spasticity decreased significantly after obturator nerve neurolysis. ON, obturator nerve; MAS, Modified Ashworth Scale. ** $P < 0.001$.

(Figure 1). No significant differences were observed in repeated measurements between the AIS-A and AIS-B patients (between-subject factors; $P > 0.05$). In addition, mean hip adductor spasticity decreased significantly after ON neurolysis ($P < 0.001$) (Figure 2). No complications due to phenol neurolysis were recorded.

Discussion

Despite comprehensive rehabilitation, improvements in assistive device technology, and preventive recommendations, pressure ulcers are a common and challenging complication in SCI patients with spasticity. It is the second leading cause of re-hospitalization after SCI and requires a multidisciplinary treatment approach. In recent years, research has increased our understanding of the factors associated with the formation of pressure ulcers. They usually occur over bony prominences of the buttocks region. Pressure-induced occlusion of capillary blood flow, resulting in tissue ischemia, is considered to be the primary cause.³ Thus, the distribution and intensity of BSIP is very important, as is the duration of pressure, to SCI patients that use a wheelchair. Active patients with SCI spend many

hours sitting in their wheelchairs. The existence of a relationship between pressure intensity and the duration of pressure on the buttocks region, and pressure ulcers has been reported.¹⁶ Higher BSIPs have been associated with higher pressure ulcer incidence rates.^{3,17} Thus, high BSIP should be reduced to prevent pressure ulcers.

There are some factors that affect the intensity of BSIP, including personal and postural factors, and chair and cushion factors. Personal factors include anthropometric features, body mass index, gender, muscle tone, body composition, and cutaneous and subcutaneous tissue features. Postural factors include backrest angle, leaning forward, upright postures, reclined postures, use of armrests, and leg position.¹⁸ Hip adductor spasticity can adversely affect the distribution of BSIP according to muscle tone and leg position. As such, hip adductor spasticity negatively effects the distribution of BSIP.

In this study, we observed that ON neurolysis with phenol decreased hip adductor spasticity. Another finding is that decreased hip adductor spasticity positively affected BSIP. The percentages of buttock pressure distribution over 37 mm Hg changed positively and reduced after the neurolysis of ON with phenol. Although the buttock area with the pressure of < 37 mm Hg was extended, the area with more intense pressure was decreased.

The relationship between pressure ulcers and spasticity is like a vicious cycle. Spasticity, especially in hip adductors, leads to pressure ulcers by impairing lymphatic circulation and hypoperfusion of the tissue, impairing perineal dryness and hygiene; however, increased spasticity could be considered a complication of unhealed pressure ulcers, as its presence can inhibit or disrupt the healing process after surgical or non-surgical treatment. Pressure ulcers can be subliminally perceived as a noxious stimulus and trigger spasms that can be considered as aggravated withdrawal reflexes. A new-onset infected pressure ulcer or abscess qualifies as a noxious stimulus, and increased spasticity might be the first clue that an infection is present. Conversely, one of the adverse effects of spasticity is the causation of pressure ulcers secondary to the shear-generated erosion of skin associated with repeated episodic and convulsive muscle spasms. As such, controlling spasticity is essential in the prevention and treatment of pressure ulcers.

The results of this study show that ON neurolysis with phenol controlled spasticity and that buttock pressure was reduced as the level of spasticity was reduced. Thus, this treatment might have a crucial function in the prevention and treatment of pressure ulcers, breaking the vicious cycle between spasticity and pressure ulcers. Neurolysis of the ON is commonly used for the treatment of hip adductor spasticity.^{13,19} Phenol is primarily used for this intervention as a neurolytic agent.²⁰ It is a non-selective destructive agent that damages nerves proportionally with the amount used. This study examined the efficacy of a promising treatment method for hip adductor spasticity in SCI patients.

The retrospective nature of this study is its primary limitation. Lack of a control group, small patient population, and the lack of long-term follow-up are additional limitations related to the study design. Also, as a subjective

method of spasticity, reliability of Modified Ashworth Scale may be another limitation. Despite these limitations, the results obtained appear to be of value. In conclusion, phenol ON neurolysis is a promising treatment for hip adductor spasticity in SCI patients. This treatment also had positive effects on BSIP, which has a crucial function in the development of pressure ulcers. Prospective, randomized clinical trials are required to more definitively determine the efficacy of ON neurolysis with phenol on the distribution of BSIP.

Conflict of interest

The authors declare no conflict of interest.

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