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Case Report Open Access

Usefulness of Coupling Transcutaneous Electrical Nerve Stimulation with Routine Physical Therapy in Spinal Spasticity with Intolerant Drug Side-effects: A Case Report

Win Min Oo[1*] **and Myat Thae Bo**[2]

[1]*Department of Physical Medicine and Rehabilitation, University of Medicine, Mandalay, Myanmar*

[2]*University of Medicine, Mandalay, Myanmar*

[*]**Corresponding author:** Win Min Oo, Physiatrist, Department of Physical Medicine and Rehabilitation, University of Medicine, Mandalay, Myanmar, Tel: +86-10-13521069552; E-mail: winminoo@ummdy.com

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Abstract

Spasticity is a common complaint in patients with spinal cord injury. Clinically, spasticity is characterized by increased muscle tone, exaggerated tendon reflex, frequent muscle spasm and clonus. We report a case of worsening spasticity in a patient with incomplete cervical spinal cord injury (ASIA B) as a consequence to urinary tract infection. The initial baclofen dose of 5 mg/dose three times per day was increased to 15 mg/dose three times/day with dosage increment at 3-day intervals by 15 mg (5 mg/dose). Marked weakness and vertigo was reported. He continued to suffer from severe spasms and trunk tightness that limited his daily activities and induced intolerable pain. The Modified Ashworth Score was increased from 1+ initially to 3, and the Pen Spasm frequency Score deteriorated from initial 1 to 3. After eradication of urinary tract infection with ciprofloxacin, spasticity did not improve, and so was administered with high-frequency transcutaneous electrical nerve stimulation at the parameters of frequency 100 Hz, pulse-width 0.2 millisecond, intensity 15 mA for the duration of 60 minutes for 3 weeks, coupling with routine physical therapy. After 3 week of TENS therapy, final Modified Ashworth Score reduced to 1+ , and Final Penn Spasm frequency Score was decreased to 2 with much improved quality of life. We also discuss the role of coupling transcutaneous electrical nerve stimulation with physical therapy in spinal spasticity.

Keywords: Spasticity; Spinal cord injury; Transcutaneous electrical nerve stimulation; Spasm; Muscle tone

Abbreviation

ASIA: American Spinal Injury Association; SCI: Spinal Cord Injury; TENS: Transcutaneous Electrical Nerve Stimulation; UTI: Urinary Tract Infection

Introduction

Spinal cord injury is a devastating event that can severely affect every aspect of a person's life. It is a traumatic insult to the spinal cord with the resultant change in normal motor, sensory and autonomic functions. Spasticity is a common disorder, and estimated to develop in 65% to 78% of the patients with spinal cord injury (SCI) [1,2]. Of these patients, 40% to 60% describe it as clinical impairment and about 50% report it necessary for drug treatment [3].

Classically, spasticity is characterized by a velocity-dependent increase in tonic stretch reflexes with exaggerated tendon jerks, resulting from hyperexcitability of the stretch reflex [4].

Successful treatment of spasticity is still a therapeutic challenge. Suboptimal treatment may result in serious complications such as permanent deformity, and so the timely treatment is essential [5,6].

Various treatments have been recommended to reduce spasticity, including physiotherapy, pharmacotherapy and surgical treatment. Methods such as drug therapy, chemical nerve block or surgical treatment reduce spasticity but may also cause muscle weakness [7]. Priority is usually given to the most conservative measures with the fewest side-effects [3].

Transcutaneous Electrical Nerve Stimulation (TENS) is cheap, portable and simple to use at home. It has no side-effects such as muscle weakness, central nervous system depression found in oral medications. It does not have invasiveness and pain found in nerve block and surgical procedures. It can be used alone or as a supplement to systemic medications to reduce side-effects by reducing drug doses [8].

Previous studies report that a combination of TENS to physical therapy improves spasticity in spinal cord injury patients [9,10]. In addition, recent randomized control trial has demonstrated the effectiveness of coupling TENS to physical therapy in sub-acute spinal cord injury patients [11]. We described this case report who suffered from the spinal cord injury last five months ago due to road traffic accident, and developed worsening muscle hypertonia and spasms of lower limbs after recurrent urinary tract infection. We discuss the role of TENS to reduce the muscle hypertonia and spasm in this patient, combining with the routine management with physical therapy.

Case Presentation

A 55-year-old man had previously suffered a traumatic cervical spinal injury (C7 Level) resulting in incomplete quadriparesis. After hospital admission at neurosurgical ward, he was originally treated with anterior discectomy and fusion. The patient initially recovered and obtained improvements in muscle power in both the upper and lower limbs. He was able to walk again a few weeks after the surgical

intervention. Then, he was transferred to rehabilitation ward for further physical therapy. On initial neurological examination, sensory level was C7 on right side and C8 on left side. On manual motor testing, on right side, wrist extensors had power of 5/5 while elbow extensors had the grading of 3/5 and the other descending muscles had 0/5. On left side, the motor testing showed power grading of 5/5 in elbow extensors, 3/5 in the finger flexors and 0/5 in the lower muscles. He spared perianal sensation and graded as AISA B. Regarding with the spasticity, he had Modified Ashworth Score 1. Later, he gradually developed increasing spasticity of the trunk and extremities (especially the lower limbs) and was provided with titration of his initial oral baclofen dose from 5 mg/dose three times per day to 15 mg/dose three times per day with dosage increment at 3-day intervals by 15 mg (5 mg/dose), which caused marked weakness and vertigo. Manual muscle testing during baclofen therapy showed power of 4/5 in wrist extensors on right side and grading of 4+/5 in elbow extensors while the other muscle group remain the same. He suffered from severe spasms and trunk tightness that limited his daily activities and induced intolerable pain.

The Modified Ashworth Score was increased from 1+ initially to 3, and The Pen Spasm frequency Score deteriorated from initial 1 to 3. On searching for aggravating factor, Urinary Tract Infection (UTI) was implicated, and an urophysician was consulted who prescribed the patient with ciprofloxacin 500 mg bd for 10 days according to the culture and drug sensitivity results. After successful treatment and eradication of UTI, spasticity was not decreased and patient has persistent complaints of spasms and spasticity.

He was informed about the study of TENS for the reduction of spinal spasticity, and gave consent to be recruited and prescribed with high-frequency TENS at the parameters of frequency 100 Hz, pulse-width 0.2 ms, and intensity 15 mA for the duration of 60 minutes for 3 weeks. A portable dual-channel TENS/ES combo and 2 pairs of standard disposable self-adhesive square electrodes (44cm) were used for TENS administration.Electrodes from each channel were applied to each common peroneal nerve (L4-S2) in such a way that the first anode electrode was placed posterior to the head of the fibula and the second cathode electrode was applied over the deep peroneal nerve 2cm lateral to the tibial bone and 2cm below the head of the fibula.The stimulation was simultaneously delivered to both common peroneal nerves of the patient in the supine position using the symmetric biphasic rectangular waves, always before physical therapy. After every treatment session, electrodes were removed from the patient and the skin was cleaned and checked for any skin irritation.

He was also administered with routine physical management, focusing on education about spinal spasticity, triggering factors, proper positioning, and heel cord stretching exercises. After 1-week of combined therapy, the Modified Ashworth Score decreased to 2 and Pen Spasm frequency Score improved to 2. After 3 weeks, final Modified Ashworth Score reduced to 1+, and Final Penn Spasm frequency Score was 2. Then, he continued the routine physical management. On evaluation at 1 week later, the patient showed no more severe spasm and his quality of life improved.

Discussion

Urinary tract infection (UTI) is responsible for major morbidity and mortality in spinal cord injury (SCI) patients. Several factors appear to be responsible for an increased risk of infection in the neurogenic bladder. Incomplete voiding, elevated intravesical pressure and catheter use increased the risk of symptomatic urinary tract infection. While classic symptoms of UTI include dysuria, increased frequency and urgency, neurogenic bladder patients can present differently with increased spasticity, autonomic dysreflexia, urinary incontinence, and vague pains [12].

Spasticity (hypertonia) develops when an imbalance in excitatory and inhibitory inputs lead to hyperexcitability of alpha motor neurons occurs [13]. Muscle tone is maintained by regulation of stretch reflex arc which is balanced between the inhibitory influences by corticospinal tract and dorsal reticulospinal tract, and the facilitatory influences (on extensor tone) by medial reticulospinal and verstibulospinal tract (supraspinal control) [14]. Mechanism of spasticity is commonly explained by the combination of the following neurophysiological phenomena [15].

a) Presynaptic inhibition of Ia afferent terminals.

b) Disynaptic reciprocal Ia inhibition from muscle spindle Ia afferents from the antagonist muscles.

c) Recurrent inhibition via renshaw cells.

d) Non-reciprocal Ib inhibition from Golgi tendon organs.

e) Inhibition from muscle spindle group II afferents

Spasticity is a clinical diagnosis. Assessment of spasticity includes identification of which muscles or muscle groups are overactive and determination of the spasticity effect on all aspects of patient function such as activities of daily living (ADLs), mobility and employment [3].

Measurement methods for the severity of spasticity can be divided into clinical methods, biomechanical methods and electro-physiological methods. The clinical methods which are commonly used in clinical practice are rating scales such as “Modified Ashworth” [0: no increased tone, 1: mild increased tone (at the end range of motion), 1+: mild increased tone (less than half of range of motion) 2: major muscle tone increase (most of range of motion), but the limb may be easily flexed, 3: increased muscle tone, difficulty for passive mobilization, 4: total limb stiffness in flexion or extension] [16]; “Penn” (0: no spasm; 1: mild spasm with stimulation, 2: strong irregular spasms, less than one per hour, 3: more than one spasm per hour, 4: more than 10 spasms per hour) [17].

The successful management of spasticity can be a therapeutic challenge. Spasticity can assist weakened legs, permit transfer ability, and improve bed mobility. Therefore all spastic patients do not need treatments. It should be treated when it causes pain, difficulty in performing daily living activities, impaired mobility, poor joint positioning, increased risk of contracture, and skin breakdown [3].

The American Spinal Injury Association (ASIA) classification of SCI (severity) and level of injury may predict the likelihood of developing spasticity. In individuals with cervical SCI, symptoms of spasticity occur in 93% of ASIA A patients and 78% of ASIA B– D patients. However, in individuals with thoracic SCI, spasticity is found in 72% of ASIA A patients and 73% of ASIA B–D patients [2].

The mechanism of TENS in spasticity reduction is hypothesized to be mediated (1) by modulating excessive alpha motor neuron activity by releasing dynorphin [18] and (2) by inducing synaptic reorganization by increasing afferent sensory inputs [19]. Large fiber afferent stimulation by TENS therapy can modify interneuronic activities in several spinal segments through segmental and propriospinal pathways, with a net increase in inhibitory mechanisms

such as reciprocal inhibition and presynaptic inhibition [20]. Recently there is evidence in animal study that high-frequency TENS at 90% motor threshold alleviates spasticity in rats with SCI by inhibiting activated microglia [21].

Therefore, TENS coupled with routine physical therapy would be practical during sub acute SCI rehabilitation. In addition, it is synergistic in mechanism of action because, at least theoretically, the neural component of spasticity would respond to TENS and the biomechanical component of spasticity would respond to physical therapy [22].

Conclusion

Transcutaneous electrical nerve stimulation is useful and safe adjuvants in spinal patients which cannot tolerate the side-effects of anti-spastic drugs.

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