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The Effects of Robotic Rehabilitation on Spasticity in Spinal Cord Injury: Current Evidence and Methodological Limitations

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Dear Editor,

Spinal cord injury (SCI) causes irreversible motor and sensory impairments. Spasticity and pain are consequences of SCI that affect quality of life. Severe spasticity negatively impacts the patient's walking and motor functions, leading to pain and a reduced quality of life. For this reason, it is important to identify treatment strategies that can reduce spasticity in individuals with SCI. Restoring walking function is one of the goals of rehabilitation, particularly for individuals with incomplete SCI.[1]

Robot-assisted gait training (RAGT) is one of the methods increasingly used in the rehabilitation of individuals with SCI. RAGT is effective in improving gait functions by enabling the performance of repetitive and task-oriented movements.[1-3] Among the RAGT systems in use today are the Lokomat (Hocoma AG, Switzerland), the G-EO system™ (Reha Technology AG, Switzerland), Walkbot (P&S Mechanics Co., Ltd., South Korea), and ReoAmbulator™ (Motorika, Inc., U.S.), as well as wearable robotic exoskeletons such as EksoGT (Ekso Bionics, U.S.) and Indego (Parker Hannifin, U.S.).[4,5] There are differing findings in the literature regarding the benefits of this treatment on spasticity a condition commonly observed in SCI that significantly affects daily life.[1-3] In a meta-analysis published by Fang et al. in 2020, 18 studies involving a total of 301 participants were evaluated; the results of the non-randomized studies reported that robot-assisted gait training improved spasticity in individuals with SCI.[1] In contrast, a meta-analysis published by Park et al. in 2024 indicated that, in three studies, RAGT was no more effective than traditional rehabilitation in reducing spasticity.[2] In a meta-analysis published by Sun et al. in 2026, it was noted that control interventions might be more effective than RAGT in reducing muscle tone in SCI; however, it was also noted that this finding might be attributable to the selected studies.[3] In a study published by Pournajaf et al. in 2026, a reduction in lower extremity spasticity was reported following wearable exoskeleton-assisted gait training in SCI patients.[5] These differing findings across studies make it difficult to draw a definitive conclusion regarding the effect of RAGT on spasticity. Furthermore, when evaluating these results, it is important to consider that the studies may differ in terms of patient characteristics, the rehabilitation protocols used, and the methods employed to assess spasticity.

The Modified Ashworth Scale (MAS), which is widely used in clinical practice to assess spasticity, evaluates the resistance to passive movement. However, this resistance can be influenced by the characteristics of surrounding tissues, such as muscles and soft tissues. Non-neural factors, such as the elastic and viscous properties of muscle, also affect resistance to passive movement. For this reason, neural and non-neural factors must be examined separately when assessing spasticity.[6]

Baunsgaard et al. examined the reliability of the Modified Ashworth Scale (MAS) and the Spasm Frequency Score (SFS) in SCI, as well as the relationship between them; they reported that the reliability of the MAS was influenced by the statistical weighting method used, while the SFS demonstrated high reliability.[7] Furthermore, no consistent or meaningful correlation was found between the two scales. Therefore, interpreting the effects of RAGT on spasticity solely based on MAS scores may result in an incomplete assessment in terms of spasm frequency and the symptoms patients experience in their daily lives.

The Modified Tardieu Scale, one of the methods used to assess spasticity, determines the presence and severity of spasticity by mea-

suring muscle responses to passive stretching at different speeds. This feature better reflects the speed-dependent nature of spasticity.[8] The Spinal Cord Injury Spasticity Evaluation Tool measures the impact of spasticity on daily life.[9] The combined use of these different assessment methods can provide a more comprehensive evaluation of spasticity.

Because spasticity in individuals with SCI is influenced by various factors, its severity fluctuates over time. Constipation, bladder fullness, urinary tract infections, tight clothing, pain, and pressure sores can increase the severity of spasticity.[10] Therefore, these factors should not be overlooked when evaluating the effects of RAGT on spasticity.

Another important point is that the impact of spasticity on daily life should also be assessed. Spasticity can lead to pain, sleep problems, sexual dysfunction, and difficulties with activities of daily living such as personal care and transfers. However, spasticity also has benefits, such as facilitating functions like standing, sitting, and walking, increasing venous return, and protecting against muscle atrophy.[10] For this reason, a reduction in spasticity should not always be assumed to equate to a functional gain. When evaluating the effects of robotic rehabilitation, one should consider not only changes in scale scores but also how these changes impact the patient's mobility, independence, and quality of life.

In conclusion, the current findings regarding the effects of RAGT on spasticity in SCI are insufficient to reach a definitive conclusion. For this reason, in future randomized controlled trials, taking into account muscle tone, spasm frequency, speed-dependent muscle response, the impact on the patient's daily life, and clinical factors that may influence spasticity during spasticity assessment may contribute to a better understanding of the changes observed following RAGT.

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