**Commentary**
Volume 9:5, 2022

International Journal of Neurorehabilitation

ISSN: 2376-0281

Open Access

# After a Spinal Cord Injury, a Model for Respiratory Rehabilitation Using Diaphragm Pacing

**Fuller David***

*Department of Neurology, University Clinic of Navarra, Faculty of Medicine, University of Navarra, Pamplona, Spain*

## Description

Following spinal cord injury, respiratory failure is a major factor in sickness and death (SCI). The risk of respiratory dysfunction and its accompanying complications, such as pneumonia, atelectasis, and respiratory failure, is highest in those with cervical spinal cord injury (CSCI). The higher cervical segments (C1-C5) are involved in over 40% of SCI cases, which affect the phrenic system neurologically and weakens diaphragm activation. Therefore, it is vital to take into account respiratory rehabilitation strategies that can be applied in rehabilitation care settings. The use of intramuscular diaphragm stimulation, also known as diaphragm pacing (DP), for people with CSCI are covered in this viewpoint article. We also present a theoretical framework for respiratory rehabilitation and recovery (RRR) that includes DP use tactics [1].

Mechanical ventilation is the current gold standard of care for treating acute respiratory dysfunction after CSCI (MV). Despite being a life-saving strategy, it can have serious drawbacks, including quick and substantial diaphragm atrophy, increased infection rates, and a greater dependency on long-term MV. Mechanical ventilation is the current gold standard of care for treating acute respiratory dysfunction after CSCI (MV). Although this is a life-saving strategy, it may also have serious drawbacks, including quick and substantial diaphragm atrophy, increased infection rates, and a greater dependency on long-term MV.

Improved respiratory function and MV weaning are encouraged by intramuscular diaphragm stimulation, or DP, which lowers problems. This method entails laparoscopic insertion of intramuscular electrodes in each hemidiaphragm, close to the phrenic nerve insertion. To give stimulation at a rate and intensity that are specific to each patient, the electrode wires are externalised and attached to a pulse generator. In the past, DP has been applied to chronic SCI cases to facilitate MV liberation. However, the use of DP acutely following CSCI is currently expanding in order to speed up the process of weaning patients off of MV and promoting quicker shifts from acute hospitalisation to sub-acute rehabilitation care settings. According to recent reports, certain trauma centres now systematically assess all patients with acute traumatic CSCI who are admitted for DP implantation. A growing body of research shows that DP systems improve recovery of independent breathing function and diaphragm muscle health as a result of their increased use and earlier implantation. The potential advantages of DP may not come as a surprise given that electrical stimulation has been shown to effectively prevent skeletal myofiber atrophy due to inactivity [2].

As knowledge and use of DP expand, focus should be given to the development of rehabilitation models tailored to the particular conditions and requirements of the target patient population. The creation of goals, the creation of service standards, and the identification of research priorities are all framed by rehabilitation models. The use of DP has not yet been taken into consideration as a part of SCI care and rehabilitation, despite the fact that there are numerous rehabilitation models for SCI care and weaning from MV30–32. This perspective piece aims to: (1) discuss developments in the use of DP, possible side effects of diaphragm stimulation, and consideration of DP as an adjunctive rehabilitation strategy; (2) introduce a conceptual model for RRR focused on people with CSCI who may need DP due to severe respiratory impairment; and (3) describe application of the model in an inpatient SCI rehabilitation programme.

## Advancements in Diaphragm Pacing Post-SCI

To encourage MV weaning and reduce MV-related problems, DP has started to be applied immediately following CSCI. The ability to shift from intensive care facilities to less acute settings and from acute to subacute care settings, where intensive rehabilitation can be the focus, is another advantage of using MV early in the course of care. Gains in respiratory function, a return to voluntary diaphragm activation (measured by indwelling wires), and the ability to breathe independently without the use of DP are all linked to acute DP use. These signs that DP may be helpful are not limited to SCI situations. For instance, in patients with Pompe disease, a rare but severe neuromuscular illness where respiratory failure frequently necessitates ventilator dependence, enhanced respiratory function, decreased ventilator reliance, and higher voluntary diaphragm activation were described after DP. Diaphragm stimulation may be a useful rehabilitation method with advantages beyond maintaining respiratory rhythm and use as a replacement for MV, according to the observed gains in function and patient outcomes linked to DP use [3].

## Effects of Stimulation on Diaphragm Function and Respiratory Pathways

By directly affecting the diaphragm myofibers and stimulating sensory afferents, DP has the potential to be used as a rehabilitation technique. Given that VIDD is linked to diaphragm atrophy using DP to avoid diaphragm inactivity may be advantageous. Studies performed during acute surgical operations demonstrate that direct electrical stimulation of the diaphragm enhances contractile force and mitochondrial activity, lending support to this idea. Therefore, it is likely that enhanced diaphragm muscle health accounts for at least some of the physiological advantage of DP.

There are various hypotheses regarding a potential neurological influence of DP and subsequent neuroplastic alterations. First off, the forceful diaphragm contractions brought on by DP will undoubtedly stimulate the diaphragm's sensory afferents. Large-diameter myelinated (groups Ia, Ib, and II), small-diameter myelinated (group III), and unmyelinated axons are among the numerous sensory afferents found in the phrenic nerve (group IV). Numerous fibres with a smaller diameter release often during the respiratory cycle. Group I and II afferents can stimulate or inhibit diaphragm output, whereas group III and IV phrenic afferent activation increases diaphragm activity. Therefore, DP has the ability to trigger neuroplastic alterations in the neurons and networks that regulate the diaphragm through the repeated activation of sensory afferents. The trophic relationship between motoneurons and the

***Address for Correspondence:** Fuller David, Department of Neurology, University Clinic of Navarra, Faculty of Medicine, University of Navarra, Pamplona, Spain, E-mail: davidful@yahoo.com*



**Received:** 03 May, 2022, Manuscript No. ijn-22-67653; **Editor assigned:** 06 May, 2022, PreQC No. P-67653; **Reviewed:** 17 May, 2022, QC No. Q-67653; **Revised:** 24 May, 2022, Manuscript No. R-67653; **Published:** 30 May, 2022, DOI: 10.37421/2376-0281.2022.9.464

muscle fibres they innervate is a further factor to be taken into account. Due to this connection, diaphragm motor unit health may be impacted by phrenic motoneuron activation during DP [4].

## Model of Respiratory Rehabilitation and Recovery

Our suggested RRR paradigm focuses on two overarching, connected objectives: (a) restoration of breathing function and independence; and (b) encouragement of lifelong respiratory health. The two objectives serve as the model's outer framework, and bidirectional arrows show how they are interdependent. At the model's centre are overlapping circles that symbolise the model elements that help achieve these objectives. A multidisciplinary team, quantitative evaluation, training and treatment, and supplementary treatments are among these elements (ie, DP). The model shows these elements as overlapping because they should work together synergistically to, for example, improve outcomes and enable patient engagement in intensive rehabilitation interventions that are supported by quantitative measurement and further enhanced by adjunctive rehabilitative approaches like DP. This is consistent with the definition of pulmonary rehabilitation provided by the American Thoracic Society/European Respiratory Society, which describes it as a comprehensive intervention that includes exercise training and is provided by an interdisciplinary team in order to enhance function, quality of life, and long-term adherence to health-improving behaviours [5].

## Conclusion

In conclusion, there is a need and opportunity to progress patients' recovery because DP use among those with acute CSCI is increasing. As the "task" or rhythm of breathing is stimulated and facilitated, diaphragm stimulation, especially early after injury, may promote diaphragm muscle health, improve respiratory function, and potentially produce a rehabilitative or neuroplastic effect (ie, task-specific training and induction of activity-dependent plasticity). Combinatorial methods are becoming more and more popular, especially when combined with rehabilitation. Patients are transferring to rehabilitation care settings sooner with the use of DP early after injury. There are signs that DP may be an effective rehabilitation therapy, even if more research is still required to fully understand how it helps with respiratory recovery and to develop new respiratory rehabilitation techniques. We therefore stand at a crossroads: either we conceive how to maximise the use of the device to promote rehabilitation outcomes and integrate concepts and evidence to improve respiratory function following CSCI, or we choose to ignore it from a rehabilitation standpoint. The RRR model should serve as a solid foundation for developing respiratory rehabilitation, recovery, and lifelong respiratory health, we believe.

## Conflict of Interest

None.

## References

1. Brown, Robert, Anthony F. DiMarco, Jeannette D. Hoit, and Eric Garshick. "Respiratory dysfunction and management in spinal cord injury." *Respir Care* 51 (2006): 853-868.
2. Fishburn, M.J., R.J. Marino, and J. F. Ditunno Jr. "Atelectasis and pneumonia in acute spinal cord injury." *Arch Phys Med Rehabil* 71 (1990): 197-200.
3. Chen, David, David F. Apple Jr, Lesley M. Hudson, and Rita Bode. "Medical complications during acute rehabilitation following spinal cord injury—current experience of the Model Systems." *Arch Phys Med Rehabil* 80 (1999): 1397-1401.
4. Fuller, David D., Francis J. Golder, E. B. Olson Jr, and Gordon S. Mitchell. "Recovery of phrenic activity and ventilation after cervical spinal hemisection in rats." *J Appl Physiol* 100 (2006): 800-806.
5. Lane, Michael A. "Spinal respiratory motoneurons and interneurons." *Respir Physiol Neurobiol* 179 (2011): 3-13.

**How to cite this article:** David, Fuller. "After a Spinal Cord Injury, a Model for Respiratory Rehabilitation Using Diaphragm Pacing". Int J Neurorehabilitation Eng 9 (2022): 464.