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Weaning Complete Cervical Cord Injury Patients from Mechanical Ventilator Support– A Case Series

Jayaprakash Jayavelu[1], Sachin Jain[2], Satheesh Durairaj[3]

Abstract: ***The purpose of this case series report is to explain the different strategies followed in weaning the cervical cord injury patients from ventilator. Case I: A 53-year-old female admitted with history of fall on 01/04/14 with C3-C4 grade III subluxation. C4 corpectomy with C3-5 fusion was done. Chest physiotherapy comprising of percussion, vibration, manual hyperinflation and suctioning was done every 4 hours. Inspiratory muscle training with manual facilitation, Power Breathe, and inspiratory spirometer was done regularly and patient was removed from ventilator on regular intervals. After 8 months, the patient was completely weaned from ventilator. Case II: A 57-year-old male admitted with traumatic C4-5 and C5-C6 PIVD. C4-5 and C5-6 microdiscectomy and reduction stabilization of C4-C5 subluxation. One year after the trauma, patient was admitted in the hospital and decannulated. The Cough was facilitated with cough assistive devices and manual facilitation. Conclusion: Based on the case series it is observed that patients with high cervical cord injury can be weaned from ventilator and can be de-cannulated if the patient was provided intensive inspiratory muscle training using various types of inspiratory muscle training devices and training methods as well as facilitating cough capacity by use of cough assist devices.***

Keywords: Spinal Cord Injury, Inspiratory Muscle Training, Expiratory Muscle Training, Cough Capacity

1. Introduction

The global incidence of Spinal Cord Injury (SCI) varied from 8.0 to 246.0 cases per million inhabitants per year. The global prevalence varied from 236.0 to 1,298.0 per million inhabitants[1]. Mortality and morbidity after spinal cord injury depends on the level of injury, type of injury, post traumatic care and socioeconomic status of the family for providing adequate care for the patients. Most importantly, morbidity can be reduced by measures taken to prevent complications of the bed rest. Some of the complications include bed sore, deep vein thrombosis, respiratory infection, urinary tract infection and depression depending on the severity of the injury. The need for ventilator support for patients with spinal cord injury depends on the grade and level of injury.[2]In retrospective review, ventilator dependency was the strongest negative predictor of survival during the first year after hospital discharge, with respiratory complications accounting for 31% of deaths.[2]

The prevalence of long term ventilation has risen significantly over the last two decades.[2]

Respiratory function requires careful attention in patients with cervical spine injuries.[3] Voluntary respiratory control is usually possible with lesions below C4 level although paralysis of the abdominal musculature results in a decreased ability to cough and to clear secretions, which may later lead to respiratory insufficiency. Therefore, injuries above C5 usually necessitate long term mechanical ventilation.[3]

The incidence of ventilator dependence in patients with injuries at the C1 to C4 levels has been reported to be 40%. [4] In a retrospective review, Oo et al demonstrated that 7 of 33 patients with C1 to C4 SCI and diaphragmatic paralysis weaned from the ventilator in 40 to 292 days.[4] Wicks AB et al stated that there is 85% success in weaning at levels C4 and below, 60% success at C3, 28% at C2 and 15% at C1. [3]

Various measures can be taken to improve the inspiratory capacity and to wean the patient from ventilator as well as measures taken to improve the cough capacity of the patient and to decannulate the patient.There are four training principles that have been established for all skeletal muscles: overload, specificity, adaptation and reversibility. These also apply to respiratory muscles.

Inspiratory muscle training includes increasing the trigger threshold in ventilator setting, diaphragmatic facilitating exercises, intercostal muscle facilitation, flow based incentive spirometer, volume based incentive spirometer, Power Breathe, threshold devices, and resistance training in 15 degrees inclined position

Shila Amarsheda[6] et al analysed the efficacy of Inspiratory Muscle Trainer and Incentive Spirometer on Inspiratory Muscle Strength in patients with tetraplegia in Indian Setting and found that inspiratory muscle trainer is effectivethan incentive spirometry in improving inspiratory muscle strength inquadriplegics.

Expiratory muscle training is equally important to improve the cough capacity and to maintain chest hygiene. Cough assistive devices can also be used to facilitate cough

Resistance training of expiratory muscles has been proven to improve the Maximum Expiratory Pressure in spinal cord injury patients.[4]

The purpose of this case series report is to explain the different strategies followed in weaning the high cervical cord injury patients from ventilator, different types of inspiratory and expiratory muscle devices available as well as measures taken to decannulate the patient and measures taken for facilitating cough.

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Figure 1: The Boehringer High Pressure Inspiratory Force Meter

2. Case I

The 53-year-old female was admitted with the history of fall and inability to move all 4 limbs on 01/04/14. The patient was conscious at the time of admission and there is no evidence of head injury.

On examination, the patient was conscious, alert and oriented to time, place and persons. Build was normal. Her vitals was stable. Tone and Reflexes were absent in all 4 limbs. Power in all 4 limbs was 0/5. Sensation was absent below C4 level. There was no anal tone and perianal sensation was also absent. MRI Cervical spine suggestive of C3-C4 grade III subluxation with anterior translation of C3 vertebral body. C4 corpectomy with C3-5 fusion using meshed cage and plate and screws was done on Day 2.The patient on controlled mode of ventilation. The patient was tracheostomized on Day 4. The patient underwent regular passive chest physiotherapy along with inspiratory muscle training three times a day. On Day 80, the patient was put on dual chamber permanent pacemaker since the patient had bradycardia and hypotension. The patient had difficulty in weaning and sent to the room with the portable ventilator. Passive chest physiotherapy comprising of percussion, vibration, manual hyperinflation and suctioning was done every 4 hours to maintain chest hygiene. Inspiratory muscle training with manual facilitation, Power Breathe, and inspiratory spirometer was done in regular intervals and patient was removed from the ventilator for 10 minutes on regular intervals

Figure 2 and 3: MRI Cervical Spine of the Patient

Inspiratory muscle training was done to improve the strength of diaphragm and facilitate reflex activity of intercostal muscles. PNF techniques were followed to facilitate the intercostal muscles and accessory muscles. The patient was initially weaned for 10 minutes 3 to 4 times a day. Gradually, weaning period was increased to 15 to 20 minutes 4 times a day. The patient was then discharged on portable ventilation on Day 93. The physiotherapy was continued at home. Inspiratory muscle training, passive chest physiotherapy in postural drainage position and mobilization was done regularly at home. The home care nurse and the patient's family member were educated to repeat the session 3 to 4 times a day. After 6 months, the patient was weaned off from ventilator completely during the day. After 8 months, the patient was completely weaned from ventilator.

After 32 months post injury, the patient was alert, oriented, speaking through the speaking valve. Neck Control was good. Tone in the limbs increased. Power in all 4 limbs was 0/5. Sensation was absent below C4 level. Perianal sensation was also absent.

3. Case II

A 57-year-old male admitted with history of traumatic C4-5 and C5-C6 PIVD, cord contusion and inability to move all 4 limbs. The patient was operated in the private hospital on 31/5/11 (Day 1) (C4-5 and C5-6 anterior microdiscectomy and reduction stabilization of C4-C5 subluxation) and he was transferred to Medanta Institute of Neurosciences for further evaluation and management.

On admission, the patient was tracheostomized, unable to move all 4 limbs and on mechanical ventilator support with hypotension. Sensory loss below C4 dermatome level. Power in all 4 limbs was 0/5. Perianal sensation was also absent.The patient was put on ionotropes. The patient HRCT chest done showed right lower lobe atelectasis. Bronchoscopy was done.

Figure 4: MRI Cervical Spine of the patient

The patient underwent intensive physiotherapy comprising of measures to improve the chest hygiene and measures to prevent complications of bed rest. Chest physiotherapy measures included passive chest percussion and vibration in

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modified postural drainage position. On Day 33,the patient was put on BIPAP mode of ventilation. Subsequently with inspiratory muscle training, the patient was weaned off from ventilator, 7 weeks post trauma. The cough effort was poor.

Intensive inspiratory muscle training was done with Power Breathe and PNF facilitatory techniques. In order to hypertrophy the diaphragm, the resisted exercises was done in 15 degrees in head tilt position. The cough was facilitated with manual support, abdominal binder. The patient was discharged from hospital with tracheostomy tube in situ in 6 months. Detailed instructions were given to patient's family member, home care nurse and home physiotherapist.

One year after the trauma, patient was re-admitted in the hospital and decannulated. The Cough was facilitated with cough assistive devices and manual facilitation

Figure 5: Power Breathe

Figure 6: Complete Cervical Cord Injury patient doing Inspiratory

4. Muscle Training with Power Breathe

Figure 7: Inspiratory Muscle Trainer

Figure 8: Cough Assistive Device

5. Discussion

In cervical spinal cord injury, the main focus of treatment should be on respiratory function in order to reduce the morbidity and mortality. Many of these patients are tracheostomized and dependent on ventilator. Claxton et al found in his study that spinal cord injuries of C5 and above predicted the need for supported ventilation. Harrop et al found that 79% of their complete cervical spinal cord injuries above the level of C5 underwent tracheostomy. [3]

Primary muscle of inspiration is diaphragm, innervated by phrenic nerves (C3-C5). External intercostal muscles innervated by intercostal nerves (T1-T2) provides additional inspiratory effort. Accessory muscles consists of sternocleidomastoid (accessory nerve C1-2), trapezius (C1-4), scalene and pectoralis (C4-8) muscles. Inspiration is caused by contraction of diaphragm and external intercostal muscles. The accessory muscles are recruited in exertional activity. The internal and external oblique muscles (T7 to T12), the transverse abdominus (T7 to L1), the rectus abdominus (T7 to L1), and the lateral intercostal muscles (T1 to T12) are expiratory muscles and they work during forced expiration since normal expiration is mostly passive process. Therefore, complete high cervical cord injury patients above C3 level have complete loss of inspiratory and expiratory capacity. Moreover, abdominal muscles paralysis impair the cough ability and airway clearance, leading to respiratory insufficiency.[3]

Cervical spinal cord injury (SCI) resulting in chronic respiratory failure is a common clinical problem. Of the 5,000 to 6,000 new cervical spinal cord injuries reported each year, nearly 20% will require mechanical ventilation (National Spinal Cord Injury Statistical Center, 2012). While most patients can eventually breathe spontaneously, approximately 5% (200–400 per year) will require chronic mechanical ventilatory support. [7]

A. William Sheel et al[9]on their systemic review found that there are insufficient data to strongly support the use of exercise training or IMT for improved respiratory function in people with Spinal Cord Injury.

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Gabi Mueller et al[8]compared the effects of inspiratory resistance training (IRT) and isocapnic hyperpnea (IH) versus incentive spirometry (placebo) on respiratory function, voice, and quality of life in individuals with motor complete tetraplegia. He found that in individuals with complete motor tetraplegia, inspiratory muscle strength can be improved by IRT and is more advantageous compared to IH during the first year post injury.

Alyssa Rutchik[10] et al in their study suggested that in individuals with cervical SCI regular resistive inspiratory muscle training may result in decreased restrictive ventilatory impairment and reduced dyspnea and, thus, reduced incidence of chronic respiratory complaints and other pulmonary complications.

Diaphragm pacing is a clinically useful modality providing artificial ventilatory support in patients with ventilator dependent spinal cord injury. Since this technique is successful in providing full-time ventilatory support in only ~50% of patients, better methods are needed. High frequency spinal cord stimulation (HF-SCS) results in synchronous activation of the diaphragm and intercostal muscles. HF-SCS results in a more physiological activation of the inspiratory muscles[7]

6. Conclusion

Based on the cases reported above, it is observed that many of the patients with high cervical cord injury can be weaned from ventilator and also can be de-cannulatedif the patient was provided intensive inspiratory muscle training using various types of inspiratory muscle training devices and training methods as well as facilitating the cough capacity by use of cough assist devices and strengthening accessory muscles.

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