Resolution of Tracheostomy Complications by Decanulation and Conversion to Noninvasive Management for a Patient With High-Level Tetraplegia

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Objectives: To report conversion from tracheostomy (TIV) to noninvasive intermittent positive pressure ventilation (NIV) for a continuously ventilator-dependent patient with high-level spinal cord injury (SCI) with no measurable vital capacity (VC = 0 mL) to resolve tracheostomy-associated complications. **Methods:** A case report of a 38-year-old female in a chronic care facility in Japan with a 10-year history of ventilator-dependent tetraplegia (C1 ASIA-A) presented for increasing difficulty vocalizing. She had been using a fenestrated cuffed tracheostomy tube to produce speech with the cuff deflated. Speech was increasingly hypophonic, because of tracheostoma enlargement, tube migration, and tracheal granulation. **Results:** The NIV was provided via nasal and oral interfaces, the ostomy was surgically closed, and vocalization resumed. Airway secretions were expulsed using manually assisted coughing. The patient returned to the community. **Conclusion:** Conversion to NIV should be considered for ventilator-dependent patients with SCI who have adequate bulbar-innervated muscle function to permit effective speech and assisted coughing. **Key words:** *cough, mechanical ventilation, respiratory paralysis, spinal cord injury, tetraplegia*

In 1990, Bach and Alba[1] reported the systematic decanulation and transition of ventilator-dependent patients with traumatic high level spinal cord injury (SCI) to noninvasive intermittent positive pressure ventilation (NIV); they found that patients with intact bulbar-innervated muscle function were good candidates for the transition and were able to master glossopharyngeal breathing for ventilator-free breathing. In 2006, a challenge was issued to model spinal cord injury units in the United States to consider decanulation of patients with high-level SCI to noninvasive management to improve safety and quality of life (QOL).[2] Thus, conventional invasive management approaches, which include tracheostomy and electrophrenic respiration, are often unnecessary.[3] We report an example of such decanulation and transition to resolve complications of tracheostomy on speech.

Case Report

A 38-year-old female with a 10-year history of ventilator-dependent tetraplegia (C1 ASIA-A) and no ventilator-free breathing ability was referred for hypophonia from a chronic care facility 600 km away. She had been dependent on tracheostomy (TIV) via a cuffed tube since her injury. Her cuff was being deflated several hours per day to permit her to vocalize. Four years prior to referral, a fenestrated cuffed tracheostomy tube had been placed (**Table 1**). One year before transfer, she underwent intratracheal granulation resection.

At presentation, she had normal mental status, no measurable VC (0 mL), no dysphagia, and no apparent lung disease. Her height was 160 cm and her weight was 45 kg. Hypophonia was due to stomal enlargement and air leakage around the tube (**Figure 1**), and the tube tended to migrate superiorly. She contrived to anchor the tube by downward pressure from a figure-of-eight band passed under the axillae. She required endotracheal suctioning 10 times per day. Profuse secretions, need for frequent suctioning, and impaired vocalization were felt to be due to the indwelling

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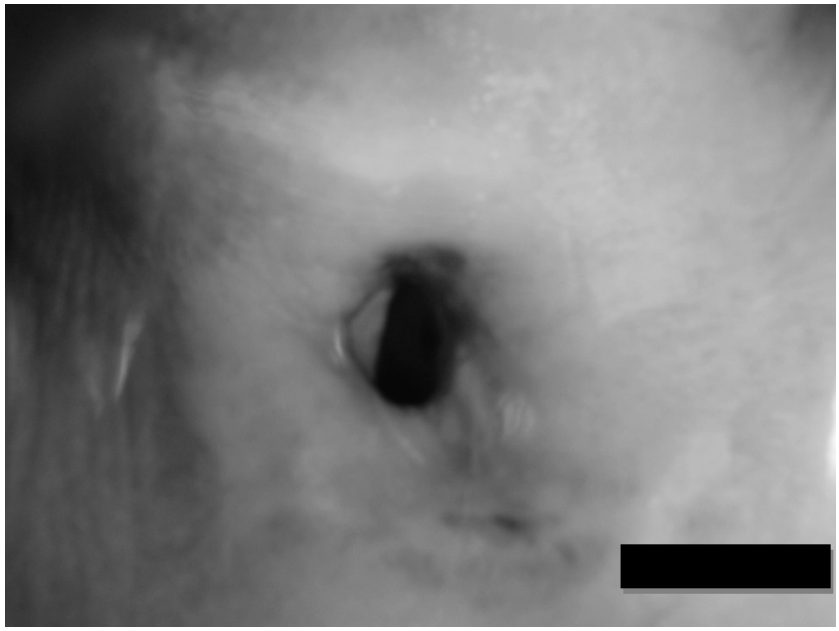

Figure 1. Superior expansion of tracheostoma of the patient due to leakage around the tube associated with poor fit and positioning.

tracheostomy tube and were motivations for its removal.

She was admitted to our facility, practiced nasal and mouthpiece NIV, and 1 month after admission was able to use NIV 24 hours a day. The ventilator settings were modified (**Table 1**). Fifty-five days after admission, her tracheostoma was surgically closed. She acquired the ability to cough forcefully by air-stacking and chest thrust.[4] Her maximal insufflation capacity was 2150 mL by air-stacking using volume-cycling NIV.[4] Assisted peak cough flows reached 300 L/min. She also mastered glossopharyngeal breathing (GPB) to a glossopharyngeal maximum single breath capacity of 1030 mL by which she could autonomously ventilate her lungs for increasing periods of time when disconnected from her ventilator.[1,5,6] The patient, family members, and caregivers were trained in adjusting ventilator settings and connections, in manually assisted coughing, in mechanically assisted coughing (MAC),[7,8] and in cardiopulmonary resuscitation.

Her previous attending physician refused to use NIV, stating that in his opinion NIV was more dangerous than TIV because of "lack of control of the upper airway." Return to a chronic care facility for respite periods, as she had been doing 3 to 4 times per year, was no longer accessible to her for the same reason. We needed several months to identify other local care providers and facilities willing to learn noninvasive management. However, she has now been successfully returned to the community using NIV continuously without complications for 10 months. She no longer requires any regular airway secretion expulsion. She was trained in and has access to MAC, a form of noninvasive airway suctioning, using the CoughAssist (Philips-Respironics International Inc.) for intercurrent respiratory tract infections or as needed. She can now vocalize effectively, enjoy social conversation, and, because of GPB, no longer has fear of ventilator failure or accidental disconnection.

Discussion

Long-term TIV is associated with many complications, including granulation formation, stomal infection, tracheomalacia, tracheal perforation, stenosis, fistulae, and hemorrhage.[9] All of these are avoided by noninvasive management.

Table 1. Ventilator settings and interfaces

	TIV	NIV
Ventilator	Achieva Plus	Newport HT50
Mode	Assist/Control	Assist/Control
Tidal volume	daytime 740 mL nighttime 600 mL	1200 mL
RR	12	12
I/E ratio	1:2.3	1:2
PEEP	0	0
FIO2	0.21	0.21
Interface	Fenestrated cuffed tracheostomy tube: I.D. 7.0 mm, O.D. 10.8 mm Inner canula: daytime fenestrated; nighttime not fenestrated Cuff air: daytime 2 mL; nighttime 4 mL	Daytime: mouthpiece or nasal prongs Nighttime: nasal prongs

Note: TIV=tracheostomy intermittent positive pressure ventilation; NIV=noninvasive intermittent positive pressure ventilation; RR = respiratory rate; I/E ratio = inspiration/expiration ratio; PEEP = positive end-expiratory pressure; FIO_2 = fraction of inspired oxygen; I.D. = inner diameter; O.D. = outer diameter.

Air-stacking, manually assisted coughing, and MAC facilitate effective expulsion of airway debris and prevent or reverse atelectasis. Freedom from tracheostomy tube irritation also eliminates the need for frequent airway secretion expulsion. Stomal closure permits use of GPB for autonomous breathing and, thus, is a back-up for ventilator failure/disconnection. Thus, high-level SCI ventilator users with functional bulbar-innervated musculature may be candidates for decanulation and conversion to NIV as part of their acute rehabilitation. This can contribute to their QOL.

Contraindications to decanulation include severe bulbar-innervated muscle dysfunction, severe concomitant lung disease, and lack of cooperation. Conversion may be indicated to improve vocalization with the use of GPB for safety. Large delivered volumes were provided both with the cuffless tracheostomy tubes and after decanulation to optimize vocalization and maintain good pulmonary compliance.[10] In Japan, small tidal volumes and cuffed tracheostomy tubes are used for most cases.

It is difficult for severely disabled individuals to seek medical care at great distances. Because there were no regional care providers experienced in these methods, reintegration into a local care system was difficult. With more widespread application of these patient-preferred and cost-saving techniques,[11,12] reintegration should become easier in the future.

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REFERENCES

1. Bach JR, Alba AS. Noninvasive options for ventilatory support of the traumatic high level quadriplegic patient. *Chest.* 1990;98:613-619.
2. Bach JR. Prevention of respiratory complications of spinal cord injury: a challenge to "model" spinal cord units. *J Spinal Cord Med.* 2006;29(1):3-4.
3. Bach JR. Noninvasive alternatives to tracheostomy for managing respiratory muscle dysfunction in spinal cord injury. *Top Spinal Cord Inj Rehabil.* 1997;2(3):49-58.
4. Kang SW, Bach JR. Maximum insufflations capacity: the relationships with vital capacity and cough flows for patients with neuromuscular disease. *Am J Phys Med Rehabil.* 2000;79:222-227.
5. Bach JR. Update and perspectives on noninvasive respiratory muscle aids. Part 1: The inspiratory aids. *Chest.* 1994;105:1230-1240.
6. Bach JR, Alba AS, Bodofsky E, Curran FJ, Schultheiss M. Glossopharyngeal breathing and non-invasive aids in the management of post-polio respiratory insufficiency. *Birth Defects.* 1987;23(4):99-113.
7. Bach JR. Mechanical insufflation-exsufflation. Comparison of peak expiratory flows with manually assisted and unassisted coughing techniques. *Chest.* 1993;104:1553-1562.
8. Gómez-Merino E, Sancho J, Marín J, et al. Mechanical insufflations-exsufflation. Pressure, volume, and flow relationships and the adequacy of the manufacturer's guidelines. *Am J Phys Med Rehabil.* 2002;81:579-583.

9. Bach JR. *Pulmonary Rehabilitation: The Obstructive and Paralytic Conditions.* Philadelphia, PA: Hanley & Belfus; 1996.
10. Consortium for Spinal Cord Medicine. *Respiratory Management Following Spinal Cord Injury: A Clinical Practice Guideline for Health-Care Professionals.* Washington, DC: Paralyzed Veterans of America; 2005.
11. Bach JR, Intintola P, Alba AS, Holland I. The ventilator-assisted individual: cost analysis of institutionalization versus rehabilitation and in-home management. *Chest.* 1992;101(1):26-30.
12. Bach JR. A comparison of long-term ventilatory support alternatives from the perspective of the patient and care giver. *Chest.* 1993;104(6):1702-1706.