Many patients undergoing major head and neck surgery require tracheostomy to maintain airway security. A significant proportion also requires admission to an intensive care unit postoperatively for respiratory support. As patients recover from their operation, they progress through stages of ventilator weaning and tracheostomy downsizing, capping, and ultimately decannulation.

Difficulty communicating is the most common distressing symptom reported by critically ill patients supported by mechanical ventilation. Panic attacks, sleep disturbances, and higher stress levels are associated with the inability to speak with high frustration while mechanically ventilated. To minimize these symptoms, a speaking valve may be placed over the tracheostomy tube to allow phonation and verbal communication.

The Passy-Muir speaking valve (PMSV) is a 1-way valve cap placed over the tracheostomy tube that allows air to pass into the lungs with inspiration but closes on expiration to direct airflow through the vocal chords enabling phonation. PMSVs have been shown to significantly improve the quality of life for patients with tracheostomies while also decreasing their risk of aspiration and infection. Additional valve benefits include improved swallow physiology, decreased aspiration, restored upper airway protective reflexes, normalized subglottic airway pressure, and improved gustation and olfaction.

Not all patients, however, can tolerate a 1-way speaking valve, commonly because of increased transtracheal pressures. Typically, this is addressed with downsizing; however, additional upper airway resistance from postoperative edema, airway stenosis, or flap bulk can also contribute. Furthermore, a large proportion of this population has underlying pulmonary disease that limits smaller diameter tracheostomy tolerance.

Two pediatric case series described related problems of upper airway resistance causing valve intolerance. This problem was addressed by drilling holes to act as a release port for excess air egress, which allowed for successful phonation and prolonged speaking valve tolerance. We describe successful replication of this modification for an adult patient after intraoral oncologic resection and free flap reconstruction.

**Summary:** Increased upper airway resistance from postoperative changes after major head and neck surgery may cause elevated transtracheal pressures and result in tracheostomy speaking valve intolerance. This may be particularly true among patients with baseline pulmonary disease. We describe a patient recovering from oral cancer resection and flap reconstruction who demonstrated prolonged ventilator dependence and tracheostomy speaking valve intolerance with abnormal tracheal manometry. We attempted to improve speaking valve tolerance through the adaptation of a valve modification intended to reduce transtracheal pressures. Drilling holes into the 1-way speaking valve allowed for excess air egress and resulted in normalization of transtracheal pressures with improved speaking valve tolerance. This 1-way speaking valve modification may serve as a simple method to allow for earlier restoration of voicing and potentially reduce the number of ventilator-dependent days in this patient population. (Plast Reconstr Surg Glob Open. 2016;4:e1082; doi: 10.1097/GOX.0000000000001082; Published online 7 December 2016.)
CASE PRESENTATION

A 66-year-old man with a history of insulin-dependent diabetes, hypertension, chronic obstructive pulmonary disease (forced expiratory volume 1 1.31 L [46%], carbon monoxide diffusing capacity 66%), active smoker (60 pack-years), and prolonged alcohol abuse was referred for biopsy-proven 3.5-cm squamous cell carcinoma of the right floor of mouth. He subsequently underwent tracheostomy with placement of a 7.0 cuffed Bivona (Smiths Medical, Dublin, Ohio), intraoral tumor resection, and right modified radical neck dissection followed by anterolateral thigh free flap reconstruction. Resection margins were negative; final pathology was T2N0M0.

Postoperative course was complicated by prolonged ventilator dependence. Assessment by speech pathology revealed limited airflow via the upper airway, and bedside transtracheal manometry demonstrated elevated pressures (30 cm H2O) well beyond the recommended range of transtracheal pressures considered optimal for valve tolerance. Supervised PMSV trials resulted in strained voicing, tachypnea, breath stacking, and respiratory distress.

Because it was unlikely that the patient would tolerate further tracheostomy downsizing without ventilator assistance, on postoperative day 21, a hole was drilled in the seam of the valve to allow for small air egress and decrease upper airway pressures. This was done with a 1.6-mm drill bit placed in the seam of the valve at an upward angle to avoid the valve leaflet and the hub. After drilling the hole, the PMSV was inspected to make sure that all particles were removed and valve integrity was maintained. The modified valve was then replaced with noticeable and immediate improvement in patient comfort and respiration; however, transtracheal pressures remained elevated above 15 cm H2O (the recommended level for likely valve tolerance is less than 10 cm H2O). A second identical hole was drilled (Fig. 1) and the patient exhibited even further improvement in valve tolerance with voice restoration and transtracheal pressures measured less than 10 cm H2O. He subsequently was able to be fully liberated from the ventilator, clear secretions through his oral cavity with a strong cough and voicing, and reported improved comfort with a noticeable decrease in his level of frustration.

He demonstrated continued improvement in respiratory function off mechanical ventilation with increased duration of speaking valve tolerance, cognitive clearing, and participation in all therapies. He was discharged to a rehabilitation facility on POD 27 without requirement for mechanical ventilation. His tracheostomy tube was further downsized and capped on POD 44, which he tolerated well, and he was subsequently decannulated on POD 53.

DISCUSSION

Many patients undergoing major head and neck procedures have underlying pulmonary disease. Diminished lung function at baseline can make weaning respiratory support difficult postoperatively. Prolonged ventilator dependence is a significant cause of increased mortality and intensive care unit length of stays and places patients at higher risk for associated complications. Patients with intraoral or pharyngeal flap reconstructions have the additional respiratory burden of flap bulk increasing upper airway resistance. Reduced transtracheal pressures achieved by the creation of a pressure relief port in the PMSV minimizes the pressure and resistance to airflow via the trachea and upper airway, thus restoring more normal airflow and increasing speaking valve tolerance. Although the increased air egress out of the PMSV with expiration restores more normal tracheal airflow, it does decrease the amount and pressure of air passing through the vocal chords. This enables better valve tolerance but may compromise voice quality and volume resulting in breathy and soft speech tones.

Despite potential compromise to voice quality with the valve modification, the ability to communicate effectively through any speech significantly improves the quality of life for patients recovering from major surgery, and its importance cannot be understated. Patients are able to better indicate symptoms, to express physiologic needs, less likely to become frustrated or agitated, and have a reduction in reported anxiety and stress. In addition, patients with speaking valves have improved cough function and

Fig. 1. Modified PMSV with 1.6-mm drill bit.
are at lower risk for aspiration. Early consultation and daily treatment with speech pathology and other therapies allow for trials of various multimodality communication options with normalization of some daytime routines. Persistent early interventions have been shown to lead to earlier lifting of sedation and cognitive clearing, decreased number of medical interventions, and reduced length of stay.\textsuperscript{16–19}

To our knowledge, this constitutes the first report on the successful use of a modified PMSV in an adult patient with elevated transtracheal pressures. This patient’s speaking valve intolerance was likely multifactorial. These include increased upper airway resistance from his flap reconstruction, underlying obstructive pulmonary disease, inability to tolerate further tracheostomy downsizing, and overall anxiety from his medical condition. We believe that this report is of benefit to critical care teams treating patients recovering from head and neck surgery as this is a common problem encountered postoperatively. This 1-way speaking valve modification may serve as a simple method to allow for earlier restoration of voicing and potentially reduce the number of ventilator-dependent days in this patient population. Further investigation is needed to explore the impact of modification of the valve on known benefits of PMSV, including restoration of subglottic airway pressure and improvement of swallowing physiology.

**CONCLUSIONS**

Postoperative changes after major head and neck surgery may cause elevated transtracheal pressures and result in tracheostomy speaking valve intolerance. We report a case of achieving speaking valve tolerance in a postoperative patient with significant baseline pulmonary disease through the adaptation of a valve modification intended to reduce transtracheal pressures.

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