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CASE REPORT

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Silver nitrate therapy for persistent tracheocutaneous fistula following prolonged tracheostomy and invasive ventilation: A case report

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Abstract

We report the case of a man with severe Guillain-Barré syndrome who developed a persistent tracheocutaneous fistula (TCF) following prolonged tracheostomy and mechanical ventilation. Following tracheostomy decannulation, the TCF had a deleterious effect on non-invasive positive pressure ventilation efficacy and ability to effectively clear airway secretions due to air leaking from the patent stoma. This case highlights a non-surgical approach to TCF management that is not well-described in the literature and presents an alternative management option for cohorts of patients in which the risk associated with surgical interventions may be undesirable.

KEYWORDS
trachea, tracheocutaneous fistula, tracheostomy, ventilation, wound healing

INTRODUCTION

Persistent tracheocutaneous fistulas (TCF) after prolonged mechanical ventilation via tracheostomy are frequently described in paediatric populations but less commonly in adults.[1–4] Most published management strategies of TCF typically focus on surgical approaches.[1,2,4] However, in certain scenarios such as patients with respiratory insufficiency or chronic respiratory failure, surgical management poses an unacceptable perioperative risk. We report the case of a man with severe Guillain-Barré syndrome, with a persistent TCF and non-invasive positive pressure ventilation (NIPPV) requirement following prolonged tracheostomy and invasive ventilation. Utilization of silver nitrate ($AgNO_3$) aided wound healing, fistula closure and ongoing respiratory support.

CASE REPORT

A 41-year-old male with no prior medical history presented to hospital with acute ataxia and limb weakness, preceded by 5 days of symptoms of lower respiratory tract infection (LRTI). He was noted to be hypoxemic (SpO_2 89% on FiO_2 0.45), with markedly abnormal neurological examination involving weakness in all four limbs, bilateral facial palsy, and bulbar weakness. Within hours of presentation, he developed flaccid paralysis and progressive respiratory failure and was emergently intubated and mechanically ventilated.

Guillain-Barré syndrome was diagnosed with supportive nerve conduction studies, lumbar puncture, and neurological imaging. In the setting of projected prolonged mechanical ventilation, a percutaneous tracheostomy was inserted. Multiple lines of medical therapies were administered, including intravenous immunoglobulin therapy and therapeutic plasma exchange. On day 127 of admission, the patient was transferred to our institution, a center with expertise in ventilation weaning and neurorehabilitation.[5]

Over the following months, the patient experienced recurrent LRTI and high-volume sputum production which was managed with mechanical insufflation-exsufflation (MIE) and antibiotic therapy. Following routine institutional practice, five routine tracheostomy changes were performed and were uncomplicated. Despite only subtle neurological recovery overall, with persistent quadriplegia and bulbar impairment, forced vital capacity gradually increased from 0.35 litres (7% predicted) to 1.45 L (31% predicted). During the 364 days following initial presentation, this improvement enabled gradual progression of ventilation weaning to tolerance of 12 h of ventilator-free time. An uninflated tracheostomy cuff and one-way speaking valve was also gradually tolerated, enabling NIPPV to be successfully trialled.

Tracheostomy decannulation occurred 374 days after initial tracheostomy insertion. At the time of decannulation, diagnostic polysomnography demonstrated persisting nocturnal hypoventilation and arterial blood gas demonstrated mild compensated hypercapnic respiratory failure (pH 7.41, $PaCO_2$ 48 mmHg, PaO_2 65 mmHg, HCO_3_30 mmol/L, BE +4.6 mmol/L). Ongoing use of nocturnal NIPPV was therefore required. Regular use of MIE was also required to aid with sputum clearance due to expiratory muscle weakness.

Despite careful attention to occlusive dressings applied to the tracheostomy stoma, nocturnal NIPPV was poorly tolerated due to air leak from the stoma. Subsequent polysomnography with NIPPV therapy revealed persistent hypoventilation and patient-ventilator asynchrony related to the stomal leak.

A TCF measuring five millimetres (mm) in diameter persisted 3 months following decannulation (Figure 1A, B). Given concerns about the patient's ability to tolerate intubation and general anaesthesia, a non-surgical management approach was entertained, utilizing topical silver nitrate ($AgNO_3$) (Avoca Caustic Applicator 75% w/w Silver Nitrate Cutaneous Stick, Bray Healthcare, Oxfordshire, UK). $AgNO_3$ was administered to the stomal edges, deeper tissues and stoma tract twice weekly over a total treatment course of 52 days (Table 1). This treatment was complicated by a single episode of self-limited small volume hemoptysis. In the setting of no new respiratory symptoms, normal

TABLE 1 Silver nitrate treatment regimen

Silver nitrate treatment regimen
1. Remove previous dressing and clean fistula and surrounding skin with 0.9% saline
2. Spray fistula once with lignocaine 5%/phenylephrine 0.5%. Wait 2 minutes
3. Dip silver nitrate applicator stick into water or 0.9% saline. Gently shake applicator stick to remove excess liquid.
4. Insert silver nitrate applicator stick ~4 mm into fistula & roll to cover skin edge. Caution should be taken to ensure liquid from applicator stick does not drip into the trachea. Repeat twice.
5. Apply 1 cm portion of 2% lignocaine gel to fistula
6. Cover fistula with an occlusive waterproof dressing. Encourage the patient to support the dressing with their fingers when voicing or coughing to reduce air leak from fistula.
7. Repeat twice weekly until healed.

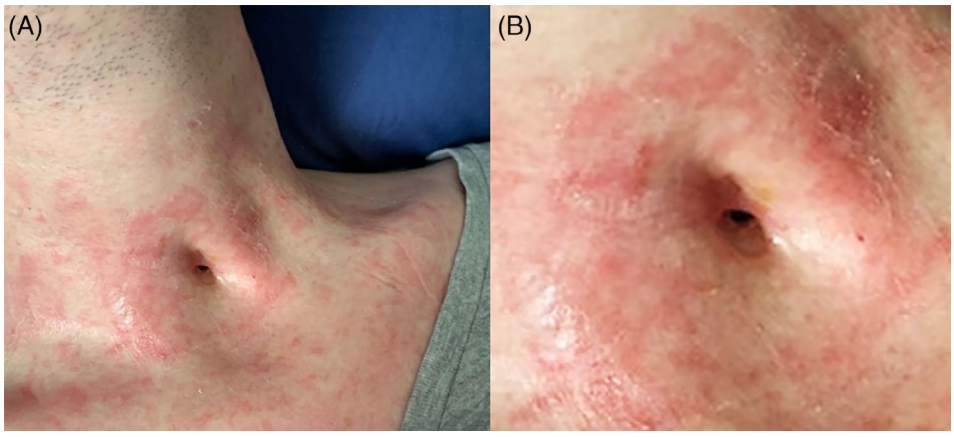

FIGURE 1 (A, B) Tracheocutaneous fistula 3 months following decannulation

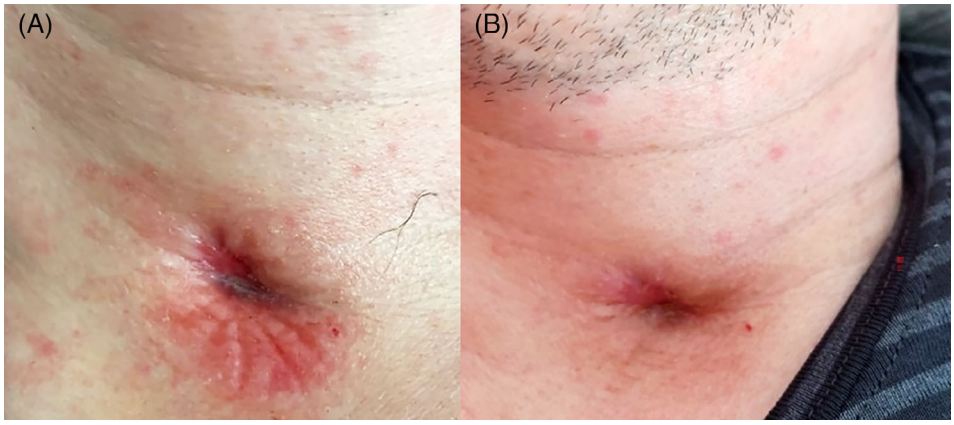

FIGURE 2 (A, B) Full resolution of tracheocutaneous fistula 2-weeks (A) and 3-months (B) after final treatment with silver nitrate

inflammatory markers and chest radiographic appearance, the hemoptysis was attributed to the $AgNO_3$ therapy.

There was significant improvement followed by complete resolution of the TCF (Figure 2A, B). NIPPV was increasingly well tolerated and frequency of LRTI decreased. This clinical improvement assisted in facilitation of transfer of the patient to a subacute rehabilitation facility, 506 days following presentation, with slow but ongoing improvement in neurological function.

DISCUSSION

Prolonged invasive ventilation is required in approximately 5% of patients admitted to intensive care units, which typically results in tracheostomy insertion.[1,5] The primary risk factor for the development of persistent TCF is the duration of tracheostomy insertion[1–4]; however contemporary data are lacking in adult populations. In our patient, ongoing NIPPV and MIE were required due to persistent neuromuscular weakness. We hypothesize that the positive pressure associated with these therapies contributed to splinting of the stomal tract and precluded the apposition required for wound healing. Persistent air leak from the TCF resulted in poor sleep quality and tolerability of NIPPV and is postulated to have resulted in decruitment of basal lung segments, creating an environment conducive to impaired sputum clearance and recurrent LRTI.[1–4]

The literature regarding the management of TCF largely focuses on surgical management strategies, particularly in paediatric populations.[1,2,4] Although there is no consensus regarding the best surgical technique, a risk stratification scoring system and decision algorithm for managing TCFs based on fistula size has been described by Kao et al.[1] This algorithm suggests that small TCFs of <5 mm may be managed without surgical intervention or with surgical primary closure, performed under local anaesthesia in selected cases. Larger TCFs (5–10 mm or >10 mm) may be stratified to various surgical flap or more complex techniques.[1] However, as with our patient, neuromuscular conditions are an important cause of prolonged ventilation, and persisting ventilatory failure make surgical interventions unattractive due to perioperative risk. In some situations, reintubation, reinsertion of tracheostomy, or insertion of a tracheal stent has been utilised.[6] Cases of other conservative strategies aimed at obliterating the fistulous tract and promoting wound healing have been reported, including local curettage, electrocautery, or the use of silver nitrate.[4]

Silver nitrate ($AgNO_3$) is a widely available caustic substance that is commonly utilized as a hemostatic and wound management agent.[7,8] Due to its mild tissue destruction properties, it is hypothesized that use of $AgNO_3$ may help disrupt the epithelial layer of the stomal tract and formation of an eschar layer, allowing for apposition of the dermal layers required for closure of the stomal tract. It is generally considered a safe therapy and if overapplication occurs, saline solution can be used to neutralize its effects.[7] Nevertheless, adverse effects of inadvertent aspiration or ingestion of $AgNO_3$ has been described.[7,8] It is a rare complication and there are no published standards of care to prevent $AgNO_3$ aspiration or ingestion.[7,8] The single episode of hemoptysis experienced by our patient is a potential warning sign, and a reminder that caution should be taken to ensure that excess $AgNO_3$ liquid does not inadvertently enter the airway during application.

Whilst surgery is a mainstay treatment for TCF,[1] this case highlights an approach to TCF management that is not well-described in the literature. It presents an alternative and less invasive management option for patients in which surgical intervention may pose unacceptable risk.

AUTHOR CONTRIBUTIONS

All authors contributed to the conception of the case report. Duncan J. Sweeney and Caroline Chao wrote the first draft. All authors revised subsequent versions and approved the final version.

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CONFLICT OF INTEREST

None declared.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

ETHICS STATEMENT

The authors declare that appropriate written informed consent was obtained for the publication of this manuscript and accompanying images.

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