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Case report

Rare Dual Subglottic Stenosis After Prolonged Intubation in a Pediatric Guillain-Barré Syndrome Patient: Successful Cryotherapy Treatment and Non-Surgical Approach

Aslı İmran Yılmaz[1], Dirk Schramm[2], Halil Çelik[3]

Abstract

Background: Guillain-Barré syndrome (GBS) is a rare, life-threatening neurological disorder often leading to respiratory failure that may require prolonged mechanical ventilation. A potential complication of prolonged intubation is subglottic stenosis (SGS), a narrowing of the airway below the vocal cords, which can cause significant respiratory difficulties. *Methods*: In this study, a 4-year-old patient who underwent treatment with bougie dilation, balloon dilation, and cryotherapy for subglottic stenosis resulting from prolonged endotracheal intubation was examined. The post-treatment condition was assessed, and current non-surgical treatment options for subglottic stenosis were discussed. *Results*: Bougie dilatation did not result in any improvement in the stridor. However, balloon dilatation and cryotherapy led to a significant reduction in stridor. Bronchoscopy performed one month after cryotherapy showed no signs of airway narrowing. *Conclusion*: This case demonstrates the successful use of cryotherapy, including cryo-devitalization and cryo-extraction, in treating SGS in a pediatric patient. The absence of airway narrowing on follow-up suggests that cryotherapy is a promising non-surgical option for managing SGS in such cases.

Keywords: cryotherapy, child, subglottic stenosis

Introduction

Guillain-Barré Syndrome (GBS) is a life-threatening condition characterized by symmetrical weakness and hyporeflexia or areflexia in the extremities, with rapid progression and maximum deficit occurring within 4 weeks. It often occurs after infections, although its etiology is not fully understood. While there are no definitive epidemiological data related to prognosis, most cases show improvement, with approximately 10% of patients experiencing mortality during the acute phase and about 20% continuing to have difficulty ambulating or requiring ventilator support (1).

Subglottic stenosis (SGS) is a narrowing of the airway just below the vocal cords, which can cause significant respiratory difficulties, such as stridor, wheezing, and even life-threatening airway obstruction. SGS can be congenital (present from birth) or acquired, with causes ranging from prolonged intubation, trauma, or inflammatory conditions. Other risk factors include gastroesophageal reflux disease (GERD), subglottic injury during tracheostomy placement, low birth weight, premature birth, and duration of intubation (2,3).

This article presents a case of Guillain-Barré syndrome requiring prolonged intensive care unit (ICU) stay due to mechanical ventilator support, which subsequently led to the development of subglottic stenosis. It also aims to discuss current non-surgical treatment methods for subglottic stenosis.

Case Presentation

A 4-year-old girl with a recent viral infection presented with leg weakness, inability to walk, pain, and respiratory distress. Examination revealed severe muscle weakness (1/5), absent reflexes, and confusion. Cerebrospinal fluid analysis and neuroimaging supported the diagnosis of acute inflammatory demyelinating polyneuropathy. She was treated with intravenous immunoglobulin (IVIG) and plasma exchange after no improvement with initial treatment. Following 28 days of mechanical ventilation, her muscle strength improved, and she was successfully weaned off the ventilator.

After extubation, the patient developed stridor and showed evidence of atelectasis on the left side, as seen on chest X-ray. Flexible bronchoscopy revealed Grade III web stenosis in the subglottic area according

[1]Department of Pediatric Pulmonology, Konya City Hospital, Konya, Turkey
[2]Pediatric Pulmonology, University Children's Hospital, Heinrich-Heine-University Düsseldorf, Düsseldorf, Germany
[3]Department of Pediatric Neurology, Konya City Hospital, Konya, Turkey
*Correspondence to: asli-turkut@hotmail.com
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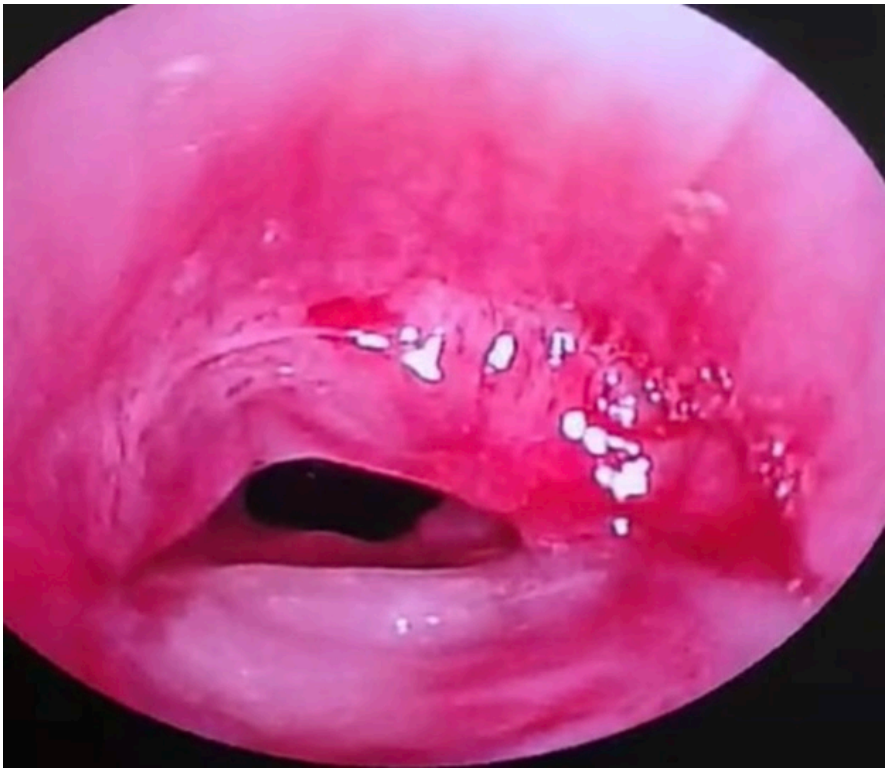

Figure 1: Patient's first flexible bronchoscopy image. The figure shows a grade III web stenotic segment in the subglottic region.

to the Cotton–Myer classification (Figure 1.). When the diagnosis was made, a smaller flexible bronchoscope was unavailable. As a result, the airway beyond the stenosis could not be assessed, as it was not possible to pass through it. Two days after the discovery, sequential dilatation was performed using a typical and conventional rigid bronchoscope (Karl Storz), starting with a 2.5 mm bronchoscope size (18,5 cm length and 4.2 mm outer diameter), and progressing to a 3 mm bronchoscope size (18,5 cm length and 5 mm outer diameter). Another larger-sized rigid bronchoscope could not pass through the stenotic area. Due to the lack of improvement in lung aeration on the left side and no reduction in stridor, the patient was re-evaluated with rigid bronchoscopy two days later, and a second bougie dilation was required with the same size bronchoscopes. Once lung aeration on the left side began to improve on the chest X-ray, further bougie dilation was not attempted, and Bilevel Positive Airway Pressure (BPAP) support was continued. One month after the diagnosis and follow-up post-discharge, due to the persistence of stridor and the lack of reduction in the need for BPAP support, flexible bronchoscopy was planned. Control flexible bronchoscopy, performed 31 days after diagnosis, revealed the presence of two crescent-shaped webs at different areas of the subglottic region, narrowing the airway. The upper web right was seen at 1 o'clock to 6 o'clock, and the (lower) left web was at 6 o'clock to 12 o'clock (Figure 2.). Because the area beyond the subglottic stenosis could not be assessed at the time of diagnosis, we are unable to determine whether the second stenosis has been present since the beginning or if it is a complication of rigid dilation.

Unfortunately, electrocautery and laser treatments are not yet available at our center, so, initially, balloon dilation was attempted to expand the stenosis (Leo Medical Co. Ltd). Balloon dilatation was attempted using a 6 mm diameter, 20 mm length balloon, which was inflated and deflated. The dilatation started at 3 atm pressure, and the balloon was dilated until resistance was felt against the pressure on the manometer. The procedure was stopped when the patient's oxygen saturation (SpO2) dropped below 90% (approximately 1.5-2 minutes). During the second dilation, the pressure was increased to 6 atm, and again, the balloon was dilated until resistance was felt for safety concerns, stopped when the patient's SpO2 dropped below 90% (approximately 1.5-2 minutes), and there was some improvement in the stenosis. Subsequently, using a 3.8 mm Fujiform flexible bronchoscope and a 1.1 mm cryoprobe, cryotherapy was performed in the same session. For the upper web, cryo-devitalization (freezing and thawing) were performed twice at each point, with 4 seconds of freezing and 4 seconds of thawing. The freezing duration was terminated when the freezing area reached the point where it exited the web. Freezing and thawing was performed at a total of 5 points, applying a sliding technique over the entire web area from the 6 o'clock position to the 12 o'clock position. The total time for the upper web consisted of 40 seconds of freezing and 40 seconds of

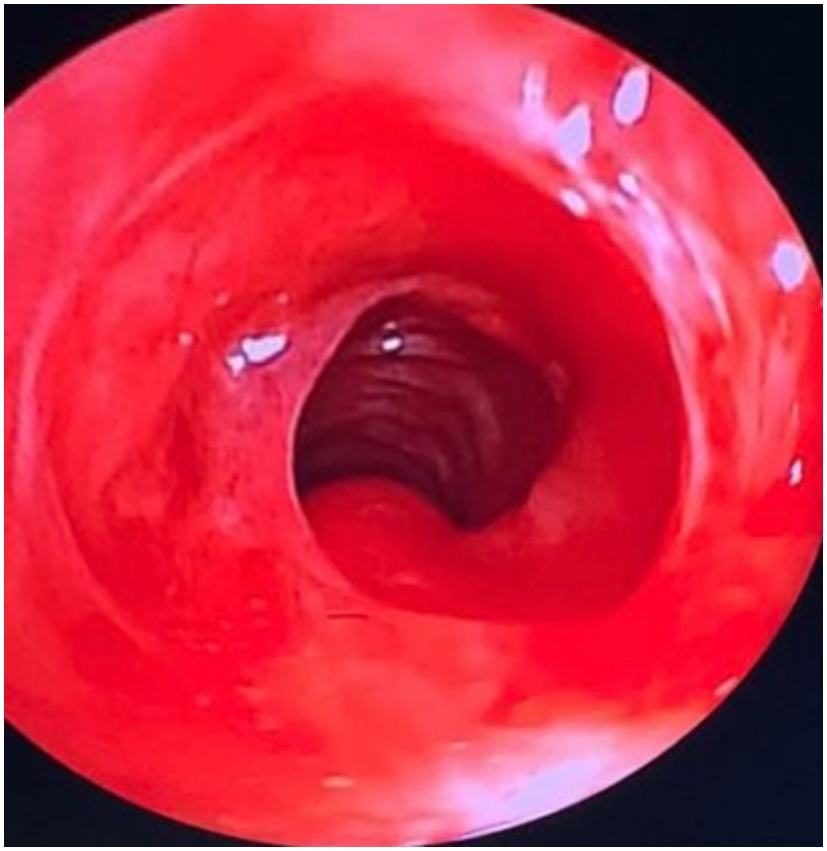

Figure 2: Bronchoscopic image of the patient at one month after diagnosis. The figure shows a crescent-shaped web in two different subglottic regions.

thawing. For the lower web, cryoextraction was applied a total of three times with the cryoprobe, starting from the left 6 o'clock position and moving towards the 12 o'clock position. Each procedure consisted of 4 seconds of freezing, followed by rapid removal of both the cryoprobe and bronchoscope together. Due to the difficulty of the anatomical position, cryo-devitalization was only performed once at a single point on the lower web, with 4 seconds of freezing and 4 seconds of thawing. On day 65 after the diagnosis and day 34 following balloon dilation and cryotherapy, bronchoscopy performed for post-treatment airway evaluation revealed no airway stenosis. During follow-up, a reduction in stridor was observed (Figure 3.).

Discussion

Subglottic stenosis is a common cause of airway obstruction in pediatric patients. Traditional treatments for SGS include surgical resection or open procedures, but these methods carry significant risks, especially in young children. In general, surgical options include open neck surgery. Open neck surgery is performed by cricotracheal resection (CTR) or laryngotracheoplasty with supporting cartilage graft. Cricotracheal resection is the most frequently performed open surgery, but it carries a higher risk of requiring a temporary tracheostomy and may result in permanent unilateral vocal cord paralysis. Other potential complications include dysphonia, tracheocutaneous fistula, and pneumothorax. Therefore, endoscopic examinations are preferred in pediatric patients because they are less invasive and have a lower risk of complications (4).

One of the oldest methods used to reduce the need for surgery is endoscopic balloon dilatation (EBD). It is a minimally invasive procedure used to treat SGS by inserting a balloon catheter into the narrowed area and inflating it to widen the airway. It generally has a high success rate in improving breathing and reducing the need for further interventions. A meta-analysis of EBD for pediatric SGS highlighted both short-term benefits and long-term challenges (5). While EBD provides significant initial improvement, many patients, especially those with severe stenosis, require repeat dilatation procedures over time. Factors such as stenosis severity, age at treatment, and the underlying cause (congenital vs. acquired) influence success and recurrence rates. Despite the need for potential repeat procedures, EBD remains an effective, minimally invasive alternative to more invasive surgeries like tracheoplasty. It should be considered a first-line treatment, particularly for mild to moderate SGS cases (6).

There are some studies in the literature suggesting that SGS can be prevented with certain medical treatments. A study investigating potential therapeutic small molecules, SB525334 and DRD1 ago-

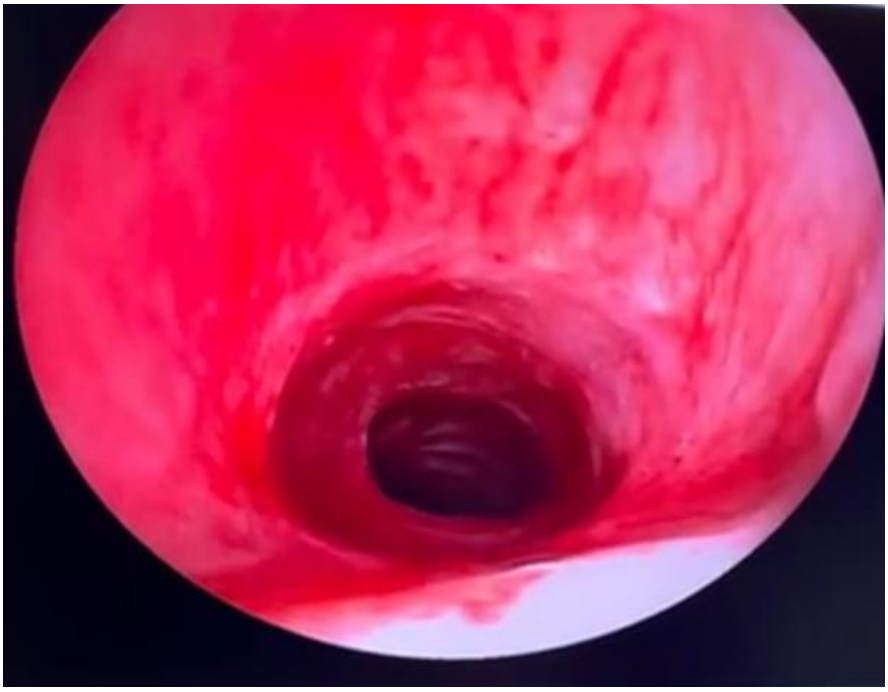

Figure 3: Airway control bronchoscopy image of the patient at one month after balloon dilatation and cryotherapy. No airway obstruction can be observed.

nist dihydrexidine hydrochloride (DHX), which inhibits TGF-β signaling, suggests it may reduce fibrosis in pediatric subglottic stenosis by modulating fibroblast mechanosensing. This approach could prevent excessive scarring and improve airway function (7). In another study, in a preclinical model, mice induced with subglottic stenosis through intubation or mechanical ventilation showed reduced fibrosis and airway narrowing when treated with azithromycin. Azithromycin also lowered inflammatory markers, suggesting a potential preventive effect on subglottic stenosis in patients at risk, such as those requiring prolonged mechanical ventilation. While human studies are lacking, these findings are promising for future therapeutic strategies (8).

One of the minimally invasive approaches in the treatment of SGS is intralesional medical therapy. A recent systematic review focuses on the use of Mitomycin C and corticosteroids as adjuncts to endoscopic procedures for treating SGS. Although the effectiveness of intralesional corticosteroids in SGS treatment remains unproven and the molecular mechanisms are not fully understood, corticosteroids are believed to reduce the inflammatory response by affecting T cells, inhibiting collagen synthesis, glycosaminoglycan deposition, and fibroblast proliferation. Due to the recurrent nature of SGS, there has been increased interest in office-based procedures, such as intralesional steroid injection (ILSI). ILSI involves the injection of corticosteroids directly into the stenotic scar tissue under local or topical anesthesia, with the patient remaining awake. According to the findings of this review, this approach has shown promising results in the management of SGS, with no serious complications observed, and it is believed to potentially extend the interval between endoscopic treatments (9). These procedures are not described with cryotherapy, so we chose not to apply these methods in our case.

A combined approach was used for the treatment of SGS in a study. This study evaluated the safety and efficacy of combining holmium laser treatment with cryotherapy via flexible bronchoscopy for managing post-intubation SGS in children. The study included 16 children and the average treatment duration was 55.31 days, with an average of 4.88 procedures per patient. Follow-up endoscopy after at least 6 months showed no restenosis. The holmium laser effectively removed scar tissue and granulation, while cryotherapy helped prevent regeneration of granulation tissue and promoted healing. This combined approach was found to be safe and effective for treating SGS, even in cases with stenosis lengths ≥ 1 cm (10).

The increasing use of cryotherapy in pediatric interventional bronchoscopy field care has attracted attention for its role in treating subglottic stenosis. This technique involves the use of a liquefied gas (cryogen), typically nitrous oxide or carbon dioxide, which is delivered through a catheter to the end of the cryoprobe, where it reaches temperatures as low as -40 °C. The cryoprobe forms a strong bond with objects it contacts, particularly those with high water content. Compared to treatments like laser therapy and balloon dilatation, cryotherapy carries a lower risk of hemorrhage, perforation, and complications, and is more cost-effective and easier to perform (11). Schramm et al. evaluated the indications, techniques, success

rates, and complications of pediatric cryotherapy by analyzing 69 cryotherapy procedures performed on 57 children (ages 0-18) across 10 medical centers in 8 countries. Results showed that cryotherapy was both safe and effective, with a high overall success rate of 93% and a 100% success rate in restoring airway patency in cases with mucus plugs, bronchial casts, and post-traumatic stenosis. A median 85% increase in airway diameter was observed, with clinical improvement in all cases (12).

A recent study reviewing the application, indications, success rates, and complications of cryotherapy in pediatric lung diseases described the use of bronchoscopic cryotherapy, including the well-known frozen resection method as well as the freeze-thaw surgical technique (cryo-devitalization). The study explained that frozen resection is primarily used for cryobiopsy and the removal of tumors, foreign bodies, and necrotic tissue. In the freeze-thaw method, the lesion is cooled and then allowed to naturally thaw, with the process repeated in conditions such as traumatic airway stenosis and granulomas. The slowest possible thawing phase, through passive thawing, is recommended. If biological tissue thaws slowly, extracellular recrystallization occurs as well as a change of the extra- and intracellular physiological concentration of saline solution, which contribute to osmolysis. It was noted that cryotherapy is more effective than thermal ablation for the treatment of scar tissue and granulation, but caution is needed for severe, acute airway obstructions due to the potential risk of mucosal swelling and necrosis (11). We performed cryo-devitalization and cryo-extraction in our patient. Bronchoscopy performed one month after cryotherapy for airway and stenosis control evaluation showed improvement in the airway narrowing. Although there is no data in the literature regarding the long-term safety and efficacy of cryotherapy, we observed a successful outcome of cryotherapy for the treatment of SGS during our patient's one-month follow-up.

Conclusion

This case demonstrates the effectiveness of cryotherapy, including cryo-devitalization and cryo-extraction, in treating two distinct web-shaped subglottic stenoses (SGS) following prolonged intubation in a patient with Guillain-Barré syndrome. At the one-month follow-up, no airway narrowing was observed, highlighting the potential of cryotherapy as a treatment option. However, further studies are needed to assess the long-term safety and efficacy of cryotherapy in the management of SGS.

Conflict of interest

The authors have no conflict of interest to disclose.

Data availability statement

Data that supports the findings of the study are available with the corresponding author and will be available on request.

Author contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis: AİY, HÇ. The first draft of the manuscript and review of literature: AİY, Writing- original draft preparation: AİY, HÇ; review and editing: DS, Supervision: DS. All authors read and approved the final manuscript.

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