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Case Series
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Endoscopic Percutaneous Suture Lateralization with Syringe Needles for Neonatal Bilateral Vocal Cord Paralysis

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Abstract

Objective: To explore the novel technique of percutaneous endoscopic suture lateralization for Bilateral Vocal Cord Paralysis (BVCP) in neonates from Shenzhen, China, and to evaluate the safety and efficacy of the operation. 1.2. Methods: In this retrospective case series, we present four neonates with BVCP diagnosed within 3 days after birth from Shenzhen Children's Hospital. All had stridor, respiratory distress and hypoxemia requiring respiratory support at diagnosis. Endoscopic vocal fold lateralization was performed under general anesthesia using 3.0 mm endotracheal intubation through the improved technique of percutaneous needle-directed placement of a 4 to 0 Prolene suture, without the use of specialized equipment. A 4 to 0 Prolene wire was led out through two 10 ml syringe needles, the left vocal cord was fully moved and fixed under the skin with endoscopy monitoring.

Results: Overall, 3/4 of the patients showed clinical improvement in stridor and dyspnea 2 to 3 weeks after the operation and avoided a tracheostomy, two of them could breathe and feed normally when they were discharged from hospital, and one patient had a weak ability to suck but could breathe normally. The last patient had to undergo a tracheotomy due to the poor improvement in respiratory distress. None of the babies experienced any complications from this surgery, but case four presented with a series of complications and other problems in postoperative care related to the tracheostomy. At the last follow-up (mean 8 months), complete function of the bilateral vocal cords was acquired in case two (6 months) and partial function of the vocal cords was acquired in case one (13 months), with the other cases still experiencing paralysis.

Conclusion: Endoscopic percutaneous suture lateralization may be a reversible, effective and minimally invasive primary treatment for neonatal BVCP. Most of neonates with BVCP undergoing this procedure avoided a tracheotomy.

Keywords: Bilateral vocal cord paralysis; Neonatal; Endoscopic percutaneous suture lateralization

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Introduction

Bilateral Vocal Cord Paralysis (BVCP) is the second most common congenital laryngeal disorder in neonates, of which the incidence is about 1 in 100,000 [1], after laryngomalacia. Bilateral Vocal Cord Paralysis (BVCP), as a kind of severe case and emergency, is a significant cause of severe respiratory distress in neonates and often requires urgent intervention, otherwise resulting in asphyxiation and death. In the past, due to the limited understanding of the obstetrician, and neonatologist, diagnosis and treatment of BVCP in neonates has been delayed, especially in developing countries. With the popularity of electronic laryngoscopy for infants, the rate of diagnosis and survival for infants with BVCP has been gradually increasing [2]. Its etiologies may be traumatic (delivery), iatrogenic idiopathic and neurological [3]. Berkowitz et al. [4] reported that children with BVCP were always accompanied by other congenital abnormalities, being related to chromosomal abnormalities, which reduced the possibility of spontaneous recovery. It has been reported that a considerable rate of spontaneous recovery, at greater than 50%, has been found in cases of idiopathic bilateral vocal cord paralysis [5,6], which would makes more invasive or destructive treatments less acceptable to parents and doctors. In this study, we present

our experience of four newborns with BVCP, who were treated with the novel technique of endoscopic percutaneous suture lateralization in Shenzhen Children's Hospital, which is the only comprehensive children's hospital in Shen Zhen, covering more than 12 million people and treating critically ill children in the city and surrounding areas. Previously, we used traditional method-tracheotomies to treat the disease. The surgery does not need any special equipment, and the availability of equipment (suspension laryngoscopy, 4.0 mm nasal endoscope) and materials (non-absorbable line, 10ml syringe, etc.) significantly improves the feasibility of the procedure.

Materials and Methods

Basic materials

A retrospective review was conducted on four patients with bilateral congenital vocal cord paralysis who underwent endoscopic percutaneous suture lateralization at Shenzhen Children's Hospital over nearly two years. The medical history data included pregnancy status, birth condition, comorbidities, complications, postoperative recovery and follow-up. Demographic information included patient age at diagnosis, complications, and etiology. Perioperative information obtained included the amount of respiratory support, medical evaluation including CT or MRI, aspiration and feeding statuses. All of the four cases were diagnosed by electronic laryngoscopy undertaken more than twice while being awake, and the diagnosis was made with the participation and agreement of at least two specialists. All of the children underwent suspension laryngoscopy while spontaneously breathing under total intravenous anesthesia to identify the movement condition of the vocal cords. A 3.0 mm trachea cannula was used. Before the operation, 0.5 mg/kg of dexamethasone was given intravenously and a cotton tablet with lidocaine or tetracaine was spread on the glottic mucosa to reduce irritation to the airway when piercing. According to Helsinki declaration, all of the patients signed informed consent forms, which offered a variety of surgical options.

Case Series

Case 1

Female, born at 40 weeks of gestation *via* eutocia delivery. Apgar scores were 8, 9, and 9 at 1, 5, and 10 minutes of age, respectively. The newborn was admitted to the Neonatal Intensive Care Unit (NICU) directly and required Non-Invasive Positive Pressure Ventilation (NIPPV) due to respiratory disorders and inspiratory stridor. Another Laryngoscopy confirmed the BVCP. An MRI of the head and neck did not show any other pathologies, but an echocardiogram showed an Atrial Septal Defect (ASD) with a left-to-right shunt and a Patent Ductus Arteriosus (PDA). Finally, the patient underwent endoscopic percutaneous suture lateralization at the age of 1 week. In the 10 days following the surgery, the patient required continuous positive airway pressure (CPAP) ventilation and additional oxygen. She was given systemic steroids, antibiotics and omeprazole in the first 5 days until the postoperative manifestations (stridor, inspiratory, and dyspnea) were obviously improved. The baby was discharged at 10 days post-operatively. At the first four follow-up points (first, third, fifth and seventh postoperative months), she had greatly improved stridor and airway patency, and was gaining weight well.

Case 2

Male, born at 40+5 weeks of gestation. Apgar scores were 10, 10 and 8 at 1, 5 and 10 minutes of age, respectively. The infant was admitted into the NICU for inspiratory dyspnea, and at the same time, had a complication- of neonatal septicemia. The patient underwent endoscopic percutaneous suture lateralization on the 11th day of life. He was extubated safely the day after surgery, but developed hypertension. Therefore, the baby required captopril 0.4 mg/kg and nifedipine 0.25 mg/kg. Blood chemistry revealed an increase of aldosterone and angiotensin II. Due to his low ability to suck, the infant was developing behind his age at follow-up.

Case 3

Male, born with eutocia at 37+2 weeks of gestation, and was admitted to our NICU on the second day of life for laryngeal stridor. Apgar scores were 9, 10, and 10 at 1, 5, and 10 minutes of age, respectively. He required NIPPV due to respiratory disorders, inspiratory stridor and hypoxia. Another laryngoscopy confirmed the BVCP. An echocardiogram presented an Atrial Septal Defect (ASD) with a left-to-right shunt and an MRI of the head and neck did not show any other pathologies. The patient underwent endoscopic percutaneous suture lateralization on his 46th day of life after adequate preoperative preparation. He was extubated safely on the second postoperative day and needed CPAP ventilation. Stridor and oxygen saturations were improved. He tolerated an oral diet, and was discharged home 20 days post-operatively. At follow-up, the baby had no respiratory problems, but he showed slight failure to thrive when compared to other children of the same age.

Case 4

Male, born with eutocia at 37+1 weeks of gestation. He was admitted to our hospital on the 20th hour of life for anhelation, severe hypoxia and respiratory stridor after asphyxia at birth. Apgar scores were 5, 3, and 5 at 1, 5, and 10 minutes of age, respectively. Intubation and NIPPV were performed to maintain his ventilation. He was diagnosed with BVCP by laryngoscope. An echocardiogram showed severe Pulmonary Arterial Hypertension (PAH) and a CT of the head did not indicate any other pathologies. Finally, the baby underwent endoscopic percutaneous suture lateralization on his 39th day of life. However, unluckily, the baby had to undergo a tracheotomy at 20 days postoperatively due to persistent dyspnea after surgery. At follow- up, the patient fed well without aspiration, and showed no failure to thrive.

Methods

Combined with our actual situation, our operation method was slightly improved on the basis of Montague GL introduction [7]. In China, it is difficult to obtain the specialized precise needles, which are appeared in many studies. Therefore, according to the size of the specialized precise needle, we tried to use the 10 ml syringe needle instead of it the first time. Our advantages include: First, it can be easily obtained in all medical institutions; next, it is cheap and affordable for all families; finally, the size is suitable for infants and has little damage to skin mucosa. Essential surgical equipment included: 1) suspension laryngoscopy; 2) 4 mm 0° endoscope; 3) micro-instruments; 4) 4 to 0 Prolene sutures × 2; 5) 10 ml syringe with stub-tip x^2; 6) 5 mm × 5 mm silicone tube, and 7) 5 to 0 absorbable sutures.

Firstly, we needed to prepare the suture prior to laryngoscopy. A 4 to 0 Prolene suture (suture #1) was loaded into a 10 ml syringe with a stub-tip, which then formed a round sleeve. A second 4 to 0 Prolene suture (suture #2) was loaded into another 10 ml syringe with a stub-tip, with the tip of the suture being beside the outside bevel of the needle (Figure 1). At the same time, a 5 mm × 5 mm silicone tube was immersed in normal saline.

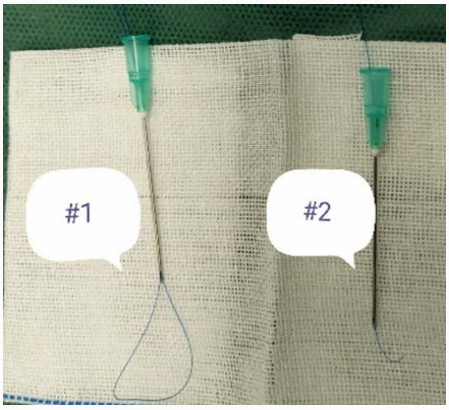

Figure 1: Suture #1 and suture #2.

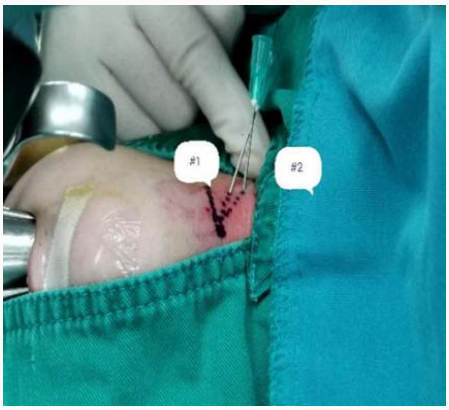

Figure 2: The site of the piercing.

Next, the patient had to have spontaneous respiration in order to confirm passive mobility by palpating the vocal folds before the operation. A 3.0 mm trachea cannula was routinely chosen due to it providing effective ventilation and enough operating space. In order to reduce the stimulus to larynx, we tended to apply lidocaine hydrochloride to the laryngeal mucosa. Best visualization was obtained with a 4 mm 0° endoscope. Next, the site of the piercing and surrounding skin needed to be disinfected with povidone iodine (Figure 2). Precise needle placement played a vital role for surgical success and reducing airway bleeding. Only when the tip was placed under the endoscope could it penetrate the mucosa and enter the airway. The needle with suture #1 was placed through the placement, approximately 18 mm lateral to the most prominent place of thyroid cartilage (left or right), approximately 8 mm at the inferior edge of it. This position was 60° from the midline of the neck. The needle was directed through the skin, muscle, and thyroid membrane to enter the airway above the true vocal folds. Once the tip of needle was seen in airway, suture #1 was advanced into the airway and taken down with laryngeal graspers under endoscopy. Then the needle was withdrawn until the tip was invisible, and was fixed in the thyroid cartilage. Next, suture #2 was punctured at another point at 45° from the midline of the neck on the inside of suture #1. The needle was passed through the airway to the subglottis. It had to be kept in mind that the tip of the needles had to be kept away from the trachea cannula. We had to be careful to avoid damaging the bilateral vocal cords and other tissues of the larynx. Finally, the suture #2 was passed through the loop of suture #1 and retrieved out of the laryngoscope under tension. The

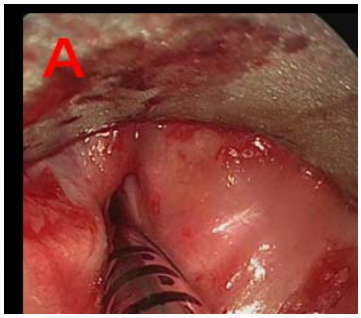

Figure 3: Endoscopic suture lateralization. **A**. Laryngoscopic view of the neonatal larynx.

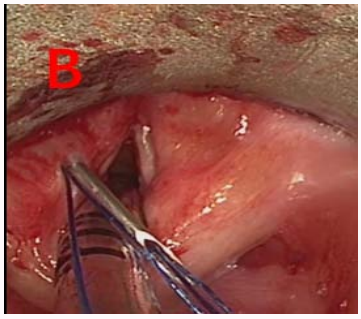

Figure 3B: Placement of needle with suture #1 in supraglottic area.

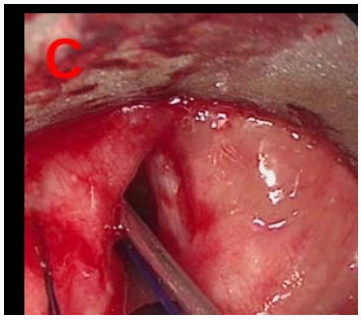

Figure 3C: Placement of needle with suture #2 in subglottic area.

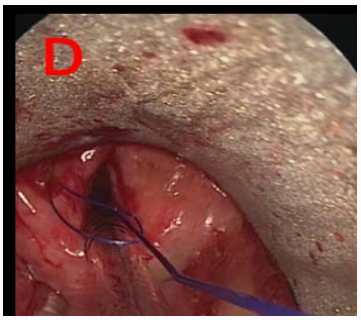

Figure 3D: The suture #2 was passed through the loop of suture #1.

suture loop was then pulled out of the back of the needle, bringing suture #2 with it. Suture #1was removed together with the needle. Then, under endoscopy, we observed for any significant abduction of the vocal cord (Figure 3).

Finally, a 6 mm neck incision was made in relaxed skin between

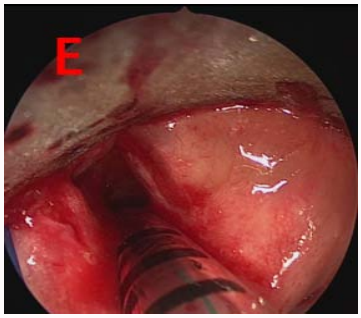

Figure 3E: Post-operative vocal cords.

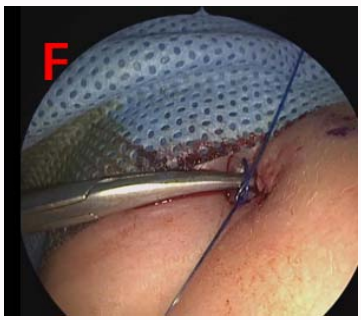

Figure 3F: A 5 mm × 5 mm silicone tube was fixed on the skin.

the two ends of suture #2. The skin was elevated, exposing the surface of the muscles to accommodate the subcutaneous 5 mm silicone tube. The two ends of suture #2 were knotted through the holes in the silicone tube. In the end, the skin was sutured with absorbable sutures.

Results

We present recent medical history data on four neonates with BVCP from the Shenzhen Children's Hospital (Table 1, 2). Being diagnosed by laryngoscopy, a variety of surgical options could be chosen (watch and wait, tracheotomy, partial cordotomy, percutaneous suture lateralization, etc). There were four parents who chose endoscopic percutaneous suture lateralization. All of the patients presented with laryngeal stridor that was worse on agitation. Preoperative management included NIPPV, intubation and nasogastric feeding. All of the patients underwent a preoperative MRI or CT of the head, all of which showed no abnormal findings.

Three patients showed clinical improvement and avoided a tracheotomy. Only one baby refused to lateralize to another vocal cord, and a tracheotomy was performed due to post-operative persistent dyspnea. Due to the low ability to suck, patient two had a lower growth and swallowing function than the other three. At the same time, the baby developed hypertension and required antihypertensive treatment.

At the first four follow-up points (first, third, fifth and seventh postoperative months), all of the patients were breathing normally on room air (including patient four who had the tracheotomy) and were fed orally. Although case 3 and case 4 had slight aspiration occasionally, nasal feeding or intravenous nutrition substitution was not required. The other two patients had no aspiration. According to the subjective observation of clinical doctors, in the 4 cases, the preoperative and postoperative voices of the first three patients were loud, but for case 4, there was no sound before surgery and at the follow-up of the 5th month after surgery, there was faint crying.

Meanwhile, during the follow-up period, patient four presented with a variety of complications related to the tracheostomy, such as excessive phlegm, recurrent pneumonia, infection and granuloma of the trachea incision. It is worth mentioning that complete function of the bilateral vocal cords was acquired in case two (6 months) and partial function of the vocal cords was acquired in case one (13 months).

Discussion

Bilateral vocal cord paralysis is a rare but challenging congenital laryngeal anomaly in children, especially in neonates. Therapies for BVCP are designed to improve airway ventilation while minimizing any long-term effects on swallowing function and phonation. Currently, a variety of treatments are available, including "watch and wait" [7], NIPPV [1], tracheotomy, anterior-posterior cricoid split [8], cordotomy [9,10] and arytenoidectomy[11,12]. Although, as a matter of fact, alternatives to tracheotomy in the vulnerable, confined neonatal airways are much more limited when compared to those in adults. In view of preserving the laryngeal anatomy, tracheotomy was the most frequently performed surgical intervention at one time [13], despite it having many well-known risks. It has been reported that tracheotomies were deemed unavoidable in 68.6% to 90% of children with BVCP [14,15]. Although, ultimately, 64.3% were successfully decannulated, tracheotomy as a highly invasive intervention led to a series of complications, such as recurrent pneumonia, which brought severe stress and economic burden to the children and their families, and in severe cases even death. One study showed that, in infants, in-hospital mortality after a tracheotomy was 125/885 (14%) [16]. Therefore, tracheotomies have become a less attractive option to the most families. Currently, in order to meet a family's requirements for quality of life, researchers must explore the under mentioned ways to treat BVCP in children.

Non-Invasive Positive Pressure (NIPPV) ventilation as a treatment means can sustain life to a certain extent, but NIPPV used for a long time can carry a separate set of complications, such as deleterious effects on the development of the face and lungs, tracheomegaly and tracheobronchomalacia [17]. Moreover, NIPPV is hard to perform at home. Therefore, in cases of severe dyspnea, urgent surgical intervention is necessary.

Posterior cordotomies are a minimally invasive endoscopic

Table 1: Patient situation in pre-operation.

Patient	Age at diagnosis (days)	Age at surgery (days)	Birth weight (Kg)	Symptoms	Complication	Etiology
1	1	5	3.15	S and D	PDA, pneumonia	Idiopathic
2	3	11	3.11	S and D	Septicemia, pneumonia	Idiopathic
3	3	46	2.87	S and D	ASD, pneumonia	Idiopathic
4	19	34	2.60	S and D	PAH, pneumorrhagia	Idiopathic

Abbreviations: S and D: Stridor and Dyspean; PDA: Patent Ductus Arteriosus; ASD: Atrial Septal Defect; PAH: Pulmonary Arterial Hypertension

Table 2: Postoperative outcome.

Patient	Airway status Pre L-FU	Feeding ways Pre L-FU	Aspiration Pre L-FU	Phonation PreL-FU	Vocal-cord paralysis Pre L-FU	Extubation time	Complication
1	NIPPV Air	NG OF	Yes NO	Weak Loud	BP PR	2nd	NO
2	NIPPV+Intu Air	NG OF	Yes NO	Weak Loud	BP CR	2nd	Pypertension
3	NIPPV+Intu Air	NG OF	Yes Some	Weak Loud	BP BP	2nd	No
4	NIPPV+Intu Air	NG OF	Yes Some	Weak Loud	BP BP	Tra in 20th day	G and F, Pne

Abbreviations: Pre: Pre-operation; L-FU: Last Follow-Up; Intu: Intubation; Tra: Tracheotomy; NG: Nasogastric Feeding; OF: Oral Feeding; BP: Bilateral Paralysis; G and F; Granulation tissue and infection in tracheal incision; Pne: Pneumonia; PR: Partial; CR: Complete Return

approach. A cordotomy consists of an incision in the posterior third of the true vocal fold. This incision frees the vocal ligament and the vocalis muscle from the arytenoid cartilage. The technique enlarges the posterior part of glottis while allowing the vocal folds to still have a good contact on the anterior commissure. In a retrospective study of 11 children with posterior cordotomies, with exception to a patient who was in a worse condition, all of the others either avoided tracheotomies or were successfully extubated, and had satisfactory phonation and swallowing functions [9]. The arytenoid cartilage is a key structure of the posterior glottis. An arytenoidectomy expands the glottis by removing the arytenoid cartilage, providing a larger airway for respiration. Aubry et al. [12] indicated that a CO_2 laser arytenoidectomy seemed to be an effective and safe treatment for BVCP in children. An endoscopic anterior-posterior cricoid split aims to expand the glottis by incising the anterior cricoid and posterior cricoid, respectively. In a series of 19 pediatric patients with BVCP who underwent anterior-posterior cricoid splits, there was a significant improvement in respiratory distress (14/19) [8]. Cordotomy, arytenoidectomy and anterior-posterior cricoid splits all result in permanent and irreversible damage to the laryngeal anatomy, although they can replace tracheotomies in improving dyspnea. In addition, infants with a fragile trachea are less resistant to damaging surgeries. Therefore, these methods are restricted when performed in neonates [6]. A report about idiopathic bilateral vocal cord paralysis in infants stated that the overall rate of spontaneous recovery was 65%, mostly within the first 2 years of life [13]. Therefore, Jomah showed that it would better to wait for a period of at least 1 year after diagnosis before performing any surgical glottic expansion procedures and the damaging laryngeal anatomy [5].

In 1993, Ejnell and Tisell first introduced unilateral endoscopic percutaneous suture lateralization for bilateral vocal cord paralysis in adults [18]. Since the glottis and laryngeal tissue of children (especially infants) is smaller and more fragile than that of adults, the laryngeal fixing device invented by Lichtenberger was difficult to apply in babies [19]. According to the physiological characteristics of the larynx in children, Lichtenberger's needle was modified by Madaani and was successfully applied in six infants with BVCP [20]. However, the specialized tool was not widespread. Subsequently, Montague et al. [21] also created two gauge needles without filters (22# and 19#) that replaced Lichtenberger's needle. Similarly, in our study, we made two technical improvements when compared to Montague GL's. First, we further simplified the needles, which were taken from two 10 ml syringes (#1 and #2, Figures 3A-3F). Compared with needles 22# and 19#, our injector is more economical and easier to obtain, and most importantly, they are more conducive to intraoperative operations because the syringe needle is sharper than a repeatedly sterilized needle. Secondly, our operations were carried out under general anesthesia with 3.0 mm intubation for the whole process, which reduced the risk of anesthesia and did not affect the operation to the larynx allowing the best visualization to be obtained with a 4 mm 0° endoscope. In contrast, Montague introduced an operation that was carried out under intermittent intubation, requiring a high level of anesthesia that may not be popular in all hospitals. To a large extent, stimulation to the thyroid cartilage and airway by puncture can be minimized. The site of puncture, being on the lateral side of the vocal cord, minimizes the risk of direct trauma to the laryngeal tissue, such as the vocal cords, arytenoid cartilage and recurrent laryngeal nerve. Of course, it needs to remain of concern whether there could be postoperative complications including hematoma, abscess or vocal cord injury.

In our research, 3/4 of the patients were able to avoid a tracheotomy and had recovered from dyspnea during the follow-up period, suggesting that endoscopic percutaneous suture lateralization without damaging the laryngeal anatomy may be an effective and minimally invasive treatment option. Although the decision was made to perform a tracheotomy on another baby due to their minimal improvement in ventilation after surgery, all of the patients were feeding by mouth without aspiration (one of the children received nasal feeding for 1 month after surgery due to a poor sucking ability) and did not appear to have any severe aspiration. However, baby four experienced recurrent pneumonia due to a large amount of sputum after their tracheotomy. Their phonation did not appear to be injured at postoperatively, and even as the vocal cords gradually were recovered, the voices of all four cases were louder than preoperatively. At every follow-up point, laryngoscopy showed there were no complications relating to the surgery, such as granulation tissue, infection or subglottic stenosis. However, we could not see the sutures under electronic laryngoscope. This leaves an important question: What happens to the suture over time? Although we keep in mind that the sutures are not absorbable, it could also be possible that they are absorbed. Montague et al. [21] reported sutures were no longer present within the airway when they were removed. They thought that the suture, while being absorbed was more likely, was still providing some lateral tension on the vocal fold, promoting abduction to the vocal cord. If respiratory improvement is poor after surgery, the other vocal cord can be lateralized. If both are ineffective (persistent aspiration or dyspnea), the suture should be removed, and tracheotomy should be performed. It is worth noting that the vocal cords experienced partial or complete functional recovery in 4/6 and 2/3 cases, respectively, in the study of Montague and Sztano [21,22]. To the best of our research, the functionality of the vocal cords in patient two achieved complete recovery at the sixth postoperative month and in patient one achieved partial recovery at the 13th postoperative month, while the others were still paralytic. We suppose that spontaneous recovery of the vocal cords is uncertain. Bilateral vocal cord paralysis in most neonates can show a natural recovery, but we would have to wait a long time. Therefore, timely surgical intervention must be taken. Reversible, minimally invasive operations may be the best option for waiting for the vocal cords to recover. Our operation does not appear to affect the nerve's self-

recovery, although this needs a longer follow-up period and more surgical cases to prove.

Conclusion

BVCP is a significant cause of severe respiratory distress in children, especially neonates, often requiring urgent intervention. Endoscopic percutaneous suture lateralization represents a reversible, minimally invasive and favorable solution, and more importantly, does not result in permanent injury to fast-growing laryngeal structures. According to our study, most newborns undergoing this procedure avoided a tracheotomy. Of course, if suture lateralization is not effective, other operations could be performed.

References

1. Ahmad SM, Soliman AM. Congenital anomalies of the larynx. Otolaryngol Clin North Am. 2007;40(1):177-91.
2. Kuo CH, Niu CK, Yu HR, M-YC, Hwang CF. Applications of flexible bronchoscopy in infants with congenital vocal cord paralysis: A 12-year experience. Pediatr Neonatol. 2008;49(5):183-8.
3. White M, Meenan K, Patel T, Jaworek A. Sataloff RT. Laboratory evaluation of vocal fold paralysis and paresis. J Voice. 2017;31(2):168-74.
4. Berkowitz RG, Bankier A, Moxham JP, Gardner RJM. Chromosomal abnormalities in idiopathic congenital bilateral vocal cord paralysis. Ann Otol Rhinol Laryngol. 2001;110(7 pt 1):624-6.
5. Jomah M, Jeffery C, Campbell S, Krajacic A, El-Hakim H. Spontaneous recovery of bilateral congenital idiopathic laryngeal paralysis: Systematic non-meta-analytical review. Int J Pediatr Otorhinolaryngol. 2015;79(2):202-9.
6. Miyamoto RC, Parikh SR, Gellad W, Licameli GR. Bilateral congenital vocal cord paralysis: A 16-year institutional review. Otolaryngol Head Neck Surg. 2005;133(2):241-5.
7. Chen EY, Inglis AF Jr. Bilateral vocal cord paralysis in children. Otolaryngol Clin North Am. 2008;41(5):889-901.
8. Rutter MJ, Hart CK, Alarcon A, Daniel SJ, Parikh SR, Balakrishnan K, et al. Endoscopic anterior-posterior cricoid split for pediatric bilateral vocal fold paralysis. Laryngoscope. 2018;128(1):257-63.
9. Lagier A, Nicollas R, Sanjuan M, Benoit L, Triglia JM. Laser cordotomy for the treatment of bilateral vocal cord paralysis in infants. Int J Pediatr Otorhinolaryngol. 2009;73(1):9-13.
10. Ruf K, Hackenberg S, Kraus F, Wirbelauer J, Frieauff E, Hagen R, et al. Carbon dioxide laser cordotomy as possible alternative for tracheotomy in a neonate with idiopathic bilateral vocal fold paralysis. Klin Padiatr. 2016;228(4):213-5.
11. Yilmaz T, Altuntas OM, Suslu N, Atay G, Ozer S, Kuscu O, et al. Total and partial laser arytenoidectomy for bilateral vocal fold paralysis. Biomed Res Int. 2016;2016:3601612.
12. Aubry K, Leboulanger N, Harris R, Genty E, Denoyelle F, Garabedian EN. Laser arytenoidectomy in the management of bilateral vocal cord paralysis in children. Int J Pediatr Otorhinolaryngol. 2010;74(5):451-5.
13. Lesnik M, Thierry B, Blanchard M, Glynn F, Denoyelle F, Couloigner V, et al. Idiopathic bilateral vocal cord paralysis in infants: Case series and literature review. Laryngoscope. 2015;125(7):1724-8.
14. Sanders CD, Guimbellot JS, Muhlebach MS, Lin FC, Gilligan P, Esther CR Jr. Tracheostomy in children: Epidemiology and clinical outcomes. Pediatr Pulmonol. 2018;53(9):1269-75.
15. Perez-Ruiz E, Caro P, Perez-Frias J, Cols M, Barrio I, Torrent A, et al. Paediatric patients with a tracheostomy: A multicentre epidemiological study. Eur Respir J. 2012;40(6):1502-7.
16. Lee JH, Smith PB, Quek MB, Laughon MM, Clark RH, Hornik CP. Risk factors and in-hospital outcomes following tracheostomy in infants. J Pediatr. 2016;173:39-44 e1.
17. Zhang H, Zhang J, Zhao S. Airway damage of prematurity: The impact of prolonged intubation, ventilation, and chronic lung disease. Semin Fetal Neonatal Med. 2016;21(4):246-53.
18. Hasse Ejne U, Tisell LE. Acute temporary laterofixation for treatment of bilateral vocal cord paralyses after surgery for advanced thyroid carcinoma. World J Surg. 1993;17(2):277-81.
19. Woodson BT, McFadden EA, RJ T. Clinical experience with the lichtenberger endo-extralaryngeal needle carrier. Laryngoscope. 1991;101(9):1019-23.
20. Madani S, Bach Á, Matievics V, Erdélyi E, Sztanó B, Szegesdi I, et al. A new solution for neonatal bilateral vocal cord paralysis: Endoscopic arytenoid abduction lateropexy. Laryngoscope. 2017;127(7):1608-14.
21. Montague GL, Bly RA, Nadaraja GS, Conrad DE, Parikh SR, Chan DK. Endoscopic percutaneous suture lateralization for neonatal bilateral vocal fold immobility. Int J Pediatr Otorhinolaryngol. 2018;108:120-4.
22. Sztano B, Bach A, Matievics V, Erdelyi E, Szegesdi I, Wootten CT, et al. Endoscopic arytenoid abduction lateropexy for the treatment of neonatal bilateral vocal cord paralysis-Long-term results. Int J Pediatr Otorhinolaryngol. 2019;119:147-50.