Bilateral Recurrent Laryngeal Nerve Injury after Thyroid Surgery: A Case Report

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Abstract:

The recurrent laryngeal nerve (RLN) roughly consists of 1–3 abductor branches that innervate the posterior cricoarytenoid muscle, and 3–5 adductor branches that respectively innervate the lateral cricoarytenoid, thyro-arytenoid and interarytenoid muscles. The mechanisms of injury to the nerve include stretch, clamping, suture ligation, scarring and hematoma compression, electrical burns, and transection due to limited knowledge of the anatomic course of the nerve. Studies have shown that factors such as ≥ 65 years of age, thyroid carcinoma, secondary surgery, total thyroidectomy, external laryngeal branch variation of the RLN and anatomical variation, and failure of nerve identification are likely to cause RLNI. Bilateral posterior branches are injured, the patient may have breathing difficulties and even suffocation. This article reports a case of bilateral recurrent laryngeal nerve injury (RLNI) after thyroidectomy.

The patient, a 35-year-old female, was admitted to the hospital on April 6, 2021 because of "the discovery of a mass for more than 3 years". Total thyroidectomy was performed under general anesthesia on April 8, 2021.Surgery-caused bilateral RLNI occurred after the surgery. The patient underwent direct end-to-end anastomosis and free nerve grafting for the injured left and right RLNs, respectively. Three months after the operation, the symptoms of hoarseness and choking on water disappeared, and the vocal cord movement was significantly improved.

For RLNI, if conservative treatment fails, active surgical exploration should be performed, and surgical repair should be provided as soon as possible to restore nerve function. Using the ansa cervicalis as a free nerve to directly bridge the two ends of the RLN with a larger defect has shown a significant repair effect. To date, no related clinical cases have been reported.

Key words: recurrent laryngeal nerve, ansa cervicalis nerve, free nerve grafting.

1.Introduction

The RLN roughly consists of 1–3 abductor branches (also known as posterior branches) that innervate the posterior cricoarytenoid muscle, and 3–5 adductor branches (also known as anterior branches) that respectively innervate the lateral cricoarytenoid, thyro-arytenoid and interarytenoid muscles (transversus and obliques). If a posterior branch on one side is injured, the patient will not experience any clinical symptoms; if an anterior branch or all branches on one side are damaged, hoarseness may occur; if bilateral posterior branches are injured, the patient may have breathing difficulties and even suffocation[1].

The mechanisms of injury to the nerve include stretch, clamping, suture ligation, scarring and hematoma compression, electrical burns, and transection due to limited knowledge of the anatomic course of the nerve. The distribution of RLNI types, in order of frequency, was traction (52.6%), compression (38.8%), thermal (7.8%), and nerve transection (0.9%). 93.1% of nerve injuries can be fully recovered, while nerve ruptures are often difficult to recover[2,3]. Studies have shown that factors such as ≥ 65 years of age, thyroid carcinoma, secondary surgery, total thyroidectomy, external laryngeal branch variation of the RLN and anatomical variation, and failure of nerve identification are likely to cause RLNI. The incidence of RLNI is also closely related to the training and experience of the surgeon. RLNI is relatively low among less experienced physicians, however, the incidence increases as more experience is gained, and then gradually decreases with further accumulation of experience[4,5]. In this case, the bilateral RLNs were completely severed, which is very rare in clinical practice. Comprehensive analysis indicated that failure of nerve identification, intraoperative overstretching, total thyroidectomy and inadequate experience of the surgeon were the main causes of bilateral RLNI in this case.

2.Case presentation

The patient, a 35-year-old female, was admitted to the hospital on April 6, 2021 because of "the discovery of a mass for more than 3 years". Clinical manifestations: Complaint: The patient stated that a neck mass was found 3 years ago with no obvious cause. The mass was located on the right side of the middle of the neck, which gradually increased in size, with a diameter of about 4 cm at the time of consultation. No redness, swelling, pain, dysphagia, polyphagia, high irritability, weight loss, cough and expectoration, blood in the sputum, chest tightness, tightness of breath, dizziness, headache or other discomforts were noted. Physical examination: A raised mass was seen under the thyroid cartilage, about 4.0 cm×3.0 cm in size, without tenderness. It had a hardness similar to normal tissue and moved up and down with swallowing. The local skin had no rupture or flush. There was no obvious hyperemia in the pharyngeal mucosa, the bilateral vocal cord movements were normal, and the glottal closure was normal. Auxiliary examination: 1. Color Doppler ultrasound examination of thyroid and cervical lymph nodes: Multiple cystic and solid nodules in both lobes of thyroid: Category T-RADS3. 2. Video laryngoscopy: Bilateral vocal cord movements were normal, and the glottal closure was normal (Figure 1). CT of the neck: Bilateral thyroid lobe lesions, suggesting the possibility of nodular goiter (Figure 2). Total thyroidectomy was performed under general anesthesia on April 8, 2021. Symptoms of RLNI such as hoarseness and choking on water occurred after the surgery. Video laryngoscopy revealed bilateral vocal cord paralysis with markedly restricted vocal cord abduction and adduction movements in a paramedian position (Figure 3). Postoperative hormone shock, eurotrophic and other treatments were provided for 5 days, which were ineffective. Surgery-caused bilateral RLNI was considered. On April 13, 2021, the patient was again subjected to RLN exploration under general anesthesia. A second skin incision was made along the original thyroid incision to separate the subcutaneous tissue and the anterior cervical muscle group. Part of the RLN entering the larynx was exposed behind the cricothyroid joint, and the RLN was reversely separated to the injury site of the RLN. The bilateral RLNs were seen to be completely severed, and the two severed ends of the left RLN could be joined without tension. The right RLN had a defect of more than 10 mm. RLN repair was therefore performed. The left RLN was subjected to end-to-end anastomosis: The proximal and distal ends of the RLN were separated long enough to relieve tension. After appropriate trimming of the two severed ends, tension-free anastomosis was performed under a microscope, and the nerve junction was sutured with 9-0 polypropylene sutures. The epineurium was sutured with 4 stitches (Figure 4). The right RLN underwent free nerve grafting (i.e., RLN-ansa cervicalis-RLN anastomosis): The affected carotid sheath was separated to expose the common carotid artery and internal jugular vein, and the ansa cervicalis nerves travel through the common carotid artery and the internal jugular vein. The main branch of the ansa cervicalis was carefully separated, and a segment of the branch was cut off as a free nerve. After the two severed ends of the RLN were properly trimmed, they were sutured to the two ends of the free nerve of ansa cervicalis with 9-0 polypropylene sutures under a microscope. The epineurium was sutured with 4 stitches, and the nerve was ensured to be not tight after suture. The incision was closed after adequate hemostasis (Figures 5 and 6).

3.Findings

One month after the operation: The symptoms of choking on water and hoarseness were the same as before. The bilateral vocal cords were completely paralyzed in the paramedian position, with restricted abduction and adduction movements, and the glottis could not close (Figure 7). Follow-up visit at 2 months after nerve repair: The symptoms of choking on water and hoarseness were significantly improved. The adduction movement of bilateral vocal cords was improved, and there was a gap in the closure of the glottises. During inspiration, the left vocal cord was in the median position and the right vocal cord was in the paramedian position (Figure 8). Three months after the operation, the patient's symptoms of choking on water and hoarseness were resolved. The bilateral vocal cord movements were further improved, with restricted abduction movement and basically normal adduction movement, and the glottis could be closed completely. For the left side, both adduction and abduction movements returned to normal, with the vocal cord in paramedian position during deep breathing and in median position during phonation. For the right side, the adduction movement was improved significantly but was still restricted compared to the left side, and the abduction movement was slightly restricted, with the vocal cord in paramedian position during deep breathing and in median position during phonation (Figure 9). There was no spastic immobility and synkinesis or laryngospasm of the vocal cords.

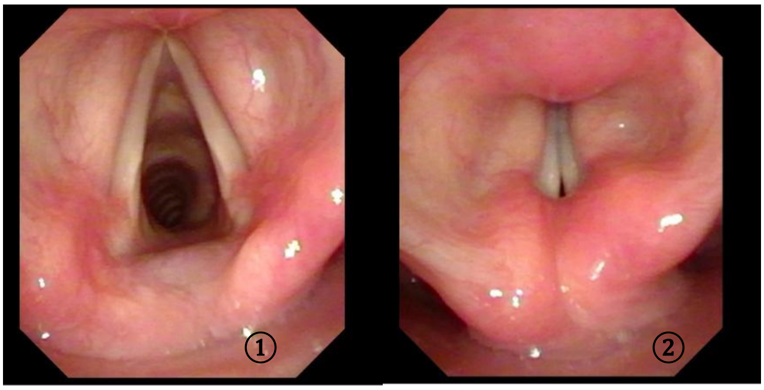

Figure 1. Preoperative video laryngoscopy: Bilateral vocal cord abduction and adduction movements were normal, and the glottises were well closed. (1): Vocal cord abduction (2): Vocal cord adduction.

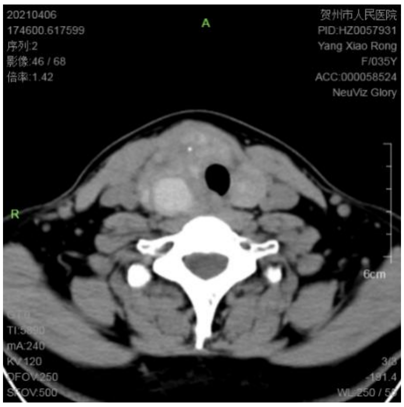

Figure 2. Preoperative CT scan of the neck showed multiple cystic and solid nodules in both lobes of the thyroid.

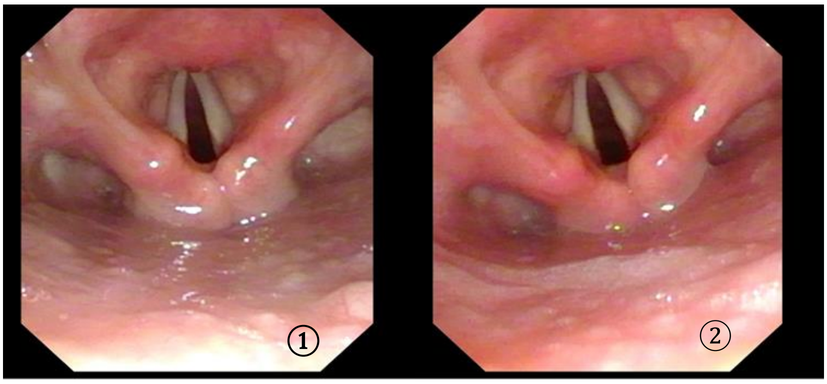

Figure 3. Video laryngoscopy 2 days after the operation: (1) (2) Bilateral vocal cord abduction and adduction movements were completely restricted, and the vocal cords were located in the median position. (1): Vocal cord abduction (2): Vocal cord adduction.

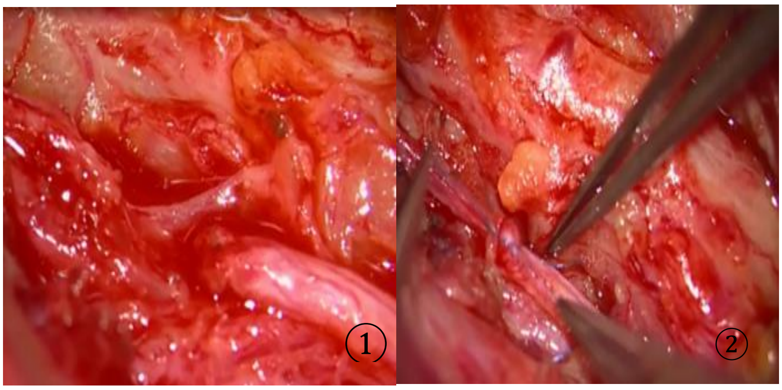

Figure 4. (1) Severed left RLN; (2) End-to-end anastomosis of the left RLN

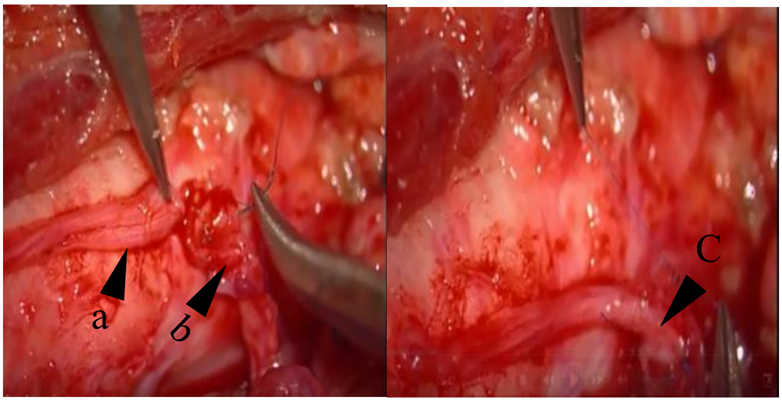

Figure 5 a: Ansa cervicalis; b: Proximal end of the right RLN; c: Proximal end of the right RLN-ansa cervicalis anastomosis.

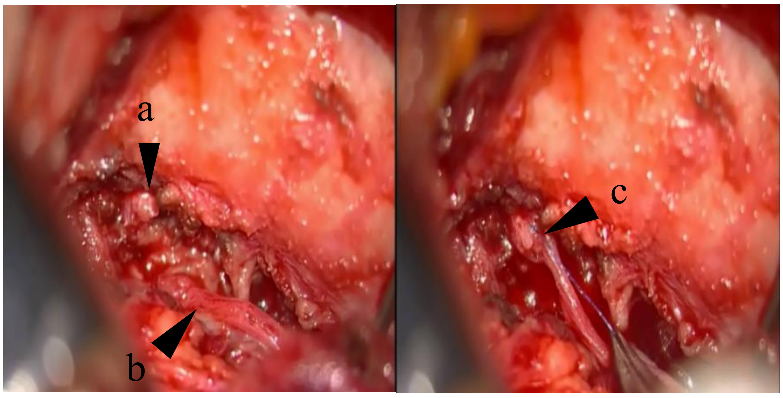

Figure 6. a: Ansa cervicalis; b: Distal end of the right RLN; c: Distal end of the right RLN-ansa cervicalis anastomosis

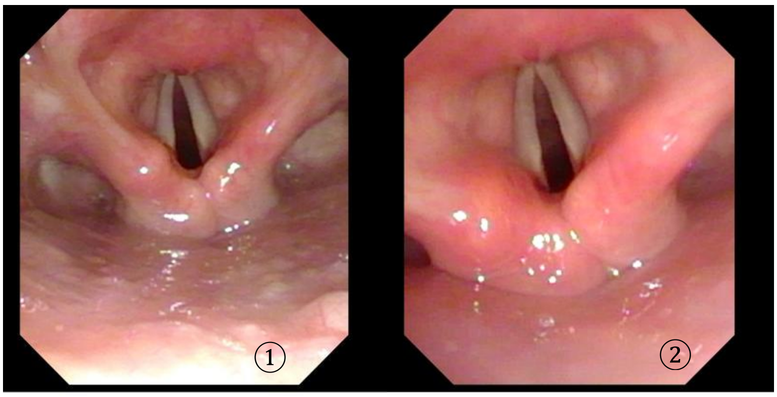

Figure 7. Electronic laryngoscopy at 1 month after nerve repair. The bilateral vocal cords were completely paralyzed in the paramedian position, with restricted abduction and adduction movements, and the glottis could not close. (1): Vocal cord abduction (2): Vocal cord adduction.

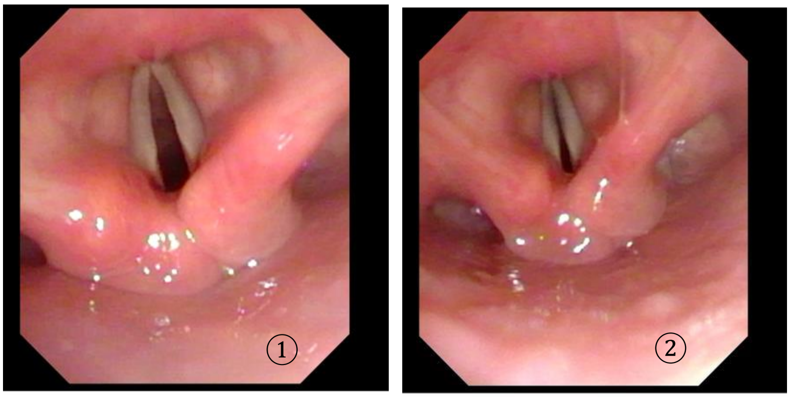

Figure 8. Electronic laryngoscopy at 2 months after nerve repair: Bilateral vocal cord adduction was improved, and there was a gap in the closure of the glottises. During inspiration, the left vocal cord was in the median position and the right vocal cord was in the paramedian position. (1): Vocal cord abduction (2): Vocal cord adduction.

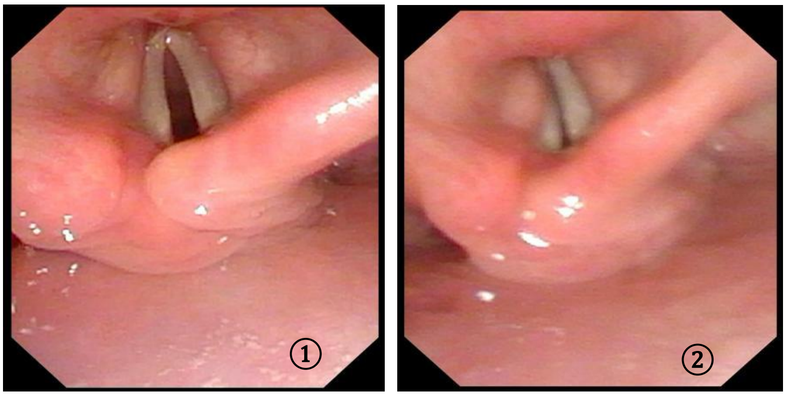

Figure 9. Video laryngoscopy at 3 months after nerve repair: The bilateral vocal cord movement was further improved. For the left side, both adduction and abduction movements returned to normal, with the vocal cord in paramedian position during deep breathing and in median position during phonation. For the right side, the adduction movement was improved significantly but was still restricted compared to the left side, and the abduction movement was slightly restricted, with the vocal cord in paramedian position during deep breathing and in median position during phonation. (1): Vocal cord abduction (2): Vocal cord adduction.

4.Discussion

RLN repair for unilateral vocal cord paralysis aims to restore the RLN adduction function. Nerve repair methods for unilateral RLNI include RLN decompression, direct end-to-end anastomosis, free nerve grafting, ansa cervicalis-RLN anastomosis, vagus nerve-RLN anastomosis, and implantation of ansa cervicalis nerve-muscle pedicle in lateral cricoarytenoid and thyroarytenoid muscle, etc.[6]. The purpose of repair of bilateral RLNI is to relieve airway obstruction and preserve or restore speech and swallowing functions as much as possible. For the repair of bilateral RLNI, scholar Crumley recommended against the technique of direct end-to-end anastomosis due to the following fact: The vocal cord abductors only have the posterior cricoarytenoid muscle, while the vocal cord adductor muscles include lateral cricoarytenoid, thyro-arytenoid and interarytenoid muscles, the misdirection of regenerating nerve may cause a stronger vocal cord adduction force compared to the abduction force, resulting in inward displacement of the vocal cords, which may exacerbate dyspnea in patients with bilateral vocal cord paralysis[7,8]. Zheng Hongliang's research team attempted to repair the bilateral RLNI via the selective laryngeal reinnervation technique using the superior root of unilateral phrenic nerve and the thyroglossus branch of the hypoglossal nerve, and has achieved good results. The surgical procedure was as follows: The superior root of unilateral phrenic nerve is selected for anastomosis with the common trunk of the free Y-shaped cervical plexus nerve; the other two severed ends of the Y-shaped cervical plexus nerve are respectively anastomosed with the proximal laryngeal abductor branches of the bilateral RLNs, and the proximal laryngeal adductor branches of the bilateral RLNs are respectively anastomosed with the proximal ends of the bilateral hypoglossal nerve thyroglossus muscle branches through separating the cervical plexus nerve. Since the phrenic nerve discharges during the inspiratory phase, the bilateral posterior cricoarytenoid muscles, after being reinnervated by it, can abduct the bilateral vocal cords during inspiration, while the thyroglossus branch of the hypoglossal nerve discharges during vocalization and innervates bilateral vocal cord adductors to improve bilateral vocal cord closure during phonation. This method enables selective reinnervation of bilateral internal laryngeal muscles, restores coordinated abduction and adduction movements of bilateral vocal cords, and improves dyspnea and vocal function[9].

After end-to-end anastomosis of the RLN, nerve fibers may regenerate in the wrong direction, and the regenerated axons fail to enter the target tissue accurately and selectively, which may cause a greater adduction force of the vocal cords compared to the abduction force, resulting in inward displacement of the vocal cords and paradoxical movement of the vocal cords or laryngeal synkinesis after surgery[7]. In addition, the number of RLN adductor muscle fibers is 4 times that of the abductor muscle fibers, the laryngeal adductor muscle is thicker than the abductor muscle, and therefore the vocal cords with nerve regeneration are often fixed in the median position[10]. In this case, the left vocal cord was over-adducted after surgery, and the position was fixed to the median position, which may be caused by paradoxical movement of the vocal cord due to misdirection of regenerating nerve after end-to-end anastomosis of the left RLN.

A free nerve bridging two severed nerve ends can be used to repair the RLN with a larger defect. It has been reported that the use of a segment of free cervical plexus to bridge the proximal end of the ansa cervicalis nerve and the distal end of RLN has a good effect in repairing unilateral RLNI[11]. The ansa cervicalis nerve and the RLN are very similar in function and structure, and their anatomical positions are close. There are few complications in sacrificing the ansa cervicalis nerve, and therefore the ansa cervicalis is often used as a substitute of RLN[12]. It is conventionally believed that in free nerve grafting, less nerve fibers will reach the effector (internal laryngeal muscle) as the regenerated nerve fibers have to cross two anastomosed sites, and therefore, the surgical effect will be expectedly undesirable, and the time required for sound recovery will also be longer. In this case, the ansa cervicalis nerve was used as a free nerve to bridge the two severed ends of the right RLN, so as to guide RLN repair. At the follow-up visit 3 months after surgery, the right vocal cord's adduction and abduction movements of the patient were well recovered. There were no excessive inward displacement of the vocal cords, spasm or paradoxical movements, indicating good repair effect, but the specific mechanism remained unclear.

Whether the nerve function bundles can be accurately docked is the key to the repair effect. Studies have shown that nerve regeneration is selective and chemotactic. Reserving the space between the two ends of the nerve for selective regeneration is beneficial to the accurate docking of the nerve axons. By using autologous arteries, veins, and autologous epineurium as the tubing material, the small gap bridging technique achieves a better postoperative nerve repair effect than direct epineurial suture[13-15]. For patients with large nerve defects that cannot be repaired with small gap bridging, the nerve conduit bridging technique can be performed, which provides a "microenvironment" suitable for nerve growth. This technique has the following advantages: 1. Supporting and guiding nerve repair; 2. Preventing the invasion of surrounding connective tissue and the formation of scarring; 3. Preventing regenerated axons from overflowing from the anastomosed site, which can reduce the occurrence of neuroma compared with traditional nerve anastomosis; 4. Maintaining the endogenous and exogenous substances (such as neurotrophic factors) that promote the chemotactic growth of axons[16]. By wrapping or intertwining with the severed nerve, the artificial nerve conduit forms a new extracellular scaffold around the lesion, providing guidance for the growth of axons, allowing blood vessels, fibroblasts and Schwann cells to migrate on the scaffold and form new neural structures, while creating a barrier between the healed nerve and the surrounding inflammation and fibrosis[17]. In this case, the right RLN defect was repaired by bridging with the ansa cervicalis nerve, which, from a structural point of view, is similar to small gap bridging and nerve conduit bridging techniques. It not only ensures sufficient space between the two nerve ends for selective and chemotactic nerve regeneration, facilitating accurate docking of nerve axons, but also constructs a nerve regeneration chamber to provide a "microenvironment" suitable for RLN nerve growth. Nerve fragments can effectively promote peripheral nerve regeneration in veins or skeletal muscle bridges[18]. Studies have shown that adding of nerve fragments into the small space of the epineurium can promote nerve regeneration[19]. Were the nerve fibers in the free ansa cervicalis nerve acting as nerve fragments in this case? To answer this question, further discussion is required.

In this case, the left RLN was subjected to end-to-end anastomosis, and the right RLN underwent free nerve grafting. The adduction function of the left vocal cord was obviously restored, and the right vocal cord had certain adduction and abduction functions. After the operation, the patient had fully recovered speech function, without complications such as choking on water and shortness of breath. The bridging technique using ansa cervicalis as the free nerve avoids the denervation dysfunction of donor site caused by the cut of the substitution nerve, compared with ansa cervicalis-RLN anastomosis, vagus nerve-RLN anastomosis, phrenic nerve transposition and other surgical methods.

5.Conclusions

Anatomical and functional preservation of the RLN is the key to thyroid surgery. Therefore, surgeons should improve their awareness of protecting the RLN and avoid violent operations. For RLNI, if conservative treatment fails, active surgical exploration should be performed, and surgical repair should be provided as soon as possible to restore nerve function. Using the ansa cervicalis as a free nerve to directly bridge the two ends of the RLN with a larger defect has shown a significant repair effect. To date, no related clinical cases have been reported. This case created a paradigm shift and provided new ideas for the treatment of bilateral vocal cord paralysis. However, because clinical cases are relatively contingent, it is necessary to carry out a randomized controlled study with a large sample size.

References:

[1]. Chen, D., et al., Spontaneous regeneration of recurrent laryngeal nerve following long-term vocal fold paralysis in humans: histologic evidence. Laryngoscope, 2011. 121(5): p. 1035-9.

[2]. Liu, N., et al., Mechanisms of recurrent laryngeal nerve injury near the nerve entry point during thyroid surgery: A retrospective cohort study. Int J Surg, 2020. 83: p. 125-130.

[3]. Wu, R., et al., Clinical observation of end-to-end neuroanastomosis in the treatment of complete injury of the unilateral recurrent laryngeal nerve. Gland Surg, 2020. 9(6): p. 2017-2025.

[4]. Zakaria, H.M., et al., Recurrent laryngeal nerve injury in thyroid surgery. Oman Med J, 2011. 26(1): p. 34-8.

[5]. Joliat, G.R., et al., Recurrent laryngeal nerve injury after thyroid and parathyroid surgery: Incidence and postoperative evolution assessment. Medicine (Baltimore), 2017. 96(17): p. e6674.

[6]. Expert consensus on the diagnosis and treatment of vocal cord paralysis. Chinese Journal of Otolaryngology Head and Neck Surgery, 2021. 56 (03): p. 198-209.

[7]. Crumley, R.L., Laryngeal synkinesis revisited. Ann Otol Rhinol Laryngol, 2000. 109(4): p. 365-71.

[8]. Crumley, R.L., Experiments in laryngeal reinnervation. Laryngoscope, 1982. 92(9 Pt 2 Suppl 30): p. 1-27.

[9]. Li, M., et al., Selective reinnervation using phrenic nerve and hypoglossal nerve for bilateral vocal fold paralysis. Laryngoscope, 2019. 129(11): p. 2669-2673.

[10]. Miyauchi, A., et al., Improvement in phonation after reconstruction of the recurrent laryngeal nerve in patients with thyroid cancer invading the nerve. Surgery, 2009. 146(6): p. 1056-62.

[11]. Li, M., et al., Bridging gaps between the recurrent laryngeal nerve and ansa cervicalis using autologous nerve grafts. J Voice, 2013. 27(3): p. 381-7.

[12]. FAABORG-ANDERSEN, K. and W. VENNARD, ELECTROMYOGRAPHY OF EXTRINSIC LARYNGEAL MUSCLES DURING PHONATION OF DIFFERENT VOWELS. Ann Otol Rhinol Laryngol, 1964. 73: p. 248-54.

[13]. Jiang Baoguo, Li Jian, Replacing the traditional neural epineurium suture-small gap bridging method to repair peripheral nerve injury. Chinese Journal of Orthopaedic Surgery, 2003 (08): p. 36-38.

[14]. Yin Weitian et al. Experimental study on small gaps bridging and epineurial suture in repairing rupture of peripheral nerve. Journal of Jilin University (Medical Edition), 2005 (06): p. 869-871.

[15]. Ma Hua, Nerve fragments combined with NGF in the repair of peripheral nerve injury in the small space of autologous epineurium. Journal of Aerospace Medicine, 2017. 28 (04): p. 389-391.

[16]. Taras, J.S., V. Nanavati and P. Steelman, Nerve conduits. J Hand Ther, 2005. 18(2): p. 191-7.

[17]. Sun Guoping, Luo Xuanxiang, Pan Bin, Material types and application status of artificial nerve conduits for treating peripheral nerve injury. Chinese Journal of Bone and Joint Injury, 2021. 36 (03): p. 334-336.

[18]. Uchio, E., et al., A novel device for minimally invasive harvest of the sural nerve. Conn Med, 2012. 76(1): p. 27-31.

[19]. Ma Hua, Nerve fragments combined with NGF in the repair of peripheral nerve injury in the small space of autologous epineurium. Journal of Aerospace Medicine, 2017. 28 (04): p. 389-391.