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ORIGINAL ARTICLE

Arytenoid Release Procedure Plus Exo-Endolaryngeal Suture Lateralization with Precise Suture Placement

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Purpose: Bilateral vocal fold immobility (BVFI) presents a challenging endeavor to surgeons and a suture lateralization (SL) procedure under endoscopy has been proposed to treat BVFI. The goal of this study is to introduce an adaptable method to calibrate an appropriate entrance on the thyroid lamina for the stitch canal to precisely reach an appropriate endolaryngeal site for the suture loop placement and minimize the endolaryngeal soft-tissue (ELT) damage. **Materials and Methods:** From 2007–2015, a total of 38 patients with BVFI due to various causes had undergone 40 exo-endolaryngeal SL (exoeSL) procedures in our hospital. The former 20 patients had undergone so-called blind suture loop placement procedures. The latter 18 patients had been treated with a refined suture placement technique. **Results:** The suture placement in former 20 patients had undergone one to three episodes of needle entrances into the ELT with average of 1.7 episodes each patient and caused one paraglottic hematoma. The latter 18 of the 38 patients had obtained one episode of ELT damage each patient and produced no vascular events. **Conclusions:** The topographic relationship of the pyriform recess on the thyroid lamina can serve as a consistent and surgically useful landmark for avoiding the paraglottic dead space infection from the stitching canal during the SL procedure. With this suture placement refinement, the exoeSL procedure can really obtain a relatively appropriate endolaryngeal site to place the suture loop and decrease the ELT damage.

Key words: Bilateral vocal fold immobility, suture lateralization, pyriform sinus mucosa, paraglottic hematoma

INTRODUCTION

The literature indicates that bilateral vocal fold immobility (BVFI) will frequently occur after thyroid surgery (25.7%), followed by endotracheal intubation (15.4%), brain stroke (12.8%), and chemoradiotherapy (1.7%).[1] Several operations to eliminate the dyspnea and the resultant tracheostomy will often result in impaired voice quality and aspiration subsequently. Among them, laser surgery had become widespread because of its ease and rapidity since Ossoff *et al*. proposed this procedure in 1984.[2] Endoscopic laser surgery had commonly been used but could result in the formation of granulation tissue leading to renarrowing of the airway or excessive enlargement of the glottic lumen which was irreversible.[3] Most of the laser surgery actually ablated partial arytenoid cartilage, large proportion of vocal ligament, and the thyroarytenoid (TA) muscle to achieve enlargement of the glottic lumen.[3-5] The cricoarytenoid joint (CAJ) and CAJ fixation (CAJF) were often developed after the first session of laser surgery. This will complicate the following salvage procedure if it recurred. Although the laser surgery could be reused, the scarring tissue composed of the vocal ligament, TA muscle, and the remnant arytenoid cartilage became more and more firm and limited its subsequent use. Some of the participants had even been condemned to total laryngectomy eventually.

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Endoscopic suture lateralization (SL) has gradually become widely used because it has a lower recurrence rate and better reversibility than endoscopic laser surgery.[6] A SL procedure using special designed instruments to achieve the endo-exolaryngeal SL (endoeSL) or using so-called blind exo-endolaryngeal SL (exoeSL) had been proposed to maintain the mucous membrane integrity and even expected the recovery of vocal mobility for patients with temporary neurogenic vocal palsy.[6] In 1997,[7] Lichtenberger and Toohill used an endo-extralaryngeal needle carrier for SL to secure the effect of laser surgery. To reduce laryngeal obstruction, Ejnell *et al*.[8,9] firstly suggested a simple method of lateral fixation of the vocal fold through the use of an exoeSL without the aid of laser surgery in 1980. Su *et al*.[10] further confirmed the value of the exoeSL in patients with bilateral vocal cord paralysis in 2014.

The endoeSL using special designed instruments has been characterized with the direct visional guidance under endoscopy. On the contrary, the exoeSL had usually been criticized as a blind procedure. We have carefully reviewed all the English written literature introducing their surgical techniques placing the suture loops exo-endolaryngeally.[8,9] Various landmarks for the needle introduction on the thyroid lamina had simply been described which still made them appear blind procedures. Because of this blind procedure and one resultant episode of the paraglottic hemorrhage in our previous exoeSL, we introduce an adaptable technique to calibrate an appropriate entrance on the thyroid lamina for the stitch canal to precisely reach an appropriate endolaryngeal soft tissue (ELT) for the suture loop placement and minimize the ELT damage.

MATERIALS AND METHODS

Between 2001 and 2015, 213 patients were diagnosed as vocal cord palsy in two institutions and one single surgeonti practice. Among them, 75 patients suffered from BVFI due to various causes and 38 of them who had undergone SL between 2007 and 2015 were included in this series. The former 20 patients had undergone so-called blind suture loop placement procedures. The latter 18 patients had been treated with this slightly refined technique.

If the previous laser surgery had been used on one side, then the contralateral side will be preferred. If both the vocal cords had been operated by laser surgery, either vocal cord is available, although the cord with smooth surface and less fibrosis, if it exists, is usually reserved to allow for postoperative phonatory function or for a second operation if required. After the rigid videolaryngoscopy is introduced under general anesthesia, the CAJ mobility and vocal fold volume and its texture are checked by tactile sensation through the cold instrument. Plus the history of laser surgery, the operative side will be determined.

The first step is an open surgery for the arytenoid release. We have previously described the specific details of the surgical technique.[10,11] Briefly, a horizontal incision is made at the level of the lower edge of the thyroid cartilage. Strap muscles and inferior constrictor muscle are divided to expose the oblique line and the lower half and posterior edge of the thyroid lamina on the lateralization side. The inferior constrictor muscle and its inner lining, the pyriform sinus mucosa, are dissected from the thyroid cartilage. The anterior border of the pyriform sinus is further bluntly dissected and retracted in a lateral-to-posteromedial direction until the muscular process can be palpated. Then, the CAJ is identified, and the arytenoid cartilage is separated from the cricoid cartilage or totally removed. The TA muscle, vocal ligament, and their fibrotic tissues are completely detached from the arytenoid cartilage. The depth of the paraglottic dead space is measured from the posterior edge of the thyroid lamina to the deepest end of the space [B in Figure 1]. A mark is made on the thyroid lamina which is opposite to the "he as a reference for injection needle entrance.

The second step is an exoeSL procedure after the larynx is exposed microsurgically using a 0° telescopy. An injection needle (1.1 × 40 mm, 21# Sterican Hypodermic Needle; Braun Melsungen AG, Melsungen, Germany) is used to mark a point [C in Figure 1] on the thyroid lamina 2 mm at least anterior to the reference point [B in Figure 1] and 5 mm superior to the inferior margin of the thyroid cartilage in men and 4 mm in women. A needle canal is created on the thyroid lamina for the upper stitch (stitch above the vocal cord) at the previously

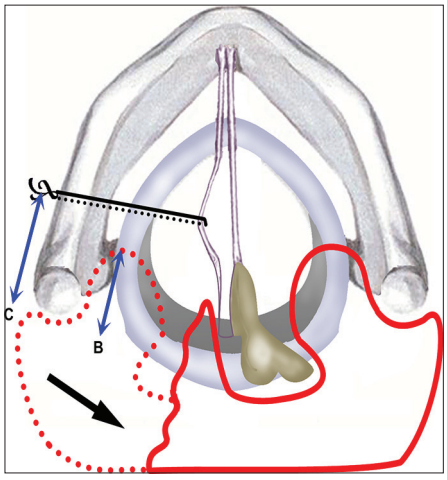

Figure 1: A pen drawing further illustrates the surgical method in the clinic. The pyriform sinus mucosa (arrow) has been peeled off from thyroid lamina. "B": distance from the deepest wound bed in the paraglottic space and "C": from the entrance of needle to the margin of thyroid lamina. It should be 2 mm anterior to the measurement B

measured point [Figure 2A: a]. If the injection needle enters the dead space which can be actually felt by surgeonyn hand, the injection needle entrance point should be moved anteriorly (2 mm at least). A blunt needle (A same size needle reshaped into a blunt tip) will reenter the thyroid canal and push the ELT on the inner perichondrium which will show a protuberance [Figure 2B: a'] on the endolarynx. If the protuberance is an appropriate point for the suture placement, a 21# needle will be introduced into the glottic lumen and the 2# nylon stitch will be carried through the needle canal, and then into the lumen. If the protuberance is not appropriate, a second attempt [Figure 2A: b] and its protuberance [Figure 3A: b'] can be created according to the previous thyroid entrance [Figure 2A: a] and its protuberance [Figure 2B: a']. Thus, the stitch canal into the glottic lumen will damage the ELT for only one episode. The protuberance for the lower stitch (stitch below the vocal cord) will be searched for according to the upper stitch. The loop [Figure 3B] and knot formation is the same as the previous method.[10]

Ethical considerations

The study was reviewed and approved by the Institutional Review Board of Buddhist Tzu Chi General Hospital-Taipei Branch. All methods were performed in accordance with the relevant guidelines and regulations.

RESULTS

A total of 38 paticipants (8 men and 30 women) were analyzed. The vast majority (31) of the patients had BVFI following thyroid surgery. The other causes of the BVFI were cardiac surgery in 2 patients, surgery of esophagus in 2 patients, traffic accident in one patient, irradiation for nasopharyngeal cancer in 1 patient, and an unknown cause in 1 patient. Their mean age was 58 years (range, 30–81) and the mean time from the onset of the BVFI to the operation was 37 months (range, 0–282). The mean follow-up duration was 37 months (range, 9–88) and 9 months at least.

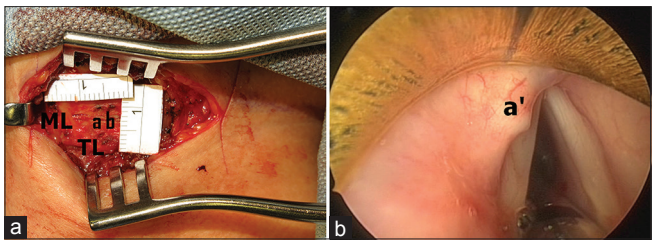

Figure 2: (a) The first needle entrance (a) on the left thyroid lamina was measured as 14 mm from the midline and 12 mm above the lower edge of thyroid lamina. (b) The endolaryngeal protuberance (a') arising from the blunt needle in the paraglottic soft tissue appeared at the ventricular fold near anterior one-third of the membranous cord and was not favored

The suture placement in former 20 patients had needed one to three episodes of needle entrance into the ELT with average of 1.7 episodes each patient and caused one paraglottic hematoma. The refined technique has helped identifying the appropriate suture placement in the latter 18 of the 38 patients and produced no vascular events.

Case 1

A 62-year-old female suffered from BVFI after thyroidectomy 22 years ago and had undergone 4 sessions of laser surgeries among those years. Emergency intubation was performed due to hepatic coma 2 months before this admission. Decannulation was demanded after the hepatic event. The general anesthesia was performed through the existed tracheostoma. After the arytenoid release procedure was performed in the left side, the mucous membrane of vocal cord showed pliable compared to the opposite cord and eligible for an exoeSL procedure. The decannulation and well respiration were eventually obtained at 12 months of follow-up. No acute infection of the surgical wound was resulted.

Case 2

A 63-year-old female suffered from BVFI after thyroidectomy for 7 months. Mild Parkinson'r disease with no obvious extremities disability had produced little swallowing problem for 12 years. Diabetes mellitus had been controlled by insulin injection for 7 years. After the arytenoid cartilage was separated from the cricoid cartilage in the left side, the exoeSL procedure with lower needle at lower edge of thyroid lamina 20 mm from the posterior edge of the thyroid lamina and upper needle at 22 mm from the posterior edge produced a sufficient glottic gap [Figure 3B]. Moreover, the glottic gap persisted sufficiently for 1 year. Decannulation and uneventful postoperative course were obtained.

DISCUSSION

The main objective in the treatment of patients with BVFI is to provide a competent and stable airway without the need

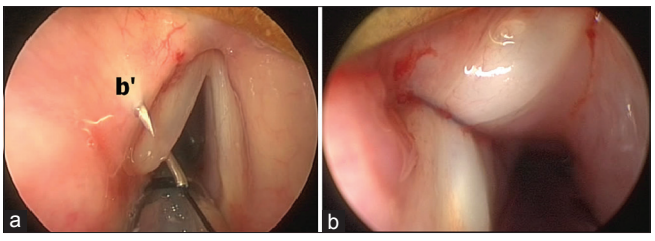

Figure 3: (a) The calibrated entrance (b in Figure 2A) showed its protuberance (b') near the posterior one-third of the membranous cord and served as a favored upper stitch canal. (b) The endoscopic view showed an enlarged posterior glottis after the suture lateralization

for a tracheostomy. Although the laser surgery had provided a rapid and simple method to resolve the airway compromise, its inconsistency however supported or justified the SL procedure characterized by its efficacy-persistence. To achieve adequate lateralization of vocal fold by the suture, two conditions are usually required in the glottis to provide adequate compliance for lateralization; a pliable vocal fold and a free CAJ mobility. In the BVFI victims without related surgery on the glottis, the vocal fold usually appeared pliable, and the CAJ might be usually free (35/38 in our chart review) or occasionally fixed (3/38). However, in the BVFI victims with previous laser surgery on the glottis, the vocal fold usually turned to be firm and the CAJ was consequently fixed because of the thermal effect. In our experience, after 23 successful decannulations or dyspnea eliminations by a single exoeSL procedure, one exoeSL procedure failed in a patient suffering from BVFI with CAJF which urged us to search for a new, improved method.

A SL procedure under endoscopy has usually been used to treat BVFI. Actually, an exoeSL procedure had several advantages over the endoeSL one. For example, it can be commonly performed without the demand of jet ventilation or special designed instruments. Severely calcified thyroid cartilage can be also easily overcome with a drill to create a stitch canal from outside the larynx. However, the suture placement from outside the larynx has usually been criticized as a blind procedure no matter what surgical landmarks on the thyroid lamina they used to introduce the needle into the larynx. Ejnell *et al*.[8,9] had suggested that an injection needle was inserted 5 mm anterior to the oblique line and 5 mm above the lower margin of the thyroid cartilage. Ezzat *et al*.[12] had suggested that two cannulae were inserted into the thyroid cartilage 0.5 cm above and below the level of the true vocal cord without basic measurements on the thyroid cartilage. Su *et al*.[10] had suggested a basic measurement that was 13 mm from the midline and 5 mm superior to the inferior margin of the thyroid cartilage in men and 11 and 4 mm, respectively, in women.

Because the vocal cord position relative to the thyroid lamina lower edge [Figure 2A: TL] may be changed with the rigid laryngoscope placed inside the endolarynx, the entrance on the thyroid lamina to reach an appropriate suture placement in the endolarynx may be consequently changed. This change usually makes the basic measurements on the thyroid lamina even more inaccurate. Through the visual feedback of the endolaryngeal protuberance, we can change the entrance on the thyroid lamina without the ELT damage.

In our previously used method, we had usually introduced the sharp needle through the thyroid lamina, ELT and then glottic lumen directly. Thus, one or two or even three episodes of ELT damage had occurred and had usually been criticized as blind procedure. After this adaptable method started to be applied in the last 18 patients, we had successfully minimized the ELT damage using the endolaryngeal protuberance as the visual feedback instead of the needle tip in the glottic lumen.

Although the endoeSL can also provide a precise suture placement, a videoendoscope and a special designed instrument[3,13] seem to be crowded inside the limited laryngoscopic space, and consequently, the use of jet ventilation seems to be unavoidable. On the contrary, in the exoeSL procedure, a videoendoscope and a thin forceps for the thread grasping can even allow the coexistence of the endotracheal tube. After this suture placement refinement of surgical technique, the exoeSL procedure can really highlight itsh advantages.

The vasculature in the posterior paraglottis appears more abundant than that in the anterior one.[10] We had encountered one endolaryngeal hematoma in the former 20 patients which suggested the endolaryngeal vascular risk using a sharp penetration. This precise suture placement had minimized the ELT damage and consequently decreased the vascular risk. Although the suture loop itself can offer a tamponade effect on the ELT, the acute hemorrhage at the ELT may jeopardize the airway postoperatively or intraoperatively, especially using a jet ventilation anesthesia. Therefore, the endolaryngeal artery anatomy should be further investigated.

CONCLUSIONS

After all, the specially designed needle carrier and jet ventilation are not so commonly used in diverse affiliations. A relatively precise SL through the commonly used laryngoscope performed under widely used endotracheal anesthesia appears to be a viable option and merits an advocacy in the future. Certainly, further progress in the future with more refined techniques is demanded to establish the justification of this salvage surgery in the clinic.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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