

Laryngeal reinnervation in unilateral vocal fold paralysis - case report and literature review

Reinnerwacja krtani w jednostronnym porażeniu fałdu głosowego – opis przypadku i przegląd piśmiennictwa

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ABSTRACT:

Laryngeal reinnervation is the method of treatment in unilateral vocal fold paralysis. During the surgery an anastomosis between the main branch of ansa cervicalis and recurrent laryngeal nerve is formed. Regeneration of the nerve's functional abilities is a long process, lasting from 4 to 6 months, up to a year.

A 35 year-old male was admitted to the Department of Otolaryngology at Warsaw Medical University in order to undergo surgical removal of recurrence of Schwannoma in left cerebellopontine angle by translabyrinthine approach. Post-operative period was complicated with vagal nerve paralysis. The patient reported hoarseness, dysphagia and choking. Physical examination revealed left vocal fold immobilization in abducted position, saliva in piriform recess and left-sided soft palate paralysis yet the patient was discharged home. 4 weeks after the surgery, the patient was admitted to the hospital again due to developing aspiration pneumonia. Augmentation of the left vocal fold with calcium hydroxyapatite was performed 2 months later. After this intervention temporary vocal improvement and choking frequency reduction was observed. Finally, the patient underwent laryngeal reinnervation with formation of ansa cervicalis main branch to recurrent laryngeal nerve anastomosis. Left vocal fold regained its functional abilities and the quality of the voice improved. Laryngovideostroboscopy performed 6 months later revealed mobilization of left vocal fold sufficient for proper glottis closure. The voice measures normalized and the swallowing improved.

Conclusions This case report and analyzed data confirm that laryngeal reinnervation surgery in unilateral vocal fold paralysis helps achieve satisfactory effects in voice function and life quality.

KEYWORDS:

laryngeal reinnervation, unilateral vocal fold paralysis, glottis insufficiency

STRESZCZENIE:

Reinnerwacja krtani jest jedną z metod leczenia jednostronnego porażenia fałdu głosowego. Jedną z technik operacyjnych polega na wypreparowaniu nerwu krtaniowego wstecznego przy jego wejściu od krtani oraz zespoleniu go z gałęzią pętli szyjnej. Proces powrotu czynności nerwu krtaniowego wynosi średnio 4-6 miesięcy, ale może przedłużyć się nawet do roku. Autorzy przedstawiają opis przypadku pacjenta, u którego wystąpiło jednostronne porażenie fałdu głosowego na skutek uszkodzenia nerwu błędnego po reoperacji z dostępu przezbłędnikowego wznowy nerwiaka osłonkowego w kącie mostowo – mózdkowym. Z powodu zaburzeń głosu oraz połykania, wykonano u chorego zabieg reinnerwacji krtani, który pozwolił uzyskać powrót ruchomości fałdu głosowego i trwałą poprawę głosu.

SŁOWA KLUCZOWE: reinnerwacja krtani, jednostronne porażenie fałdu głosowego, niedomykalność głośni

INTRODUCTION

Unilateral vocal fold paralysis is usually caused by damage to the vagus nerve or the recurrent laryngeal nerve [1]. Iatrogenic damage to the vagus nerve and its branches is a common cause of unilateral vocal fold paralysis (UVFP), and accounts for about 36-55% of all cases of unilateral vocal fold immobilisation [1,2]. Surgical interventions that may cause damage to the trunk of the vagus nerve are associated with an otolaryngological and neurosurgical approaches. The recurrent laryngeal nerves are damaged far more often than the vagal trunks. This complication is usually a result of the thyroid and parathyroid gland surgery, however, it may occur after resection of cervical and oesophageal tumours [2]. Neurosurgical access to the cervical spine, endarterectomy of carotid arteries, as well as some cardiac and thoracic surgical interventions may result in damage to the recurrent laryngeal nerve. UVFP with medial or median positioning of the vocal folds may not cause any significant voice impairment and the complication remains undiagnosed after surgery. In some patients with UVFP, the vocal fold is adducted, which leads to glottic insufficiency, caused by a non-complete closure of the glottis during phonation. Patients complain about hoarseness, the voice becomes weak, breathy, with audible air [1]. Glottic insufficiency results in a greater effort associated with phonation. In the case of high-level injury to the vagus nerve, dysphagia is possible with a risk of choking.

CASE REPORT

A 35-year-old male patient was admitted to the Department of Otolaryngology of the Medical University in Warsaw for surgical treatment of the relapse of schwannoma in the left cerebellopontine angle. MRI scan showed progression of a schwannoma-like tumour in the left cerebellopontine angle compressing the pons and left cerebellar hemisphere, displacing and partially obstructing the fourth ventricle with no signs of an impaired cerebrospinal fluid circulation. The translabyrinth approach was performed. The sigmoid sinus, as well as the dura mater of the middle and posterior cranial fossa were exposed during surgery. The labyrinth was removed and the internal acoustic meatus was identified. A tumour arising from the lower cranial nerves was revealed and fully resected. During the postoperative course, the patient presented with dysphonia and dysphagia. On indirect laryngoscopy, the immobilization of the left vocal fold in adduction with saliva retention in the piriform recess was observed. Once the wound healed, the patient was discharged home and was given recommendations as to further phoniatic and speech rehabilitation. After about four weeks since discharge, the patient was again admitted to the Department due to aspiration pneumonia. The antibiotics were administered and the

patient was subjected to an intensive voice rehabilitation under phoniatrist's guidance, the difficulties swallowing were managed under the supervision of a speech therapist. No improvement in voice quality was achieved, and episodes of aspiration continued despite the rehabilitation. The decision was reached to perform an injection laryngoplasty of the larynx using calcium hydroxyapatite. The operation was performed under local anaesthesia and the material was applied laterally to the vocal muscle until the displacement of the vocal fold cord to the midline was achieved. After surgery, a transient improvement in voice quality and reduction in aspiration frequency was observed lasting for 2 months. Because the patient wanted to be professionally active and a proper quality of the voice was necessary for him to continue with his profession, the decision was made to perform reinnervation of the larynx 5 months after UVFP. During surgery, the recurrent laryngeal nerve was identified and dissected from the laryngoesophageal groove [piriform fossa – transl.]. It was transected as distally as possible from the laryngeal inlet. The branch of the ansa cervicalis was identified and transected. Both stumps of the nerves were prepared and an end-to-end nerve repair was performed using the recurrent laryngeal nerve and the ansa cervicalis on the left side. The anastomosis site was covered with a flap of the sternocleidomastoid muscle. Picture 1.

On laryngovideostroboscopy (LVS) 4 months after surgery, the return of vocal fold mobility and a decreased glottic insufficiency were observed. LVS examination 6 months after surgery proved even greater improvement of the vocal fold mobility and tension, so that the glottal closure was complete. Before surgical intervention, the patient's voice was evaluated in using Hirano's GRBAS scale with the following results: very severe dysphonia (G3), normally rough voice (R0), very intense breathiness (B3), very weak (A3) and very tense (S3) voice. However, perceptual assessment six months after intervention showed normalization of the following parameters: absence of dysphonia (A0), normal roughness (R0) absence of breathiness (B0), normal voice strength (A0), and slight tension (S1). Maximum Phonation Time (MPT), defined as the longest time of the phonation of 'a' vowel after maximum inhalation, was 2.1 seconds prior to reinnervation. Six months after the procedure, MPT increased to 20.8 seconds, meaning normalization of the parameter. Also, the acoustic parameters of the voice evaluated before surgery were far from normal: fundamental frequency (F0) - 180 Hz, Jitter - 10.916, Shimmer - 11.25, noise-to-harmonic ratio (NHR) - 0.43. On examination after six months, all acoustic parameters were within the normal range (F0- 160 Hz, Jitter - 0,463, Shimmer - 3,028, NHR - 0,122).

Also, self-assessment of the voice disability improved according to the Voice Handicap Index (VHI) questionnaire significantly with a decrease from 45 before treatment to 7 after surgery. The

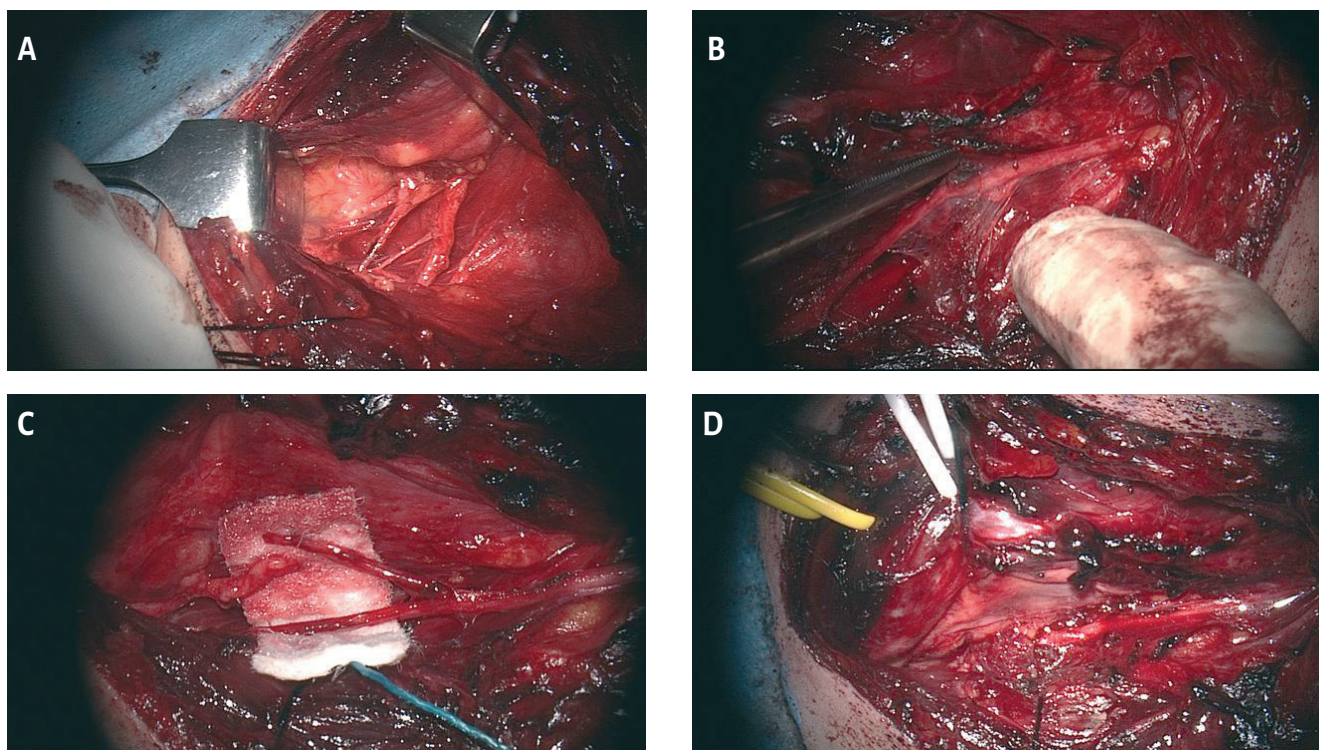


Fig. 1. Stages of laryngeal reinnervation:

- 1a – identification of the recurrent laryngeal nerve,
- 1b – identification of ansa cervicalis,
- 1c – transection of nerves and preparation for anastomosis formation,
- 1d – anastomosis between the recurrent laryngeal nerve and the branch of ansa cervicalis (end-to-end).

voice-related quality of life evaluated using the Voice-Related Quality of Life (VRQoL) questionnaire showed significant improvement from 24 to 15 following reinnervation.

DISCUSSION

Unilateral vocal fold paralysis as a complication of various surgical procedures is challenging for otolaryngologists, phoniatic specialists, and speech therapists. If a diagnosis of neurotmesis of the vagus or recurrent laryngeal nerve is not confirmed intraoperatively, usually a conservative treatment and rehabilitation are applied, waiting for a return of nerve function. Nerve regeneration is a long-term process, hence different recommendations as to the observation period ranging from 6 to even 12 months [1,2]. Unfortunately, glottic insufficiency in UVFP with adduction causes a significant decrease of the quality of voice and a significant effort related to speaking. Many patients want to stay professionally active, but UVFP prevents them from a fast return to work when they use their voice for occupational purposes. An alternative to waiting and observation

is a postoperative revision in the case of the UVFP in order to establish whether the continuity of the nerve is preserved, and in the case of a damage – to provide an early reconstruction and reinnervation of the larynx [3]. Dzodzic et al. presented the results of 11 patients, in whom the release of the recurrent laryngeal nerve from the scar immediately after the diagnosis of UVFP following strumectomy led to the return of mobility and correct phonation within 3 weeks after surgery [4].

In UVFP, it might be helpful for the patient in the process of returning nerve function and vocal fold mobility to perform an early injection laryngoplasty using absorbable filling materials [5]. The reconstruction of the recurrent laryngeal nerve may focus on connecting nerve stumps end-to-end, or forming an anastomosis of the nerve with the ansa cervicalis or the hypoglossal nerve [3]. The first direct anastomosis of the laryngeal nerve was described by Horsley in 1909 [3]. Crumpley and Izdebski described reinnervation in selected patients diagnosed with unilateral vocal fold paralysis in 1986 and 1991 respectively [4]. This procedure is not, however, routinely used in all patients with UVFP. Many authors

present encouraging results, which prove that it is possible to normalize the quality of voice by reinnervation procedure as well as to improve mobility of a previously paralysed vocal fold [4, 6-10]. Paniello et al. compared the quality of voice after reinnervation and medialization thyroplasty [6]. After 12 months, both groups showed a considerable improvement of quality of life based on the GRBAS scale as well as an improved voice-related quality of life based on the VRQoL questionnaire. However, considering age, much better results were observed in patients under the age of 52 who underwent laryngeal reinnervation [6].

Wang et al. reported, based on a large study on 237 cases, better results of the voice quality and an improvement of the tension of the vocal folds on LVS examination with complete glottal closure in 92.4% of patients who underwent reinnervation [7]. Normalization of voice according to the GRBAS scale, acoustic parameters and increase of the mean MPT from 6.18 seconds to 17.2 seconds were observed. Dzodic et al. reported normalization of the voice quality in 43% of patients 2-6 months after reinnervation [4]. The study by Smith et al. is worth mentioning, in which the author assessed treatment outcomes performing laryngeal reinnervation in patients aged 12-21 diagnosed with UVFP, the paralysis having occurred 0.8 to 15.2 years prior to surgery [8]. The author reported an improvement in the voice quality in all patients, however, the correlation between the results and duration of the paralysis before reinnervation had a negative value [8]. Yoshioka et al. proved that only 10% of 228 cases treated by reinnervation did not achieve any satisfactory improvement of voice and aerodynamic parameters (MPT < 9.1 seconds) [9]. In their study, they also investigated factors which may affect the quality of voice following reinnervation, such as patient's age, surgeon's experience, technique of the procedure (anastomosis of the ansa cervicalis with the recurrent laryngeal or hypoglossal nerve, reconstruction with free nerve graft), thickness of surgical sutures, and no significant correlations were found.

Lorenzo et al. describe the effectiveness of reinnervation based on LVS examination in 37 out of 38 patients [10].

The full return of mobility of the paralysed vocal fold after reinnervation procedure is still debatable. Patient's age and duration of the paralysis may constitute important factors [6,8]. Numerous connections of the laryngeal nerves also seem to be significant [3]. The innervation of the laryngeal muscles seems to be more complicated than according to the approved classification stating that the superior laryngeal nerve is responsible for innervation of the cricothyroid muscle, while the recurrent laryngeal nerve innervates the rest of the inner laryngeal muscles. It has been proven that over 80% of the examined larynges have the anastomosis of Galen connecting the superior and recurrent laryngeal nerves [11]. Furthermore, the posterior cricoarytenoid muscle has cross-innervation from both sides. Also, there is an anastomosis between the adductor and abductor branches of the recurrent laryngeal nerve [3]. The functional outcome of reinnervation is hence dependent on predominance of the nerve fibres to the abductor muscles compared with the adductor muscle [3]. Regardless of the share of the regenerated fibres, the mass of the vocalis muscle increases and its tension improves [8].

CONCLUSIONS

Reinnervation of the larynx is a non-complex surgical procedure, which allows to increase tension and muscle mass of the vocal fold, which in turn effectively and permanently normalizes the quality of voice in patients with unilateral vocal fold paralysis. The procedure usually brings effects after 2-6 months. Functional effects of reinnervation seem to be negatively correlated with patient's age and duration of paralysis. If reinnervation fails, it does not exclude other methods such as medialization or injection laryngoplasty.

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