

Comparison of Short and Long-Term Results after Injection Laryngoplasty with Radiesse® Voice and Thyroplasty Type I in Unilateral Vocal Fold Palsy

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ABSTRACT

Objectives: Unilateral vocal fold palsy independently of etiology results in glottic insufficiency leading to unfavorable short or long-term impact on voice quality. Our aim was to evaluate the effect of injection laryngoplasty using Radiesse® Voice and thyroplasty type I on glottic closure, voice quality and aerodynamics by comparing preoperative, short- and long-term results.

Materials and Methods: Data of 32 consent patients were reviewed between 2012 and 2023. All patients underwent either injection laryngoplasty (14 patients) or thyroplasty type I (18 patients) under local anesthesia. Maximum phonation time, glottic closure based on videolaryngostroboscopy, VHI-30 values and GRBAS scale were recorded prior, short-term (3 month) and long-term (12 months) after procedures for statistical comparison. Friedman test, Mann-Whitney test and Wilcoxon signed rank tests were used for statistical analysis. **Results:** In injection laryngoplasty group, we found significant improvement in maximum phonation time ($p = 0.002$), grade of hoarseness ($p = 0.002$) and breathiness ($p = 0.000$) when comparing results before and short-term after procedure. In thyroplasty type I group we saw significant improvement of maximum phonation time ($p = 0.000$), glottic insufficiency ($p = 0.000$), all three VHI-30 components ($p = 0.000$), as well as grade of hoarseness, breathiness (both $p = 0.000$) and roughness ($p = 0.011$) of GRBAS scale when comparing voice outcome before and short-term after procedure. There was no significant difference in voice outcome results neither between short and long-term results nor between the two groups in any parameter.

Conclusion: These results demonstrate both short and long-term efficiency of injection laryngoplasty and thyroplasty type I in the improvement of voice quality and glottic closure.

KEYWORDS

glottic closure; injection laryngoplasty; thyroplasty type I; unilateral vocal fold palsy; voice quality

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INTRODUCTION

Unilateral vocal cord palsy (UVFP) refers to the reduced motion of the vocal fold on one side due to the hypofunction of the recurrent laryngeal nerve (RLN) or the vagal nerve (VN). Motion disturbance can range from incomplete to complete paresis (also known as paralysis), depending on the altered innervation of the vocal, abductor and adductor muscles. In the clinical practice, the term UVFP is used for both conditions for the sake of simplicity. Most common etiology is iatrogenic injury of the RLN during thyroid gland surgery. Further iatrogenic injury of the nerve can occur due to parathyroidectomy, anterior cervical disc surgery, esophagectomy, thymectomy, neck dissection, carotid endarterectomy, mediastinoscopy and cardiothoracic surgery. UVFP can also develop due to the involvement of the RLN or VN by mediastinal space occupying processes, esophageal, thyroid gland cancer as well as lateral skull base and brainstem lesions. Viral and idiopathic palsies also can occur. UVFP can be asymptomatic or present with various changes in quality of voice due to inadequate glottic closure, swallowing difficulty or even penetration/aspiration which can lead to recurrent pneumonias or life-threatening suffocation. Nerve regeneration depends on the type of neuronal injury (1) and site (2). Spontaneous recovery of the nerve can be expected within the first 12 months (3). Workup in cases of UVFP involves taking a thorough medical history to consider all etiologic possibilities, physical examination with videostroboscopy and evaluation of quality of voice which includes four different approaches: perceptual evaluation (GRBAS scale), acoustics, aerodynamics and subjective rating by the patient (4). If etiology is unknown, further examinations are necessary including most importantly imaging studies (CT or MRI) and viral serology. Additional examinations such as barium swallow test, fibre-optic endoscopic evaluation of swallowing (FEES) and laryngeal EMG may also have their role in the diagnostics. Treatment strategies to improve glottic closure may include speech therapy, injection laryngoplasty (IL), thyroplasty type I (TPL) and reinnervation (5, 6). IL is a safe option, does not interfere with spontaneous recovery and can be repeated if necessary (7). This procedure can be performed under local or general anesthesia with various injectable materials including Gelfoam™, collagen, hyaluronic acid, calcium-hydroxyapatite (8, 9). TPL procedure is a definitive management performed under local or general anesthesia, resulting in permanent change in the position of the vocal fold (medialization) (10–12). This type of framework surgery is performed as a definitive solution for permanent UVFPs. A window is created via external approach on the thyroid cartilage at the level of the vocal fold and an implant (e.g autologous cartilage, hand-carved silastic bloc, Gore-Tex® material or the dedicated Montgomery® thyroplasty Implant System) (13, 14) is placed into this window. Both IL and TPL have the advantage of prompt judgement of voice intraoperatively allowing further correction if necessary. Both voice rehabilitation options are widely accepted and considered safe and effective (7, 15–20). The aim of this study was to evaluate the effect of IL using Radiesse® Voice and TPL and on glottic closure,

quality of voice and aerodynamics by comparing preoperative, short- and long-term results in UVFP.

MATERIALS AND METHODS

This study was designed as a prospective study including patients with UVFP treated at the Department of Otorhinolaryngology and Head and Neck Surgery University Hospital Hradec Kralove, Charles University, Faculty of Medicine in Hradec Králové from January 2012 to January 2023. Thirty-two consent patients (18 males, 14 females, average age: 58 years) with UVFP were included regardless of underlying etiology of UVFP, age and gender. We were focusing on two groups of patients: 14 patients prior and after (short and long-term) IL with calcium hydroxyapatite (Radiesse® Voice) and 18 patients prior and after (short and long-term) TPL due to UVFP. We set 3–6 months postoperatively as a short-term result and 1 year after procedure as a long-term result. Indication for type of procedure included period post UVFP and width of glottic insufficiency. Patients whose UVFP lasted more than 1 year or the width of glottic gap was more than 3 mm were treated with TPL. Patients with early diagnosis of UVFP or small glottic gap (less than 3 mm) were treated with IL with Radiesse® Voice. All the 32 procedures were performed under local anesthesia by the same surgeons (V.C., J.D., J.M., K.S.) The following basic parameters were evaluated pre- and postoperatively by three experienced phoniatricians (J.D., J.K.): aerodynamics (maximum phonation time – MPT), changes in glottic gap size (0 – no glottic gap, 1 – small/moderate glottic gap, 2 – large glottic gap) based on videolaryngostroboscopy, self-evaluation of voice quality by the patient (VHI-30) and perceptual characteristics of voice (GRBAS scale – G-grade, R-roughness, B-breathiness, A-asthenia, S-strain). Friedman, Mann-Whitney and Wilcoxon signed-rank tests were used for statistical analysis of the gained data. SPSS Statistics 25.0 software was applied for this purpose (IBM). Level of significance was determined as $p < 0.05$. Ethical Committee of University Hospital Hradec Králové approved the study (number: 201312S03P).

RESULTS

MPT showed significant improvement in both IL and TPL group before and short-term after procedures ($p = 0.001$ and $p = 0.000$ respectively). There was no significant difference between short and long-term results within both groups regarding MPT. Furthermore, significant change was found in glottic closure before and short-term after TPL ($p = 0.000$). However, there was no significant change in glottic insufficiency in IL group ($p = 0.267$) when comparing findings before and short-term after procedure. We found no significant difference between short and long-term results in any groups concerning glottic insufficiency. When we looked at VHI-30 results there was significant improvement in both the functional (F), emotional (E) and physical (P) components of the measure in TPL group before and short-term following surgery (F, E, P – $p = 0.001$). In IL group improvement was noted when comparing

Tab. 1 Statistical results of the injection laryngoplasty group.

	MPTs short-term – MPTs before	MPTs long-term – MPTs short-term	G short-term – G before	G long-term – G short-term
Z	-2.238	-1.320	-2.859	-0.274
p values	0.025	0.187	0.004	0.784
	B short-term – B before	B long-term – B short-term		
Z	-3.108	-0.287		
p values	0.002	0.774		

Tab. 2 Statistical results of the thyroplasty type I group.

	MPTs short-term – MPTs before	MPTs long-term – MPTs short-term	VHI F% short-term – VHI F% before	VHI F% long-term – VHI F% short-term
Z	-3.295	-0.052	-3.576	-0.283
p values	0.001	0.959	0.000	0.777

	VHI E% short-term – VHI E% before	VHI E% long-term – VHI E% short-term	VHI P% short-term – VHI P% before	VHI P% long-term – VHI P% short-term
Z	-3.101	-0.628	-3.294	-0.026
p values	0.002	0.530	0.001	0.979

	Glottic gap short-term – glottic gap before	Glottic gap long-term – glottic gap short-term	G short-term – G before	G long-term – G short-term
Z	-2.697	-1.342	-3.447	-0.962
p values	0.007	0.180	0.001	0.336

	R short-term – R before	R long-term – R short-term	B short-term – B before	B long-term – B short-term
Z	-2.858	-0.966	-3.541	-0.647
p values	0.004	0.334	0.000	0.518

preoperative and short-term postoperative VHI-30 results (F – p = 0.089, E – p = 0.219, P – p = 0.232) but it was not statistically significant. Analysis of GRBAS scale showed differences between the two groups when comparing before and short-term postoperative measurements. In IL group, there was significant improvement in grade (p = 0.002) and breathiness (p = 0.000). Non-significant improvement was noted in roughness (p = 0.109), asthenia (p = 0.140) and strain (p = 0.311). In TPL group we found significant improvement in grade (p = 0.000), roughness (p = 0.011) and breathiness (p = 0.000). No significant

improvement was seen in asthenia (p = 0.206) and strain (p = 0.368). There was no significant difference in any groups when comparing short and long-term GRBAS results. No statistically significant difference was found in results between IL and TPL groups when we compared each parameter. Statistical results are demonstrated in Table 1 and 2. No intraoperative or postoperative complications occurred in connection with the procedures.

DISCUSSION

UVFP independently of etiology may result in low quality of life due to voice deterioration, inefficient cough, swallow difficulties and consecutive penetration/aspiration risk with recurrent pneumonias. Therefore, voice and swallow rehabilitation should equally be granted. Rehabilitation possibilities range from speech therapy to surgery: IL, TPL and reinnervation techniques. Common feature of the listed options is that all of them aims the improvement of glottic closure. Speech therapy is an important supplementary element of the other therapeutic possibilities, though it is employed as monotherapy in the first 12 months while spontaneous recovery can be expected. IL is one of the most frequently applied voice rehabilitation techniques. A wide variety of materials are available as injectable materials. Contrary to the initially used materials (e.g. Teflon, collagen), the currently applied materials cause less foreign body and allergic reactions owing to their tissue-friendly characteristics. Injection of autologous fat tissue is mostly applied under general anesthesia but used as a definitive solution for permanent UVFPs. In acute case, injection of absorbable materials is preferred that do not interfere a possible spontaneous recovery. Injection of cross-linked hyaluronic acid derivatives and polyacrylamide hydrogel (7–9, 21) serves on one hand as early rehabilitation and on the other hand as a trial before permanent surgery, if needed. Calcium hydroxyapatite (e.g. Radiesse® Voice, Renú® Voice) offers a longer lasting (5–18 month) effect (22) placing this material between fast absorbable hyaluronic acid derivatives and definitive solutions including lipoaugmentation and laryngeal framework surgery. IL performed under local anesthesia (also called office-based IL) is a cost-efficient and safe minimally-invasive procedure independently of the used injectable material (23–25). Office-based IL can be applied successfully in case of small glottic gaps (< 2 mm) and acute UVFPs (26), as we also followed this principle when we injected Radiesse® Voice. TPL as a type of laryngeal framework surgery can be performed safely in case of permanent UVFPs, wide glottic closure defects and serious symptoms including inefficient cough, swallow and penetration/aspiration with or without pneumonia (12). In our study we also indicated TPL in case of permanent cases with large glottic insufficiencies (> 2–3 mm) according to the general practice seeing that only expert opinions exist determining glottic gap width for indication of TPL (27).

Success of UVFP rehabilitation – as well as the efficiency of phonosurgical interventions – can be measured in several parameters proposed by the European Laryngological Society (28) and Mattei et al (29). In our study we evaluated

changes in MPT, glottic insufficiency, VHI-30 and GRBAS. We found significant MPT elongation in both IL and TPL group short-term following procedures ($p = 0.002$ and $p = 0.000$ respectively) in comparison with preoperative measurements. At the same time no further MPT changes could be recorded in any groups when short and long-term results were compared. Overall, these results show the effectiveness of both procedures and support the aim of both surgical techniques to achieve and maintain proper glottic closure. When glottic insufficiency was evaluated during videostroboscopy, significant improvement could be observed in glottic closure before and short-term after TPL ($p = 0.000$). However, there was improvement regarding glottic insufficiency in IL group but interestingly it did not prove to be significant ($p = 0.267$) when comparing findings before and short-term after procedure. We found no significant difference between short and long-term results in any groups concerning glottic insufficiency that may indicate on one hand no migration of the thyroplasty silastic implants during the investigation period and on the other hand it may indicate the expected long-lasting effect of calcium hydroxyapatite owing to its slow absorption.

Functional (F), emotional (E) and physical (P) components of the VHI-30 showed significant improvement in TPL group comparing preoperative and short-term results (F, E, P - $p = 0.000$). Certain improvement was also noted in IL group when preoperative and short-term postoperative VHI-30 results were compared (F - $p = 0.089$, E - $p = 0.219$, P - $p = 0.232$), although it was not statistically significant. These results highlight improvement of quality of life in both groups.

Regarding GRBAS scale, there was significant improvement in grade ($p = 0.002$) and breathiness ($p = 0.000$) in the IL group comparing before and short-term postoperative measurements. Although not significant, but certain improvement was noted in roughness ($p = 0.109$), asthenia ($p = 0.140$) and strain ($p = 0.311$). In TPL group we found significant improvement in grade ($p = 0.000$), roughness ($p = 0.011$) and breathiness ($p = 0.000$). Asthenia ($p = 0.206$) and strain ($p = 0.368$) also improved but it did not prove to be significant. No statistically significant difference was found in results between IL and TPL groups when we compared each parameter, which makes the almost identical efficiency of the applied procedures probable. There was no significant difference in any groups when comparing short and long-term GRBAS results suggesting invariable long-term voice quality perceptible by experienced examiner. No minor or major complications occurred neither in the intraoperative nor during the postoperative period in accordance with the literature reporting safety of both IL and TPL (23–25, 30, 31).

For the sake of completeness, we must note the bias of our study. Taking the subjectivity of the examiners' judgement into account when evaluating the glottic gap size is also important. Minimization of this subjectivity could be achieved by comparing pre- and postoperative glottic gap size with more precise software technologies based on for example the estimation of area under the curve. Long-term results were not available in all patients most frequently due to non-compliance regarding follow-up, COVID19 pandemic, other medical health issues and death.

CONCLUSION

Our results suggest that IL and TPL are nearly equally effective procedures in both short and long-term improvement of voice quality and glottic closure in the management of UVFP.

CONFLICT OF INTEREST

The authors declare no competing interests.

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