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Outcomes versus complications in patients undergoing different modalities of injection laryngoplasty

Mohamed E. Darweesh[1*], Aml F. Y. El-Gazzar[1], Shaimaa M. Sarag[1] and Ayat-Allah Raouf Sheikhany[2]

Abstract

Background: Glottal insufficiency results in glottal gap between the two vocal folds, which in turn might cause dysphonia, dysphagia, and breathing problems. Vocal fold injection is considered a safe, reliable, and highly effective method of treatment.

The purpose of the present study was to assess voice outcomes and complication rates in patients with glottal insufficiency undergoing injection laryngoplasty (IL) under local versus general anesthesia before, 1 week then 1 month after IL.

Results: Examined patients were 13 males and 12 females, suffering from dysphonia due to glottal insufficiency with mean age 43.68 ± SD 14.55. Unilateral vocal fold paralysis (UVFP) was diagnosed in seventeen cases, vocal fold scarring in six cases, presbylarynx in one case, and sulcus vocalis in one case. IL was performed in 18 cases under local anesthesia, and 7 under general anesthesia. Hyaluronic acid was injection material in 23 cases and calcium hydroxylapatite in two cases. IL by either local or general anesthesia has improved the patients' auditory perceptual analysis of voice quality as assessed by "GRBAS" scale and Voice Handicap Index (VHI). There were four (16% of all injections) minor and self-limited complications (12% under local and 4% under general anesthesia).

Conclusion: Injection laryngoplasty performed under local and general anesthesia offers similar voice outcomes, but with slightly higher self-limited complications in IL under local anesthesia.

Keywords: Injection laryngoplasty, Complications, Voice handicap index, Vocal fold paralysis, Vocal atrophy, VRQOL, Vocal fold scarring, GRBAS

Background

Glottic insufficiency, also known as vocal fold insufficiency, results in glottal gap between the two vocal folds, which in turn might cause dysphonia, dysphagia, and breathing problems. Unilateral vocal fold paralysis (UVFP) is the most common cause of incomplete glottal closure [1]; other causes include presbylarynx (age-related changes of the larynx), VF paresis, scar and atrophy and sulcus vocalis [2].

Injection laryngoplasty (IL) is a valuable technique used for augmenting or medializing the vocal folds to decrease the glottal insufficiency caused by multiple conditions [3].

Vocal fold injection (VFI) is considered a safe, reliable, and highly effective method of treatment. Injection laryngoplasty is a minimally invasive procedure that can be performed under general anesthesia by using microscopic suspension laryngoscopy or it can be performed in the office under local anesthesia [4]. Three endoscopic approaches may be used in the office with a flexible laryngoscope: percutaneous (trans-cricothyroid membrane, trans-thyroid cartilage, and trans-thyrohyoid membrane), trans-nasal, and trans-oral [3].

Studies have shown that IL under local anesthesia is safe to perform in patients with terminal illness and

* Correspondence: mohameddarwish@hotmail.com
[1]Unit of Phoniatrics, ENT Department, Tanta University, Tanta, Egypt
Full list of author information is available at the end of the article

improves overall quality of life, whereby general anesthesia would be risky to this group of patients [5].

There are no absolute contraindications for office-based VFI; however, the procedure would be less desirable in anxious patients who are unable to tolerate flexible naso-endoscopy and injection under local anesthesia [6].

In addition, patients with large glottal gap (more than 3 mm) or involvement of arytenoids and patients with glottal insufficiency caused by an irreversible etiology would achieve better results from thyroplasty or arytenoid adduction [6].

VFI is not contraindicated in patients taking anticoagulants. In a case series by Luu et al. [7], patients underwent VFI while on warfarin without any complications. However, as a precaution, it is better to withhold anticoagulants for a period prior to the procedure to avoid excessive bleeding leading to airway obstruction or aspiration pneumonia.

Injection under general anesthesia plays a very important role as it allows for better control of needle location and injectable distribution as compared to an injection in awake patient. Furthermore, it allows for additional surgical procedures, such as autologous fat or fascia harvest [4].

On the other hand, general anesthesia is contraindicated in old-aged patients especially patients with comorbidity or patients that are not willing to do the injection with general anesthesia [8].

Office-based VFI is a type of phonosurgery performed at an outpatient clinic under local anesthesia, with the help of high-resolution fiberoptic endoscopy. This type of surgery is emerging as a reliable and practical method for managing multiple VF lesions [9].

Pointing to the popularity of this technique, a recent multi-institutional review revealed that VFI was performed equally often in an awake patient as one under general anesthesia [4, 10].

There are multiple situations in which this technique is advantageous; as in patients with significant comorbidities that make them at risk for complications associated with general anesthesia. Also, if the patient has symptoms that are not severe enough to merit the risk of general anesthesia, an awake injection is favored [4].

Awake VFI also offers the advantage of allowing for the immediate assessment of the injection result, based on the voice quality, airway patency, location, and diffusion of the injected material. Sulica et al. [4] have pointed out that continuous visualization of the dynamic larynx allows for optimal injection placement and quantity to reach an adequate functional outcome and avoid complications.

The major advantages of office-based injection over traditional surgery are avoidance of general anesthesia with its inherent risks and increased cost, and allowing real-time assessment of voice outcome during the procedure [11].

Some difficulty with this procedure was reported by the surgeons; the most common reported problems included copious secretions, inability to suppress a patient's gag reflex, and poor visualization [12]. In addition, it can show some limitations in cases requiring high-power micro-laryngoscopy and phono-microsurgical techniques [11].

VFI has some complications in spite of being commonly performed laryngeal procedures [13]. The most common complication of office-based VFI is the failure to complete the procedure due to inability to visualize the VFs due to overhanging arytenoids, inability to obtain proper angle of visualization, excessive secretions, pain, and strong gag reflex that cannot be overcome [12].

The most significant but rarely occurring complication is airway obstruction which can occur due to laryngeal spasm, overcorrection of both VFs, and laryngeal edema secondary to over-manipulation of the larynx [4].

Para-glottal hematoma has been reported with the trans-thyroid cartilage approach; this can be treated with oral corticosteroids and strict voice rest when this occurs in professional voice users [14]. Hematoma at the skin overlying the injection site may also occur [15].

The ideal injection material should be low cost, biocompatible, and inert and does not cause local tissue reaction or fibrosis, easy to prepare, easy to inject, contained in a self-sufficient delivery system, and be delivered with a fine-gauge needle [16].

There are limited reports about patients benefit after laryngoplasty under general anesthesia and office-based injection. Thus, the main objective of this study was to assess voice outcomes and complication rates in patients with glottal insufficiency undergoing injection laryngoplasty (IL) under local versus general anesthesia to determine its effectiveness as a promising therapeutic option for those patients.

Methods

This prospective interventional study was carried out following the approval of the Research Ethical Committee from January to December 2018, on twenty-five consecutive cases (13 males and 12 females), ranging in age between 19 and 68 years, suffering from dysphonia (for more than 3 months) due to glottal insufficiency having different glottal gap size. The exclusion criteria were anatomical abnormalities of the larynx, patients with glottal gap lasting more than 2 years due to muscle atrophy, patients with previous injection, patients with history of neck irradiation, and patients with other laryngeal pathologies.

All patients in the present study underwent injection laryngoplasty (office based and under general anesthesia) to assess voice quality and were recruited from the Phoniatrics Outpatient Clinic of Tanta University Hospitals. Informed written consent was obtained from all participants prior to injection after full explanation of the aim and the procedure of the study.

At first, patients were subjected to the following voice assessment protocol that is structured and applied at the Phoniatrics Unit-ORL department, Tanta University Hospitals:

Full history taking (personal data); complaint and analysis of symptoms; complete ENT examination; neck examination for lymph nodes, thyroid mass, scars, or any anatomical abnormalities; examination of vocal tract and cranial nerve.

Auditory perceptual assessment (APA): By careful listening to the patient's voice using modified GRBAS scale [(G) Overall Grade, (R) Rough, (B)Breathy, (A) Athenic and (S) Strained] with 4 grades from 0 (normal) to 3 (severe dysphonia) for determining grade and character of dysphonia [17].

Augmentation and documentation of the glottal picture and gap size: By telescopic rigid laryngoscopy and video recording of the patient's larynx in quite respiration and in sustained phonation of vowel /a/. Flexible naso-laryngoscopy was used for patients having severe gag reflex and could not tolerate the rigid laryngoscope.

Judging the patient's satisfaction about his/her voice: By Voice Handicap Index (VHI) Arabic version (Additional file 1: Appendix 2) [18]. Each patient was asked about his/her satisfaction preoperative, 1 week, and 1 month after injection.

Acoustic analysis of voice: A voice sample was analyzed using KAY PENTAX Computerized Speech Lab (CSL) model 4500 version corporation Multidimensional Voice Program (MDVP) system, a computer program to obtain parameters including jitter, shimmer, and noise to harmonic ratio (N/HR).

Maximum phonation time: this was measured in seconds using a stop watch during production of prolonged /a/ sound at comfortable pitch and loudness.

CT scan: from the base of the skull to upper chest—when required—to identify cause of glottal insufficiency if no obvious cause. This was performed on initial assessment.

After the previously mentioned assessment protocol, all the twenty-five cases were subjected to vocal fold injection either office based or under general anesthesia.

Decision of injection under local or general anesthesia was according to patient's cooperation; neck morphology and anatomical defects and general fitness for surgery under general anesthesia.

Office-based VFI was performed through percutaneous approach: By passing the injection needle into the VFs through trans-cricothyroid membrane, at the ORL department in the recovery room next to the operating theater. Prior to injection, bleeding profile {(international normalized ratio (INR)}, bleeding time, clotting time, and prothrombin time and activity) were measured to evaluate bleeding tendency.

Using Xylocaine pump spray 4% to anesthetize the Oro-pharyngeal and laryngeal mucous membranes. The subcutaneous tissue overlying the landmark of interest was injected with (Lidocaine HCL 2%) for infiltration and nerve block anesthesia.

Equipment was readily available before starting the procedure. Injection materials were supplied as commercially available preparations and came ready to use in self-contained syringes. The materials used in this study were hyaluronic acid (HA) and calcium hydroxylapatite (CaHA).

HA was used in vocal fold paralysis (VFP) for patients with the onset of paralysis less than 6 months, also in patients with VF scarring, sulcus vocalis, and presbylarynx. CaHA was used in VFP for patients with the onset of paralysis more than 6 months.

Office-based VFI procedure

The patient was seated upright position with the neck in neutral position and the head slightly extended. Flexible laryngoscope was used by an assistant to visualize the larynx and help in confirming the needle site and observing the injection results.

During injection, the surgeon stood to the right of the patient and slightly anterior while the assistant operating the flexible laryngoscope stood to the left and slightly anterior.

The video tower and screen were usually placed left and posterior of the patient. A small stand with the required instruments and injection material was placed to the front or left of the surgeon. A nurse was present to help for handling instrumentation.

Technique of injection

- A marker was used to plot a point at the cricothyroid membrane to detect site of entry of the needle.
- A disposable needle was inserted below the lower border of the thyroid cartilage, 5 to 7 mm lateral to the midline and advanced 3 to 4 mm perpendicular to the thyroid ala.
- A slight bend was placed in the needle 2 cm away from the tip to help in directing the needle to the VF via cricothyroid membrane.
- The needle was then directed anteriorly and passed slowly back and forth to look for transmitted motion

and to be sure that it is placed at the vertical level of the VF.
- The needle was then moved slowly to avoid perforating the mucosa. It should be introduced as lateral as possible and deep to avoid injection into the Reinke's space.
- The procedure then continued while the patient was asked to project his/her voice and observing endoscopically for augmentation until the desired augmentation and voice quality were achieved.
- The amount of injection material used depended on the indication and on the estimation of the glottal gap.

Postoperative care

- Patients were put under observation for a short period immediately after office-based VFI to monitor any complications as respiratory difficulties or bleeding that might occur after injection. In uncomplicated cases, patients are observed for 15–30 min.
- Patients were instructed not to eat or drink for 1 to 2 h after the procedure.
- Patients were evaluated with the assessment protocol 1 week then 1 month after injection to assess the progress of treatment.

Injection laryngoplasty under general anesthesia

Patients were placed in the optimal position, which was supine with the neck flexed and the head extended (flexion of the cervical spine and extension of the atlanto-occipital joint). The teeth and alveolar ridge were protected, with insertion of adequately sized laryngoscope. The optimal laryngoscope was used to allow the maximal amount of exposure for operating the VFs.

This procedure required general anesthesia with complete relaxation of the patient throughout the operation. Preoperative IV administration of steroids was given (unless contraindicated) to decrease secretions and postoperative edema. A suitable sized endotracheal tube (4.5 mm in males and 4 mm in females) was used to diminish the chance of injury to the vocal folds on intubation and also to improve visualization for the surgeon.

Surgical technique of injection

- After insertion of adequately sized laryngoscope, the degree of glottal gap was assessed through a combination of preoperative awake stroboscopy and intraoperative visualization with micro-laryngoscopy.
- This provided direct access to the VFs and allowed for precise needle placement along the superior arcuate line with a direct linear trajectory.
- The needle was used to inject the upper surface of the vocal fold at the posteromedial aspect until the body of the VF bulged and the free edge almost reached midline.
- The site of injection was approximately 3 to 5 mm deep to mucosa, and the needle was angled laterally to ensure a lateral VF injection site.
- Good visualization allowed determining the ideal amount and the site of injection by observing immediate changes in VF contour during the injection.

Postoperative care

- Voice rest for 1 day, hydration, and humidification were advised with administration of analgesia and the patient discharged on the next day.
- Patients were evaluated with the assessment protocol 1 week then 1 month after injection to assess the progress of treatment.

Statistical analysis was performed comparing preinjection, 1 week and 1 month postinjection voice scores using the paired t tests; analysis was performed with the SAS software package (SPSS version 15.0, SPSS Inc., Chicago, IL). P values ≤ 0.05 were statistically significant.

Results

Demographics

The average age of all patients 25 cases was 43.68 ± SD 14.55 years old (range, 19–68 years). There were 13 (52%) males and 12 (48%) females. The cause of glottal insufficiency was unilateral vocal fold paralysis (UVFP) in seventeen (17) cases, vocal fold scarring in six (6) cases, presbylarynx in one (1) case, and sulcus vocalis in one (1) case (Table 1).

Injection laryngoplasty was performed in all patients. Eighteen (18) cases underwent office-based-injection and seven (7) cases were injected under general anesthesia. Twenty-three (23) cases were injected using Hyaluronic acid (HA), while only two (2) cases were injected by Calcium hydroxyl apatite (CaHA) (Table 1).

The previous table shows that UVFP was the most common cause of glottal insufficiency in 17 patients (68% of cases), followed by VF scarring in 6 patients (24% of cases), sulcus vocalis in 1 patient (4%), and presbylarynx in 1 patient (4%) (Fig. 1).

The present study showed that the most common cause of UVFP (17 patients) in our studied patients was thyroid surgeries in 8 patients (47.1% of cases). Other

Table 1 Descriptive data for patients enrolled in the study (n = 25)

Patient number	Age	Gender	Etiology of glottal gap	Side of pathology	Injection material	Type of anesthesia
1	58	M	UVFP	Left	CaHA	General
2	34	M	UVFP	Right	Hyaluronic acid	Local
3	52	M	VF scarring	Bilateral	Hyaluronic acid	Local
4	37	F	UVFP	Right	CaHA	General
5	65	F	UVFP	Right	Hyaluronic acid	Local
6	33	F	UVFP	Right	Hyaluronic acid	Local
7	28	F	Sulcus vocalis	Left	Hyaluronic acid	General
8	60	F	UVFP	Right	Hyaluronic acid	General
9	57	F	UVFP	Left	Hyaluronic acid	Local
10	27	M	UVFP	Left	Hyaluronic acid	Local
11	52	M	VF scarring	Left	Hyaluronic acid	Local
12	53	M	UVFP	Left	Hyaluronic acid	Local
13	48	F	UVFP	Left	Hyaluronic acid	Local
14	33	M	UVFP	Right	Hyaluronic acid	Local
15	55	M	UVFP	Left	Hyaluronic acid	Local
16	52	M	VF scarring	Left	Hyaluronic acid	Local
17	36	F	VF scarring	Left	Hyaluronic acid	General
18	22	F	UVFP	Right	Hyaluronic acid	General
19	31	M	VF scarring	Right	Hyaluronic acid	Local
20	68	M	Presbyphonia	Bilateral	Hyaluronic acid	Local
21	28	F	UVFP	Right	Hyaluronic acid	Local
22	46	F	UVFP	Left	Hyaluronic acid	Local
23	64	M	VF scarring	Right	Hyaluronic acid	Local
24	34	M	UVFP	Left	Hyaluronic acid	Local
25	19	F	UVFP	Right	Hyaluronic acid	General

causes were upper respiratory tract infection in 2 patients (11.7% of cases), cervical disc operation in 1 patient (5.9% of cases), cardiomyopathy in 1 patient (5.9% of cases), vagal schwannoma in 1 patient (5.9% of cases), neck trauma in 1 patient (5.9% of cases), and idiopathic in 3 patients (17.6% of cases) (Fig. 2).

Voice outcome assessment after injection laryngoplasty

Vocal fold injection under either local or general anesthesia had improved the patients' voice-related quality of life (VRQOL) measures and reduced glottal gap size. As regard glottal gap, we considered it as a small gap if it was less than 1 mm, moderate gap if it was 1–2

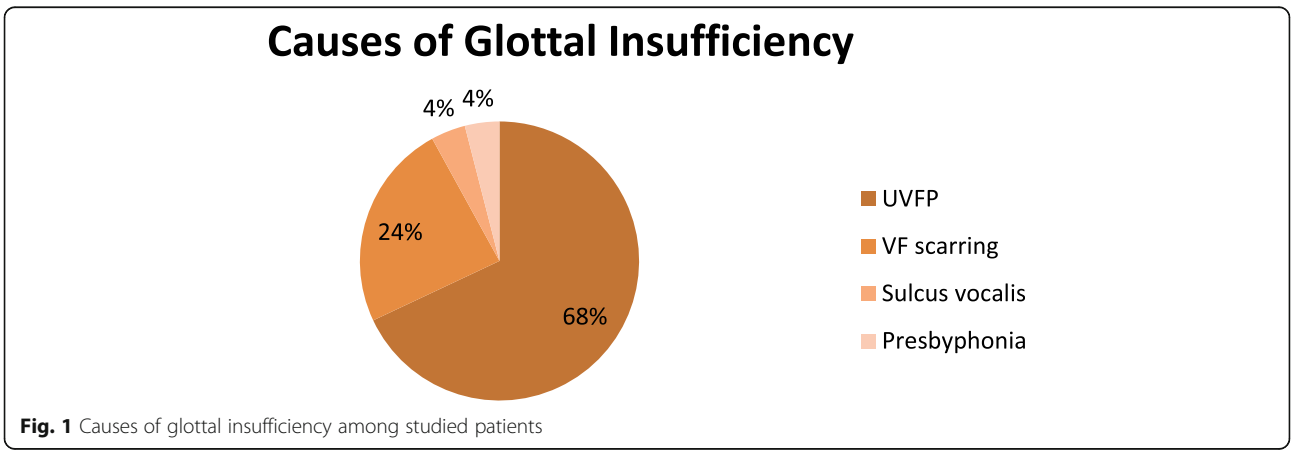

Fig. 1 Causes of glottal insufficiency among studied patients

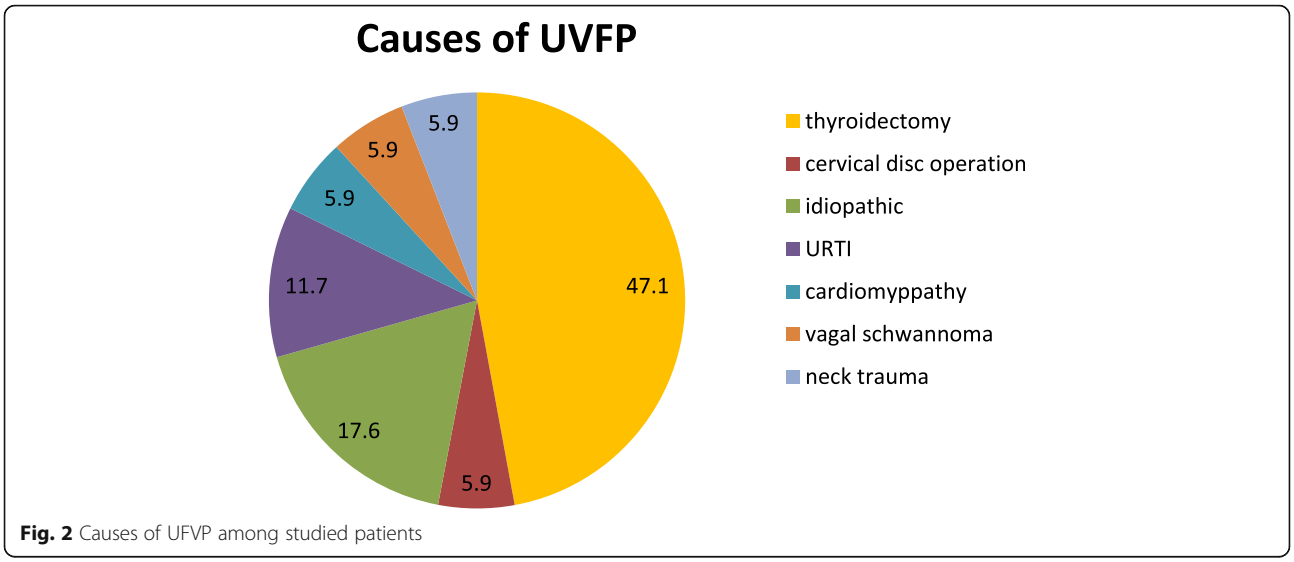

Fig. 2 Causes of UFVP among studied patients

mm, and large gap if it was more than 2 mm. In studied patients, there were 2 with small gaps, 18 with moderate gaps, and 5 with large gaps. IL under local anesthesia was done in all small gaps patients (2), 15 with moderate gaps and 1 with large gap. The rest of patients 3 with moderate gaps and 4 with large gap had IL under general anesthesia.

The parameters of cases are summarized in Table 2 for local anesthesia and Table 3 for general anesthesia. The parameters include the auditory perceptual analysis of voice quality as assessed by "GRBAS" scale, Voice Handicap Index (VHI) and the size of glottal gap, Jitter%, shimmer (db), and noise to harmonic ratio (N/HR) all showing improvement after injection in both IL cases. This was clear from the significant difference between pre-injection and post-injection results. Maximum phonation time (MPT) was sufficiently increased following injection, and improvement was consistent throughout the follow-up periods.

Both local and general anesthesia IL demonstrated statistically significant improvement in voice parameters with no significant difference between them (Tables 2 and 3, Figs. 3 and 4).

Patient's satisfaction of his/her own voice quality using Voice Handicap Index (VHI) was improved after injection with statistically significant value.

The present results demonstrated that there was an improvement of the size of glottal gap. There was complete closure (no gap) in 6 out of 25 (24% of cases) and decrease of the gap to less than 1 mm (small gap) in 17 patients (68% of cases). However, 2 patients (8% of cases) still had moderate gap (1–2 mm) (Tables 2 and 3).

There were 4 complications (16% of all injections), which included 12% of office based and 4% under

Table 2 Comparison between pre-injection and post-injection results of voice analysis after IL by local anesthesia (n = 18)

Parameter	GRBAS					Voice evaluation		Acoustic analysis			
	G	R	B	A	S	VHI	Glottal gap size	Jitter%	shimmer (db)	N/HR	MPT
Pre-injection scores (mean ± SD)	2.74 ± 0.42	2.11 ± 0.52	1.66 ± 1.02	0.611 ± 0.86	0.94 ± 1.02	60.42 ± 11.02	-No gap -2 Small gap -15 Moderate -1 Large gap	6.44 ± 3.02	1.28 ± 0.72	0.210 ± 0.08	5.28 ± 0.48
1 week post injection scores (mean ± SD)	1.52 ± 0.48	1.64 ± 0.34	0.68 ± 0.58	0.28 ± 0.56	0.44 ± .0.64	40.02 ± 8.06	-No gap -12 Small gap -6 Moderate -0 Large gap	3.428 ± 2.88	0.764 ± 0.44	0.157 ± 0.04	7.26 ± 0.62
1 month post injection scores (mean ± SD)	0.98 ± 0.48	0.54 ± 0.58	0.28 ± 0.62	0.166 ± 0.34	0.22 ± 0.40	28.06 ± 6.14	- 4 No gap -12 Small gap -2 Moderate -0 Large gap	1.87 ± 1.62	0.39 ± 0.04	0.111 ± 0.03	8.68 ± 0.82
***P* value**	P1, P2, P3 < 0.05					P1, P2, P3 < 0.05		P1, P2, P3 < 0.05			

P value < 0.05 is significant; *P* value > 0.05 non-significant.
P1 comparison between pre-injection and 1 week post-injection, *P2* comparison between pre-injection and 1 month post-injection, *P3* comparison between 1 week post-injection and 1 month post-injection

Table 3 Comparison between pre-injection and post-injection results of voice analysis after IL by general anesthesia (n = 7)

Parameter	GRBAS					Voice evaluation		Acoustic analysis			
	G	R	B	A	S	VHI	Glottal gap size	Jitter%	shimmer (db)	N/HR	MPT
Pre-injection scores (mean ± SD)	**2.57 ± 0.43**	**1.71 ± 0.64**	**1.68 ± 1.32**	**0.428 ± 0.86**	**1.14 ± 1.36**	**59.48 ± 9.02**	-No gap -0 Small gap -3 Moderate -4 Large gap	**7.28 ± 2.34**	**1.16 ± 0.82**	**0.180 ± 0.06**	**5.88 ± 0.42**
1 week post injection scores (mean ± SD)	**1.57 ± 0.43**	**1.02 ± 0.04**	**0.98 ± 0.58**	**0.26 ± 0.56**	**0.71 ± 0.34**	**38.02 ± 8.44**	-No gap -2 Small gap -3 Moderate -2 Large gap	**4.28 ± 1.54**	**0.864 ± 0.58**	**0.147 ± 0.08**	**8.26 ± 0.82**
1 month post injection scores (mean ± SD)	**0.98 ± 0.48**	**0.54 ± 0.58**	**0.28 ± 0.62**	**0.167 ± 0.34**	**0.18 ± 0.20**	**26.08 ± 5.14**	- 2 No gap -5 Small gap -0 Moderate -0 Large gap	**2.24 ± 1.24**	**0.38 ± 0.08**	**0.098 ± 0.03**	**9.24 ± 0.42**
***P* value**	**P1, P2, P3 < 0.05**					**P1, P2, P3 < 0.05**		**P1, P2, P3 < 0.05**			

P value < 0.05 is significant; *P* value > 0.05 non-significant
P1 comparison between pre-injection and 1 week post-injection, *P2* comparison between pre-injection and 1 month post-injection, *P3* comparison between 1 week post-injection and 1 month post-injection

general anesthesia. All complications were minor and self-limited. None of the patients developed stridor. One patient complained of pain after injection but improved with analgesics after 24 h. One patient had minimal bleeding in the injected VF, but it was resolved spontaneously within few days without any other complications. One patient experienced vasovagal reactions during the procedure, and one subject experienced rapid absorption of injected material.

Discussion

Vocal fold injection is a valuable treatment modality that has been used to manage glottal insufficiency. Advancement of both injection techniques and biocompatible materials has propelled the field of laryngology to a new level [19].

Sulica et al. [4] reported that the number of the office-based injections increased from 11 to 43% between 2003 and 2008. In their study, decisions regarding method of injection (awake vs. asleep) were usually based on physician and/or patient preference and several medical comorbidities led surgeons to avoid general anesthesia.

Selecting appropriate patient for VFI is important for the success of this technique. The ideal patient is the motivated one to improve his/her symptomatic complaint [20].

VFI under local anesthesia has proved to be a safe and cost-effective method corresponding to other minimally invasive surgical treatment methods [21]. However, Mathison et al. in 2009 [14] has noted increased complications with awake injection, including rapid absorption of the injected material, vasovagal reactions, inappropriate

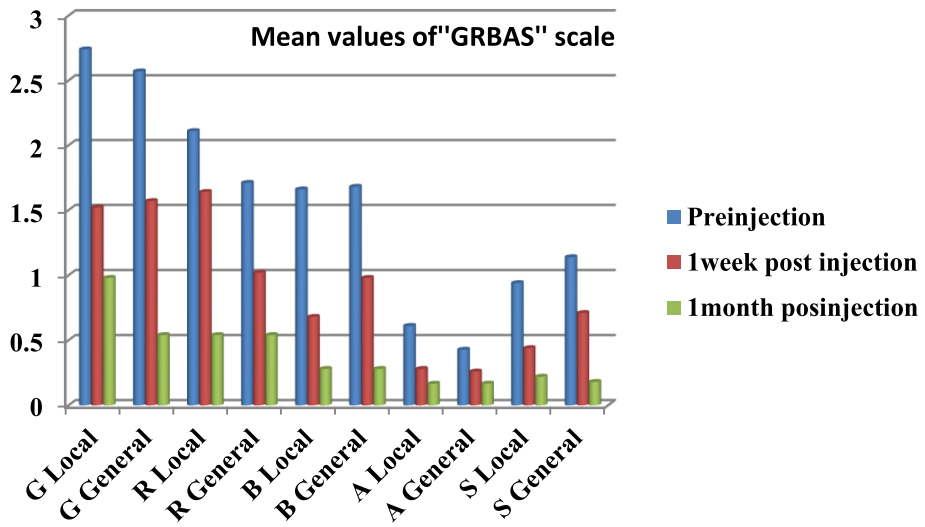

Fig. 3 Results of modified GRBAS scale among the studied patients by local and general anesthesia

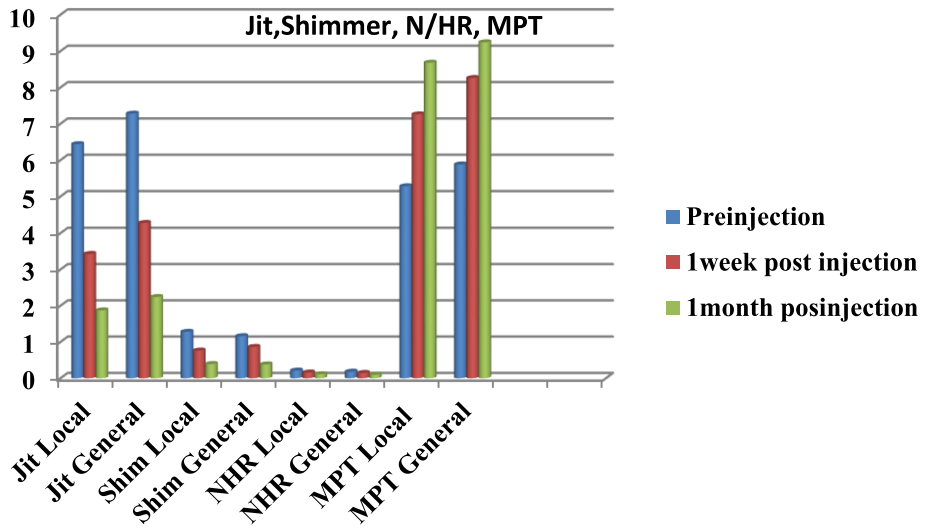

Fig. 4 Comparison between pre-injection and post-injection results of acoustic analysis by local and general anesthesia

injection into the superficial lamina propria, and vocal fold hematoma.

Our study aimed to evaluate the voice outcomes of different VFI techniques in glottal insufficiency cases. The most important factor determined the mode of injection was the general health of the patient. Elderly patients and those who had medical comorbidities were injected in the office to avoid the risks of general anesthesia.

The study group by local or general anesthesia showed gradual improvement in voice quality after injection, and better results were achieved after 1 month. Full stabilization of voice had occurred, and this was statistically significant, as well as being noticeable to the patients themselves.

The best postoperative voice outcomes were noted in patients with UVFP, which was consistent with literature reports of Friedman et al. [22] and Reiter and Brosch [23]. Also, the best results were obtained in cases with small to moderate phonatory gap, as consistent with King and Simpson [24] and Molteni et al. [25].

It was found that the commonest cause of UVFP in our study was iatrogenic (thyroid and other neck surgeries) (47.1%) and the second most common cause was idiopathic (17.6%). This was in agreement with Rudolf and Sibylle [26] and Mattioli et al. [27]. However, Alghonaim et al. [28] reported that the majority of patients had UVFP secondary to malignant etiology followed by iatrogenic etiologies.

Choosing the injectable material was based on the duration of dysphonia reported by the patients. In patients with UVFP who were dysphonic for less than 6 months, hyaluronic acid was chosen as a short-acting material that has temporary action (its effect may last up to 6 months) [15].

While dysphonic patients for more than 6 months, calcium hydroxylapatite was the material of choice as it is a long-acting material [29]. As regards patients with VF scarring, presbylarynx, and sulcus vocalis, H.A was the material of choice useful for injection into Reinke's space to correct the VF volume and relocate the free edge to the midline.

In perceptual assessment of the voice assessed by modified GRBAS scale, all parameters showed gradual satisfactory improvement after injection. This was evident from the significant difference between pre-injection and post-injection results. These results were in agreement with Woo et al. [19] and Powell et al. [30].

The patients in the present study reported significant improvement in their perceived voice in the 1st follow-up (after 1 week), and this improvement continued after 1 month as reported in the 2nd follow-up. This finding was similar to the study of Wang et al. [31] who reported that there was an improvement in all parameters.

According to our study, the follow-up periods (1 week and 1 month) after VFI by either local or general anesthesia showed decrease of glottal gap, this significant decrease in the glottal gap was close to the results reported by Rudolf and Sibylle [26] and Fang et al. [32]. In addition, Matiolli et al. [27] reported significant improvement in glottal closure within the 1st week after injection.

VFI by local or general anesthesia led to significant decrease in the values of jitter, shimmer, and N/H ratio and significant increase in MPT when comparing pre-injection with post-injection results. This improvement in the acoustic parameters implies improvement of the patients' Auditory Perceptual Assessment (APA). These results were in accordance with Fang et al. [32] and Boshnaq [33].

In the present study, injection laryngoplasty (IL) performed under local or general anesthesia offer similar voice outcomes, with comparable complication rates a slightly higher in local. Neither allergic, inflammatory reaction, nor stridor has occurred but only some patients complained of pain at the site of needle injection that was relieved by analgesics and others complained of minimal bleeding that was resolved spontaneously without any complications. One patient experienced vasovagal reactions during the procedure, and another experienced rapid absorption of injected material.

Conclusion

In the present study, injection laryngoplasty (IL) performed under local or general anesthesia offer similar voice outcomes, but with different complication rates, more when using local anesthesia.

The most important factors determining the mode of injection was the patient's cooperation, age, glottal gap size, and general health. Elderly patients and those who had medical co-morbidities were injected in the office to avoid the risks of general anesthesia.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s43163-020-00064-8.

Additional file 1: Appendix

Abbreviations

IL: Injection laryngoplasty; UVFP: Unilateral vocal fold paralysis; VHI: Voice Handicap Index; "GRBAS" scale: [(G) Overall Grade, (R) Rough, (B)Breathy, (A) Athenic and (S) Strained]; VFI: Vocal fold injection; VFs: Vocal folds; APA: Auditory perceptual assessment; CSL: Computerized Speech Lab; N/HR: Noise to harmonic ratio; CT-Scan: Computed tomography scan; INR: International normalized ratio; HA: Hyaluronic acid; CaHA: Calcium hydroxylapatite; MPT: Maximum phonation time; APA: Auditory perceptual assessment

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Authors' contributions

All authors have an equal role in design. Assistant Prof. Dr. MD, AG, and Dr. SS had an equal role in design, work, statistical analysis, and manuscript writing. Assistant Prof. Dr.AS had done workshop on different types of vocal fold injection, showed us the technique of injection, and provided us with five cases. The authors read and approved the final manuscript.

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Availability of data and materials

This is available.

Ethics approval and consent to participate

This prospective interventional study was carried out following the approval of the Research Ethical Committee of Faculty of Medicine, Tanta University, from January to December 2018, on twenty-five consecutive cases (13 males and 12 females), ranging in age between 19 and 68 years, suffering from dysphonia (for more than 3 months) due to glottal insufficiency.

All patients were informed about the aim of the study, and the procedure was fully explained to them. A written informed consent was signed by all the participants prior to injection.

Consent for publication

Informed written consent was obtained from all participants prior to injection after full explanation of the aim and the procedure of the study; together with consent to publish these details.

Competing interests

None.

Author details

[1]Unit of Phoniatrics, ENT Department, Tanta University, Tanta, Egypt. [2]Phoniatrics, ENT Department, Cairo University, Giza, Egypt.

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