



# Early Transthyrohyoid Injection Laryngoplasty Under Local Anaesthesia in a Single Tertiary Center of Southeast Asia: Multidimensional Voice Outcomes

## Original Investigation

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## Abstract

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**Objective:** To study the effectiveness of early percutaneous transthyrohyoid injection laryngoplasty under local anesthesia in improving voice quality in unilateral vocal fold paralysis (UVFP) patients.

**Methods:** Longitudinal data of 29 UVFP patients who underwent injection laryngoplasty within six months from the onset of the symptoms were studied. The injectate (0.5–1 mL) was hyaluronic acid-based material (Juvéderm ULTRA XC; Allergan Industrie, France) that was delivered under local anesthesia with transthyrohyoid approach using a double-bend 21G needle. Multidimensional voice outcomes employing: 1) Malay-Voice-Handicap Index-10 (mVHI-10); 2) maximum phonation time (MPT); and 3) acoustic analysis [jitter%, shimmer% and noise-harmonic ratio (NHR)] were used to assess the treatment progress. The voice parameters were measured at baseline (2 weeks pre-injection), and at the first and third months post-injection.

**Results:** The mean age of the 29 patients was 44.69 years, with a female-to-male ratio of 3.14:1. The voice outcomes measured at different time points were evaluated with repeated measures ANOVA. Significant improvement was observed from baseline to three months post injection laryngoplasty for mVHI-10, jitter, and NHR ( $p < 0.001$ ), shimmer ( $p = 0.005$ ) and MPT ( $p = 0.018$ ). Following the procedure, none of the patients developed any major complications.

**Conclusion:** Office setting early transthyrohyoid injection laryngoplasty using a double-bend needle is a safe and effective procedure in patients with UVFP with evidence of significant improvement in voice and life quality.

**Keywords:** Larynx, vocal cords, vocal cord paralysis, laryngoplasty, acoustic analysis, office surgery

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## Introduction

Voice plays an important role in human life. It is vital for efficient communication and expression of emotion. One of the causes of an abnormal voice is glottic insufficiency, which is commonly caused by unilateral vocal fold paralysis (UVFP). Glottic insufficiency leads to not only adverse voice quality, but also to the risk of aspiration of fluid and food material due to improper glottal closure (1). Given the considerable risks in glottic insufficiency and its adverse effects on the quality of life, early treatment is recommended.

One of the effective and less invasive modalities of early treatment for UVFP, without doubt, is injection laryngoplasty. Traditionally performed under general anesthesia, recent advancements allowed injection laryngoplasty to be performed in office settings, and thereby rendered the procedure increasingly popular in the early treatment of UVFP (2, 3). With the augmentation of the vocal fold by medializing the leading edge of the vocal fold, it improves the closure of the glottis (3).

Injection laryngoplasty in office settings is largely adopted via percutaneous technique which was first introduced by Ward et al. (4). One of the modifications of this technique is transthyrohyoid double-bend needle technique which was described by Achkar et al. (5). The double-bend-needle technique, a technique in which the needle was modified by creating two 45-degree angle bends with one at the needle hub and another 1-cm proximal to the tip of the needle, allows the laryngologist to not only estimate the needle tip depth during injection, but also facilitates access to the endolarynx, which includes the entire medial and superior surface of the true and false vocal folds and the interarytenoid regions, regardless of the thyroid cartilage angulation or the chin position during the procedure (5). A study by Song et al. (6) reported that 87% of the patients who had their vocal fold augmented using this technique demonstrated subjective improvement in voice, as measured by the Voice Outcome Survey, and all patients tolerated the procedure well without complications. There are very few comprehensive studies published with multidimensional voice outcomes data on early injection laryngoplasty using the transthyrohyoid double-bend needle technique under local anesthesia.

The objective of our study was to assess the effectiveness of early injection laryngoplasty in patients with UVFP of less than 6 months, utilizing this unique double-bend needle technique under local anaesthesia. Multidimensional voice outcomes were employed to assess its efficacy in improving the voice quality objectively and subjectively.

## Methods

Longitudinal data of 29 patients with UVFP who underwent injection laryngoplasty within six months from the onset of

the symptoms were studied retrospectively. The cases that were included were those with UVFP of less than six months duration, who had voice issues and/or aspiration symptoms, and had undergone injection laryngoplasty under local anesthesia with temporary biomaterials. We excluded cases that had injection laryngoplasty under general anesthesia or had received long-term biomaterials, or the injection laryngoplasty was done as a touch-up procedure. Cases with incomplete data were excluded from this retrospective study.

## Surgical technique

Injection laryngoplasty was performed under local anesthesia using a transthyrohyoid approach with a double-bend 21G needle (5). A hyaluronic based material, Juvéderm ULTRA XC (Allergan Industrie, France), was used as the injectate to augment the paralyzed vocal fold. The injection laryngoplasty was performed in an office setting in the clinic while the patient was sitting upright on an examination chair. First, local anesthesia was given by spraying the nostrils with Co-phenylcaine (Ent Technologies, India). Second, the subcutaneous of superior thyroid notch area were infiltrated with 1 cc of 2% lignocaine. Third, the upper airway was anesthetized by performing intratracheal anesthesia with 3 to 4 cc of 2% lignocaine. Following this, a 21G needle was bent at two points as described by Achkar et al. (5). The injection was then performed under flexible nasopharyngolaryngoscope assistance, whereby the double bend-needle was introduced at the soft tissue of the superior thyroid notch and the tip of the needle appeared in the larynx below the petiole (Figure 1a). The needle was then pushed further in the midline until the distal bend was seen. Subsequently it was aimed at lateral to the vocal fold ligament in the paraglottic space, next to the vocal process (Figure 1b). Finally, the hyaluronic acid gel was slowly injected about 0.5–1 mL until the vocal fold was augmented with about 10%–20% over correction (Figure 1c).

## Multidimensional voice assessment

Measurement of voice outcomes following the injection laryngoplasty was multidimensional, consisting of subjective and objective assessments. For subjective assessments, patients were evaluated with the Voice Handicap Index-10 (Bahasa Malaysia version; mVHI-10) (7). VHI-10 is a validated patient-administered subjective questionnaire that consists of physical, functional and emotional components to quantify the patient's perception of their own voice function (8). mVHI-10 is the culturally adapted Malaysian version of VHI-10 with a total score of 40 whereby score of more than 11 is considered abnormal (7).

The objective assessments include: 1) maximum phonation time (MPT); and 2) acoustic analysis that comprises jitter % (frequency variation), shimmer % (amplitude variation) and noise-to-harmonic ratio (NHR). The analysis of the acoustic parameters were performed using On Person Rapid

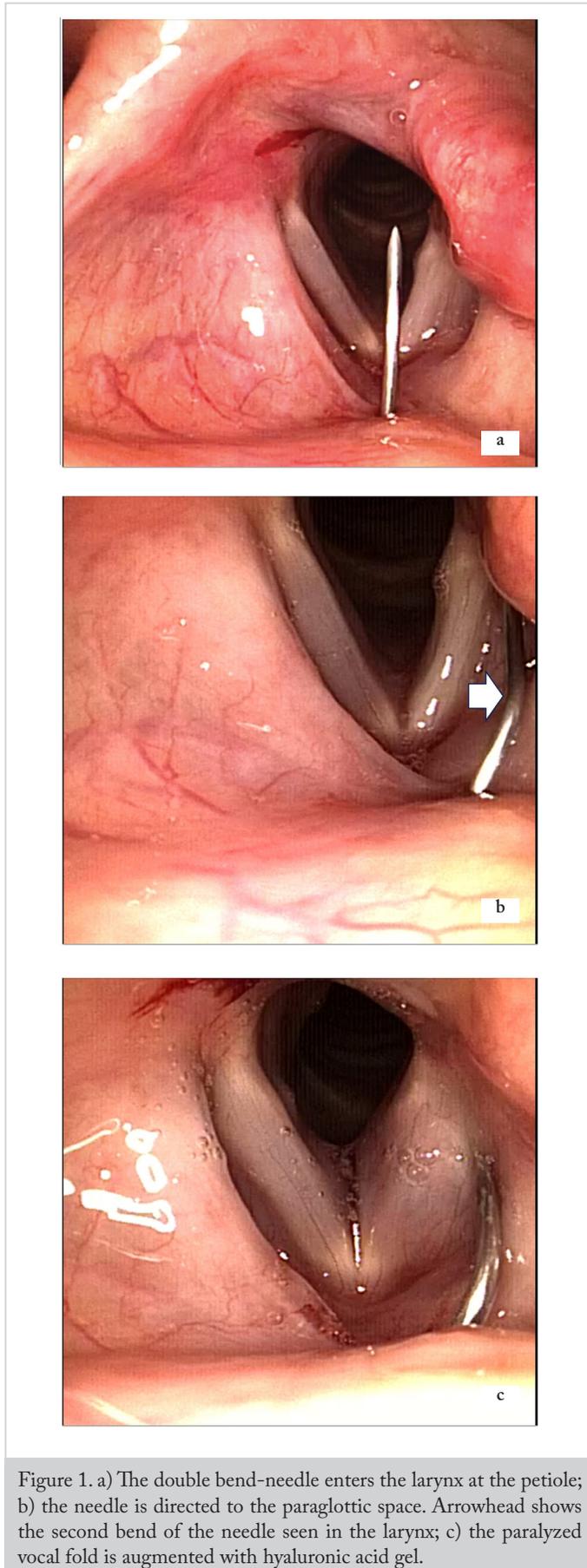


Figure 1. a) The double bend-needle enters the larynx at the petiole; b) the needle is directed to the paraglottic space. Arrowhead shows the second bend of the needle seen in the larynx; c) the paralyzed vocal fold is augmented with hyaluronic acid gel.

Voice Examiner, Oxford Research Wave Ltd (OperaVOX) in a quiet room (9). OperaVOX is objective, non-invasive, inexpensive and characterizes voice quality using intelligent tools (10). Jitter is affected by the poor control of the vocal cord vibrations with depiction of the parameter of frequency variation from cycle-to-cycle, and shimmer is affected by the glottal resistance with relation to the amplitude variation of the sound wave, while NHR assesses the components that determine speech efficacy (11). MPT, on the other hand, measures the glottic efficiency (12).

### Statistical Analysis

Voice outcomes were measured at baseline, and at the first and third months post-injection. Baseline assessments were performed within the two weeks prior to the injection laryngoplasty. Multidimensional voice measurement outcomes of mVHI-10, MPT, and acoustic analysis of jitter, shimmer and NHR were analyzed with IBM SPSS Statistics version 26. Descriptive analyses of mean and standard deviation (SD) of each element were measured. Significance of the non-categorical data of multidimensional voice outcomes were analyzed with repeated measures ANOVA.

### Results

In total, there were 58 UVFP patients who received temporary injection laryngoplasty (50 under local and 8 under general anesthesia). Of the 50 patients that had the procedure under local anesthesia, 21 were excluded either because of incomplete data such as incomplete documentation on the duration of UVFP or because patients did not come for the assessment of multidimensional voice outcomes. In consequence, data of 29 patients (22 females and 7 males) with a mean age of 44.69 years were reviewed. The demographic data are summarized in Table 1.

Causes of glottic insufficiency were identified as iatrogenic post thyroid surgery (72%), idiopathic (14%), secondary tumor (7%), and others (7%). The 7% other causes were secondary to old pulmonary tuberculosis and base of skull osteomyelitis. All patients underwent injection laryngoplasty under local anesthesia.

The mean and standard deviation of mVHI-10, MPT, jitter, shimmer, and NHR showed evidence of improvement from baseline pre injection laryngoplasty to months 1 and 3 post injection laryngoplasty (Table 2). Statistical analysis with repeated measures ANOVA depicted significant improvement from pre-injection to 3 months post injection laryngoplasty for mVHI-10, jitter, NHR ( $p < 0.001$ ), and shimmer ( $p = 0.005$ ). Patients could sustain a longer MPT in post injection laryngoplasty compared to pre injection laryngoplasty with  $p = 0.018$ . These results are presented in Table 2.

**Table 1.** Demographic data of patients with unilateral vocal fold paralysis

Case	Age (years)	Gender	Etiology	Duration of paralysis (day)
1	57	F	Iatrogenic post thyroid surgery	14
2	38	M	Iatrogenic post thyroid surgery	85
3	45	M	Iatrogenic post thyroid surgery	1
4	47	F	Iatrogenic post thyroid surgery	14
5	67	F	Iatrogenic post thyroid surgery	14
6	63	F	Iatrogenic post thyroid surgery	14
7	59	F	Iatrogenic post thyroid surgery	14
8	31	F	Iatrogenic post thyroid surgery	1
9	65	M	Idiopathic	86
10	31	F	Iatrogenic post thyroid surgery	59
11	36	F	Base of skull osteomyelitis	112
12	45	F	Iatrogenic post thyroid surgery	90
13	34	F	Iatrogenic post thyroid surgery	49
14	32	F	Secondary tumor	6
15	40	F	Idiopathic	179
16	37	F	Iatrogenic post thyroid surgery	90
17	31	M	Idiopathic	31
18	47	F	Iatrogenic post thyroid surgery	110
19	56	M	Iatrogenic post thyroid surgery	51
20	48	F	Iatrogenic post thyroid surgery	167
21	33	F	Iatrogenic post thyroid surgery	115
22	30	F	Iatrogenic post thyroid surgery	13
23	61	F	Iatrogenic post thyroid surgery	11
24	61	M	Iatrogenic post thyroid surgery	116
25	48	M	Base of skull tumor	3
26	24	F	Iatrogenic post thyroid surgery	4
27	31	F	Idiopathic	54
28	31	F	Iatrogenic post thyroid surgery	67
29	68	F	Secondary to old pulmonary tuberculosis	168

F: Female, M: Male

**Table 2.** Baseline pre injection, 1 month and 3 months post injection laryngoplasty (IL) vocal function assessment

Parameter	n	Data of vocal function assessment (mean ± SD)			Variation within samples F	Statistical significance p-value
		Baseline	1-month post IL	3-month post IL		
Jitter	29	6.71 (3.41)	4.04 (3.53)	2.86 (2.28)	18.780	0.001
Shimmer	29	13.37 (8.41)	8.47 (5.32)	7.02 (4.21)	6.459	0.005
NHR	29	1.24 (1.07)	0.59 (0.83)	0.33 (0.42)	9.343	0.001
MPT	29	5.99 (4.60)	7.54 (4.02)	9.36 (4.23)	4.713	0.018
mVHI-10	29	22.03 (12.01)	11.72 (10.70)	8.68 (8.77)	16.561	0.001

SD: Standard deviation, n: Number

None of the patients required nasogastric tube feeding following the injection.

## Discussion

UVFP can be of various causes. In our case series, surgical iatrogenic injury represented the highest percentage in the cases of UVFP, which is in accordance with the study by Rosenthal et al. (13) who reported surgical iatrogenic injury as the most common cause with a percentage of 46.3%. Unlike Rosenthal et al.'s (13) longitudinal study, in which non-thyroid surgeries had caused most of the surgical iatrogenic injuries, in our study the most common cause was post thyroid surgery with a rate of 72%. Idiopathic and other etiologies were just at 14% and 7%, respectively.

While the strong evidence of optimal management algorithm for glottic insufficiency secondary to UVFP remains a research question, injection laryngoplasty under local anaesthesia has been recommended to be a safe and effective procedure (2, 3, 13). The aim of the procedure is to augment the flaccid vocal fold by means of injecting filler substance into the paraglottic space.

For this purpose, in recent years, a variety of injectable materials with various biocompatibility and less triggering factor of foreign body reactions have been developed (14, 15). With the development of advanced digital imaging technology, injectable material can be delivered via a fine gauge needle into the paraglottic space under direct visualization (3, 15, 16). These advances have spurred the consideration of injection laryngoplasty as one of the effective treatments for glottic insufficiency (17, 18). In office setting, injection laryngoplasty is generally performed via percutaneous approaches which can be subdivided into transthyroid, transthyrohyoid and transcricothyroid (19).

Avoidance of general anesthesia is the most favorable aspect of injection laryngoplasty done in an office setting. With the patient awake and seated upright, injection laryngoplasty under local anesthesia allows real-time phonation monitoring together with the titration of the injected material amount, which is not possible under general anesthesia (3). Measurement of the voice and the airway status with the rate of permeability of the injected material location can be assessed simultaneously during injection laryngoplasty under local anesthesia (19).

Office setting injection laryngoplasty is particularly advantageous for patients with multiple comorbidities and high anesthetic risk, as it reduces perioperative morbidity with shortened hospital stay (15, 17). Notably, anticoagulation is not a contraindication as the risk of bleeding and hematoma

formation is low for injection laryngoplasty under local anesthesia (18). Office setting injection laryngoplasty is more cost-effective compared to general anesthesia, and thereby more affordable and accessible for the general population. Moreover, it helps to reduce the burden of the already rising healthcare cost to the country (3, 15). An added advantage of injection laryngoplasty under local anesthesia is the possibility of avoiding the long waiting time for an operation theater (OT) slot, which can in turn be reserved for more urgent, i.e., malignant cases that require longer OT times.

Prediction of the prognosis of UVFP is uncompromising as the best timing for performing injection laryngoplasty has been controversial previously, and there has been rationale on a waiting period of 6 to 12 months prior to intervention in certain selected cases of UVFP for possible spontaneous recovery occurrence. Recent research advocated early injection laryngoplasty in UVFP as it has been reported to statistically reduce the need for future open laryngeal framework surgery (19-21). A study by Choi et al. (22) showed that early injection laryngoplasty within one month following iatrogenic UVFP significantly improved the voice outcomes with reduction of aspiration risk.

With the convenience of the facilities in the office setting and its low complication rate, this concept provides an excellent early therapeutic option for patients with UVFP. Comprehensive clinical measurement of the voice outcome post injection laryngoplasty is essential.

A retrospective study by Bové et al. (3) comparing the clinical efficacy of injection laryngoplasty under general and local anesthesia revealed that both outcomes demonstrated similar promising improvement of voice quality based on VHI-10, thus advocated awake injection laryngoplasty in prudent patients. Powell et al. (14) assessed the subjective clinical outcome of injection laryngoplasty under local anesthesia with hyaluronic acid and calcium hydroxylapatite in 68 subjects using Voice Performance Questionnaires and GRBAS, whereas a study by Mohammed et al. (17) studied the clinical outcome of injection laryngoplasty with calcium hydroxylapatite in outpatient setting in 21 subjects solely with VHI-10. Singh and Gupta (17) evaluated videostroboscopic findings, acoustic analysis and VHI post injection laryngoplasty with calcium hydroxylapatite in only 12 patients. All three studies demonstrated relative significant improvement on the voice outcome post injection laryngoplasty under local anesthesia. Table 3 shows a comprehensive comparison of the number of patients, approaches adopted, materials used, measurement of voice outcomes and complications of injection laryngoplasty under local anesthesia in various studies.

**Table 3.** A comprehensive comparison of various studies of injection laryngoplasty (IL) under local anesthesia (LA)

Year	Authors	Technique	Sample size	Injection material	GA/LA	Outcome measurement	Complication
2010	Song et al. (6)	Transthyroid	27 (25- LA 2 - GA)	Crosslinked hyaluronic acid	LA GA	Voice-Related Quality of Life (V-RQOL) survey and the Voice Outcome Survey (VOS) both prior to and at least one month after injection - 87% reported improvement	One subject with collection of resylane at subepithelial space required drainage with suspension microlaryngoscopy
2012	Wang et al. (23)	Thyroid	20	Cross-linked porcine collagen	LA	Pre and 3 months post IL 1. Videolaryngoscopic evaluation for the glottic closure pattern - improved 2. Perceptual grading using the GRB scale (grade, roughness, breathiness) - improved 3. Acoustic analysis - improved 4. Maximal phonation time (MPT) - improved 5. Voice Handicap Index (VHI) questionnaire - improved	Mild vocal fold hematoma - resolved spontaneously in two weeks
2013	Birkent et al. (24)	Cricothyroid membrane	35	Bovine Collagen	LA	1. Voice Handicap Index (VHI)-30 - improved 2. Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) - improved 3. GRBAS - all improved except roughness 4. VAS - investigate patient tolerance to office-based IL (pain score 0-10)	-
2013	Upton et al. (25)	Transoral	27	Juvéderm Ultra Plus hyaluronic acid gel	LA	Analysis on VHI/GFI/DSI pre and 1-month post injection Subjective measures outcome 1. Voice Handicap Index - improved 2. Glottal Function Index - improved Objective measures outcome 1. Dysphonia Severity Index - improved	In one patient temporary glottic inflammation required intravenous steroids for resolution and caused no permanent sequelae. Three patients (10%) were unable to tolerate transoral injection and required conversion to the transcervical route.
2013	Wen et al. (25)	Thyroid or transoral	60 Out of 60 (33 employed porcine collagen) (27 employed Hyaluronic acid)	Cross-linked porcine collagen (PC) Hyaluronic acid (HA)	LA	Compare the outcome of VHI 10 and MPT between porcine collagen and hyaluronic acid. Both outcomes showed no significant differences.	-

Table 3. continued

Year	Authors	Technique	Sample size	Injection material	GA/LA	Outcome measurement	Complication
2014	Lee et al. (27)	Cricothyroid membrane	60  (UVFP post thyroidectomy and mediastinal surgery)	Hyaluronic acid  Calcium hydroxyapatite  Artificial collagen	LA	1. Voice analysis was performed preoperatively and at 1 month postoperatively 2. The glottal gap using glottal gap index 3. Perceptual Analysis (Grade, Roughness, Breathiness, Asthenia, Strain scale); (all improved except roughness) 4. Acoustic analysis (Jitter for frequency variation, shimmer for amplitude variation, Noise Harmonic Ratio) 5. Aerodynamic study (MPT, Mean airflow rate, Subglottic pressure) 6. MPT improved 7. Mean airflow rate improved significantly after injection 8. Subglottic pressure (remained same)	-
2014	Clary et al. (28)	Thyrohyoid With laryngeal introducer technique	21	20 with Radiesse voice gel  One with Radiesse voice	LA	Assessment:  Questionnaires post procedure on the discomfort of the IL under LA with laryngeal introducer technique – well tolerated	-
2014	Halderman et al. (29)	Transthyrohyoid and transoral	64	Restylane (crosslinked hyaluronic acid)	LA	Pre and post video stroboscopic examination  No granulomatous/scarring changes Mucosal wave amplitude preserved No foreign body reaction/inflammation	Two patients: injection into subepithelial plane One patient: developed atrial fibrillation One patient: developed shortness of breath with evidence of edema in the false cord and true cord; was resolved with steroid outpatient. One patient: hematoma in the arytenoid, a/e fold and true cord (patient on coumadin therapy)
2014	Powell et al. (14)	Cricothyroid membrane	68	Hyaluronic acid  Calcium hydroxylapatite	LA	Outcome measurement pre and 2 weeks post procedure  Voice Performance Questionnaire – significant improvement GRBAS – significant improvement	One patient developed persistent haemorrhage on injection site (on warfarin and dual antiplatelet)

Table 3. continued

Year	Authors	Technique	Sample size	Injection material	GA/LA	Outcome measurement	Complication
2015	Pei et al. (30)	Cricothyroid membrane	29 Out of 29, 14 injected with hyaluronates and 15 had conservative management	One group received Hyaluronates (Restylane)  One group received conservative treatment	LA	Outcome measurement:  Quantitative laryngeal electromyography, videolaryngostroboscopy- (normalized glottal gap area, NGGA) UVFP-related quality of life (Voice Outcomes Survey, VOS) laboratory voice analysis (include Jitter, Shimmer, Noise harmonic ratio) SZ ratio MPT health-related quality of life (SF-36)	
2016	Mohammed et al. (16)	Transthyroid	21	Calcium Hydroxyapatite	LA	VHI - 10 pre 25 VHI - 10 post 16.9 (Improved)	Three patients unable to tolerate procedure  Superficial injection
2018	Ricci Maccarini et al. (31)	Transnasal fiberoptic injection laryngoplasty  Using a high-pressure injection pistol connected to a flexible injection needle, injecting centrifuged autologous fat	22	Centrifuged Autologous fat	LA	Significant improvements in: videolaryngostroboscopic findings, perceptual evaluation (GRBA), maximum phonation time QoL self-assessment and VHI	No complication reported
2019	Lee et al. (32)	Mainly Cricothyroid approach	617	Calcium hydroxylapatite  (Long lasting material)	LA	Measure the complications of IL under LA with CaHA  Voice outcome was not analyzed.	Failure 0.52%  Superficial injection 0.82%  Acute dyspnea 0.21%

Table 3. continued

Year	Authors	Technique	Sample size	Injection material	GA/LA	Outcome measurement	Complication
2019	Choi et al. (33)	Cricothyroid	306	Long-lasting material (ArteSense)	LA	*This study evaluated the outcome of early IL with long lasting material  Outcome measurement: aspiration symptom, maximum phonation time (MPT), jitter, shimmer, noise to harmonic ratio (NHR), overall grade (G) and breathiness (B) of GRBAS (grade of dysphonia, roughness, breathiness, asthenia, strain) scale score, and Voice Handicap Index (VHI) were significantly improved after IL	-
2019	Singh and Gupta (17)	Cricothyroid	12	Calcium hydroxylapatite	LA	Stroboscopy (Symmetry of vocal cords, Mucosal wave on both vocal folds, and Glottic closure) Acoustic analysis (Fundamental frequency, Jitter, Shimmer, S-Z ratio, and Maximum phonation time) VHI	-

GA: General anesthesia; QoL: Quality of life; LA: Local anesthesia; VHI: Voice-Handicap Index

To accurately assess the voice outcome post injection laryngoplasty, a multidimensional holistic assessment is undoubtedly essential. To the best of the authors' knowledge, our research is among the very first few that have studied the multidimensional voice outcomes which consist of all subjective, objective, and acoustic analysis post early injection laryngoplasty under local anesthesia with the double-bend needle technique. According to our literature review, there are not many reported multidimensional voice outcome studies on double-bend needle technique injection laryngoplasty. Song et al. (6) reported voice outcomes with double-bend needle technique adopted mainly on subjective voice outcome survey and voice-related quality of life. Our multidimensional voice outcome study with the double-bend needle technique in post early injection laryngoplasty under local anesthesia showed significant improvement of the glottic function in the improvement of the objective and acoustic analysis, and no patients had any complications.

Hippocrates once said, "First, do no harm." Despite the promising multidimensional voice outcomes with reported low rates of complication in injection laryngoplasty under local anesthesia (17,20), safe medical practice is crucial in modern medicine. We advocate injection laryngoplasty under local anesthesia as both a clinically and financially effective modality of treatment for patients with glottal insufficiency. However, it should only be done in a setting where the transfer of patients service and emergency equipment are available at all times should any complications arise (3). The procedure should be terminated if the patient is unable to tolerate it (17). Patients with pathological laryngeal condition, low pain threshold and those who require a concomitant operative procedure with the usage of direct laryngoscope and rigid telescope should avoid injection laryngoplasty under local anesthesia (3,20).

Proper glottic closure is important for generating cough and preventing aspiration during swallowing.

Multiple studies have shown that injection laryngoplasty benefits patients with glottic insufficiency in preventing aspiration (1). EAT-10 is a validated and symptom-specific outcome tool commonly used in clinical practice to measure swallowing difficulties. However, in our study, EAT-10 scoring was not included in view of the incomplete data recruited.

### Limitations

Though the multidimensional voice outcomes post injection laryngoplasty under local anesthesia are promising, there are several limitations in our study.

1. We measured the multidimensional voice outcomes up to 3 months. A longer observational period would provide us with more concrete clinical evidence.
2. In all patients we used hyaluronic acid-based material with injection laryngoplasty; therefore, the comparative multidimensional voice outcomes of other injectable materials could not be evaluated.
3. Videolaryngostroboscopic assessments were not included in the presented study.
4. We adopted only the transthyrohyoid approach. Comparison of the outcomes with transthyroid and transcricothyroid approaches could not be made.
5. A study which includes EAT-10 would be more comprehensive, particularly in assessing the outcome of swallowing ability post injection laryngoplasty under local anesthesia.

The rationale of performing injection laryngoplasty under local anaesthesia as early as one day post recurrent laryngeal nerve (RLN) injury may be questionable as the neck is commonly edematous, inflamed and tender after thyroidectomy. Nevertheless, the injection procedure may be done under general anaesthesia or delayed until the neck is less swollen and tender. The senior author's experience in performing injection laryngoplasty in acutely injured RLN showed benefits to the patients especially in preventing patients from going home from the hospital with nasogastric feeding due to aspiration issues. Future studies also should investigate the safety and efficacy of injection laryngoplasty performed on-table or within few days of iatrogenic injury of RLN.

A future larger comprehensive study should be ideal to elucidate this information. Despite these considerations, the conclusion on the improvement of multidimensional voice outcome post injection laryngoplasty under local anesthesia from this database seems valid.

### Conclusion

Early percutaneous transthyrohyoid injection laryngoplasty with the double-bend needle technique under local anesthesia is an effective modality for the treatment of glottic insufficiency with life and voice quality improvements. Hence, with the evidence of significant improvement of multidimensional voice outcome post early injection laryngoplasty, it should be highly considered in selected suitable patients with UVFP.

**Ethics Committee Approval:** Since this study is a retrospective study, ethics committee approval is not required.

**Informed Consent:** Retrospective study.

**Conflicts of Interests:** No potential conflict of interest relevant to this article was reported.

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### Main Points

- Injection laryngoplasty under local anesthesia is a prudent and cost-effective treatment of unilateral vocal fold paralysis.
- The double-bend needle technique allows better visualization and access to the endolarynx resulting in a high success rate.
- Significant improvement on the multidimensional voice outcomes was evidenced by our series of subjective and objective evaluations.

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