

Vocal cord medialization and Sulcus-vocalis surgical management

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Abstract

Complete or partial paralysis of one or both vocal cords can significantly affect a patients phonation ability as well as risk aspiration. Sulcus vocalis is a condition where there is a groove running parallel to the edge of the vocal cord extending from the anterior commissure to the anterior edge of the vocal process of the arytenoid cartilage. Injection laryngoplasty (IL) is a minimally invasive technique which can successfully deal with both of the above-mentioned conditions directly as well as indirectly with only a slight modification in technique using autologous 'insulinated fat'. Additionally, when treating sulcus vocalis, cold steel dissection of the sulcus through a small parallel incision was preferred without subsequent mucosal suturing. Using 2 surgeons (4 hand technique) improves precision of instrumentation when using a high-definition rigid bronchoscope through a suspension laryngoscopy setup. This is needed especially for precision injection of long-term injectables in injection laryngoplasty.

Keywords: Sulcus vocalis, Vocal cord palsy, Injection laryngoplasty

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Funding: None

Competing interest: None

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Accepted Date: 18th January 2024

Published Date: 11th February 2024

Introduction

Complete or partial paralysis of one or both vocal cords can significantly affect a patient's phonation ability as well as risk aspiration. The patients usually present with a hoarse voice or aspiration pneumonia. If the cords are fixed in a median or paramedian position the resulting narrowed glottis will cause significant airway compromise in which case the patient will present with a good voice but inspiratory stridor and shortness of breath.

Sulcus vocalis is a condition where there is a groove running parallel to the edge of the vocal cord extending from the anterior commissure to the anterior edge of the vocal process of the arytenoid cartilage. There are several classifications currently available of which the classification based on the depth of the sulcus is the most popular¹. The sulcus affects the mucosal wave migration during phonation resulting in an altered voice². The patient ideally presents with a hoarseness of voice which is present over a prolonged period of time and on examination (ideally under stroboscopy) a sulcus will be visible lateral to the free edge of the vocal cords along with an interphonatory gap.

Injection laryngoplasty (IL) is a minimally invasive technique which can successfully deal with both of the above-mentioned conditions directly as well as indirectly with only a slight modification in technique. The approach can be transoral (Endoscopically) or trans-thyroid depending on available resources. Injectable substances used for this technique can vary from autologous material (Fat) augmented with platelet rich fibrin (PRF)³ to commercially available substances (Hydroxyapatite, Hyaluronic acid etc.). Our unit uses processed autologous fat (mixed with insulin) harvested from the patient at the time of surgery as it is the most economically viable option.

Patient preparation

As with any procedure, written informed consent is crucial as the majority of our patients can be professional voice users. Particular attention must also be paid to the 'harvest site' if autologous fat is to be used.

Procedure

The procedure is performed under general anaesthesia with a 'downsized' cuffed endotracheal tube (ET) inserted and the patient positioned supine with neck in the extended position (Microlaryngoscopy position). The Fat is harvested from a small transverse abdominal incision (Refer Pic. 1) and prepared using sharp dissection with a 15 blade (So that the fat lobules are separated from the fascia) (Pic. 2) until it becomes a liquid paste like material. This is then washed with saline for the first time to get rid of the excess fat and blood. Insulin is then added to the prepared fat paste and kept for 2-3 minutes (Pic. 3). Excess insulin is then washed away with saline and the final product is loaded into a 1ml syringe (An insulin syringe) with the 18G butterfly cannula (Image 1) attached to the end of it (Pic. 4). Note that the Flanges of the cannula are cut short in order to have a better grip and for the better visualization down scope.

Once the suspension laryngoscope is positioned and stabilized, a rigid endoscope is used to examine the larynx and vocal cords in detail. We use a 'four hand' technique to inject the processed fat through the incision (Pic. 5). The primary surgeon holds the rigid scope (Hopkins Rod) and the forceps equipped with a 18G modified cannula tip and the secondary surgeon operates the fat injection apparatus (1cc Syringe loaded with fat solution attached to the 18G cannula). The movements are coordinated by looking at the monitor on the 'stack'.

The technique for Sulcus Vocalis

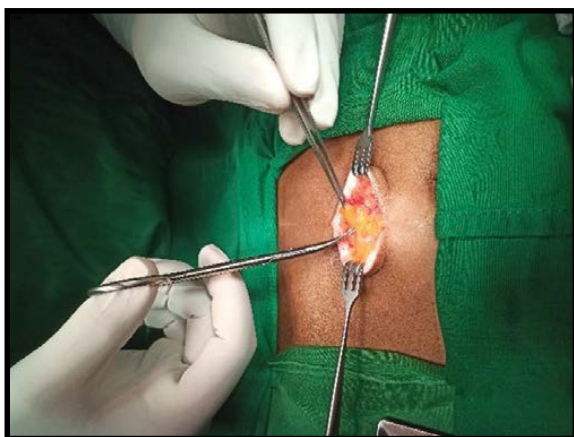
The sulcus is clearly identified and a small incision is made using the tip of the laryngeal straight scissors just lateral to the sulcus tract. A fine curved laryngeal forceps is then introduced through this small incision through which dissection of the sulcus tract can proceed superiorly and inferiorly (Pic. 6). Once adequate separation of the sulcus is achieved the forceps is removed and the 18G butterfly cannula is inserted through the incision (Pic. 7). Although a smaller needle could have been used theoretically^{4,5} in practice all smaller gauge needles obstructed after short use. The harvested 'insulinated' fat is then injected in to this dissected tract causing the sulcus to be obliterated. If injected correctly the fat can be seen tracking up the dissected tract obliterating the sulcus. Some 'spillage' will be noted through the incision site and this is to be expected. We do not suture or glue the incision site post procedure.

Additionally, the vocal cord can be further augmented by medialization of the affected cord (Indirect treatment of sulcus vocalis) by following the technique described below.

The technique for vocal cord medialization

Confirmation of the lateralized vocal cord should have been done prior to intubation as once intubated it is very difficult to identify the pathological cord due to the splinting effect of the ET tube. Visual documentation (Endoscopic photography) should be referred to whenever possible to confirm the pathological cord. The midpoint of the vocal cord is identified and the 18G cannular tip is inserted 5 to 7 mm lateral to the free edge of the vocal cord, going through the vocalis muscle up to a point where the needle tip hits the superior margin of the cricoid cartilage. The needle is then withdrawn about 5mm and the fat is injected into the vocalis muscle. An immediate medialization of the vocal cord can be visualized and it is our practice to overcompensate the medialization to a point where the airway is not compromised.

All patients who undergo any type of vocal cord surgery are given perioperative intravenous steroids and are kept on absolute voice rest for a minimum period of 24 Hrs. They are also given pre and post procedure reflux treatment and speech therapy. Patients are reviewed at 2 weeks, 1 month and at 6 months respectively with VHI scores and repeat endoscopy.



Pic 1: Abdominal incision and fat harvesting



Pic 2: Sharp dissection of fascia from fat



Pic 3: Filtrate following bathing in insulin,
Ready for loading into syringe



Pic 4: Filtrate loaded into syringe



Pic 5: Four hand technique used to inject
processed fat



Pic 6: Dissection of sulcus vocalis
tract through a small lateral incision



Pic 7: Injection of Sulcus Vocalis dissected
tract with Processed fat/insulin



Image 1: 18 Gauge Butterfly Cannula

Discussion

There are many options available to treat both sulcus vocalis and a lateralized immobile vocal cord and there is inter user variability of success. Even though there is some statistical evidence proving a any specific method's success rate, many experienced laryngologists go by the dictum 'if a particular technique works for you stick with it'

With regard to vocal cord medialisation the most popular options are injection laryngoplasty (IL) and type I thyroplasty⁶ (Using Sialastic or Titanium) or a combination of both techniques. With regard to injection laryngoplasty some studies have also shown a correlation between and quality and quantity of material used with improvement of maximum phonation time (MPT)⁷.

When dealing with Sulcus Vocalis, recent systemic reviews suggest no particular advantage in any single technique over another but rather a combination of direct and indirect treatment modalities done in a sequential fashion of increasing invasiveness⁸. To this effect the authors prefer the following sequence in surgical treatment.

1. Endoscopic cold-steel dissection of sulcus through a parallel small incision followed by autologous fat injection into the dissected space. (Direct treatment)
2. Intramuscular autologous fat injection for medialization of the affected cord and correction of the interphonatory gap. (Indirect treatment)

Unlike other techniques which rely on a longer parallel incision, by using a small incision we eliminate the need for laryngeal mucosal suturing post procedure which can be tedious. We have never used tissue glue on the larynx for mucosal approximation but may consider it at a future date if needed. We have also never had to resort to a Type 1 medialization thyroplasty⁶ to achieve adequate medialization of the cord for sulcus vocalis.

We usually treat one cord per surgical treatment cycle as 'bilateral' vocal cord treatment may risk the glottic airway. The 'other cord' is usually approached 4 to 6 months later. All patients receive speech therapy during this perioperative period.

Harvested autologous fat can further be augmented with platelet rich plasma (PRP) or platelet rich fibrin (PRF) which theoretically increases the longevity of the medialization and decreases the amount of repeat procedures although, recent studies show there was no added long-term benefit from this augmentation (MDVP and MPT scores were not significantly different)³ others demonstrate significant improvement when treating sulcus and vocal cord scarring⁵. PRF evaluation as an injectable has also been evaluated but shows no improvement over fat injection alone⁹. It is our opinion that this augmentation shows promise and that further research into its applications in laryngoplasty is needed.

Outcome prediction of injection laryngoplasty depends on a multitude of factors. Type of injectable, site of injection (Submucosal, Deep to SLP, Reinke's space, intramuscular), blood supply and innervation of the vocal cord all need to be considered before a procedure. Historically, injectables can be classified into short, intermediate and long acting/permanent categories. A newer classification based on viscoelastic studies also has emerged which helps decide at which level in the vocal cord each injectable can be used (The higher the viscosity the more lateral and deep the injection)⁴. (Refer Table 1) Autologous fat has the advantage of being a low viscosity (which is near identical to the properties of the vocal fold mucosa) long term fibrosis inducing injectable which also can be utilised within the vocal muscle as well^{4,5,9}.

Other popular options for Injection laryngoplasty also include collagen, hyaluronic acid and calcium hydroxyapatite. The former 2 of which are comparable in results¹⁰. Teflon is now rarely used due to the complication of Teflon granuloma formation⁴. We do not have any experience using these material as they are currently not available to us freely and are not cost effective to acquire.

Using a high-definition endoscopic camera system fixed to a rigid bronchoscope enabled us better visualization of the larynx during surgery and the 4-hand technique (2 surgeon technique) enabled better manipulation of instruments within the larynx increasing control and precision.

All IL procedures were carried out under general anaesthesia as high accuracy was needed for needle placement and accurate injection⁴. External approaches to the larynx for IL were not attempted.

Time based classification		Viscoelastic Classification	Usage
Short-term injections			
	Carboxymethylcellulose	Low viscosity	Useful for patients who would like to “test-drive” before proceeding with injection with longer lasting material
	Gel foam (Bovine gelatin)	Low viscosity	
Intermediate injections			
	Hyaluronic acid gels	Low viscosity	Considered more ‘forgiving’ substances that require less accuracy in delivery to specific sites in the larynx. Thus can be considered to be used in the clinic setting under local anaesthesia.
	Collagen Derivatives	Intermediate viscosity	
	Human-derived fibroblasts	No data available	
Long-term injections			
Autologous Materials	Fat (Processed)	Low viscosity (Nearly identical viscosity to true vocal fold mucosa and does not limit mucosal wave)	Even though High accuracy is required at the site of injection, extrusion into non intended areas will apparently not cause long lasting adverse effects (More forgiving). Thus, can be considered to be used in the clinic setting under local anaesthesia.
	Fascia (fascia lata, rectus sheath, temporal fascia)	Intermediate viscosity	
	Cartilage (Processed)	No data available	
	Calcium hydroxyapatite	Intermediate viscosity	High accuracy required at the site of injection and extrusion into non intended areas can be associated with increased adverse effects - Most often done under general anaesthesia
	Polydimethylsiloxane (PDMS or particulate silicone)	High Viscosity	
	Silk-hyaluronic acid (New)	No data available	
	Teflon (polytef paste)	High Viscosity	

Table 1: Classification and usage of injectables in laryngoplasty.

Key Messages

1. Injection laryngoplasty is a simple method which can be used at multiple levels (intramuscular and deep to superficial lamina propria) within the larynx to treat vocal cord paralysis and sulcus vocalis.
2. Using 2 surgeons (4 hand technique) improves precision of instrumentation when using a high-definition rigid bronchoscope.
3. When treating sulcus vocalis, a lateral and parallel ‘small’ incision avoids the need for cumbersome mucosal repair when combined with fine cold steel dissection and IL.

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