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Mini review article

CURRENT SURGICAL TREATMENT MODALITIES FOR VOCAL FOLD POLYPS: A MINI-REVIEW

AKTUELNI HIRURŠKI MODALITETI LEČENJA POLIPA GLASNICA: MINI-PREGLED

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Abstract

Vocal fold polyps represent one of the most common benign organic disorders affecting the larynx in the general population, and a relatively frequent cause of long-standing hoarseness. The exact etiology is unclear, but poor vocal behavior has been suggested as the principal etiologic factor. Histopathologically they are characterized by various structural alterations in the vocal fold superficial lamina propria, and typical clinical finding is of a solitary, unilateral and well-defined vocal fold lesion. Vocal fold polyps usually require surgical removal using microlaryngoscopy with cold steel excision in general anesthesia, which has been the practice standard for the last 60 years. Microlaryngoscopy offers the surgeon an unparalleled magnified view of the vocal folds and very precise work on a still operative field without a specific time limit. The introduction and technological development of ambulatory endoscopy and various laser systems provided the surgeon with ample therapeutic opportunities, including operating some of the patients in the office setting in local anesthesia. These outpatient procedures are technically simple and cost-effective, require fewer medical personnel, exclude general anesthesia-related risks, and are less time-consuming both for the patient and the physician. Nevertheless, the contemporary laryngologist should be able to perform both conventional microlaryngoscopy and office-based surgery for vocal fold polyps, depending on the clinical situation.

Keywords:
vocal fold polyp,
microlaryngoscopy,
office-based surgery,
laser surgery

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Sažetak

Polipi glasnica predstavljaju jedan od najčešćih organskih poremećaja larinksa u opštoj populaciji i jedan su od relativno čestih uzroka dugotrajne promuklosti. Tačna etiologija polipa glasnica je nejasna, mada se kao glavni etiološki faktor navodi loša upotreba glasa. Histopatološki, polipe karakterišu različite strukturne promene u površnom sloju lamine proprije glasnica, dok tipičan klinički nalaz odgovara solitarnoj, jednostranoj i jasno ograničenoj promeni na zahvaćenoj glasnici. Polipi glasnica se uglavnom leče hirurški i to mikrolaringoskopijom i ekscizijom "hladnim" instrumentima u opštoj endotrahealnoj anesteziji, što je metoda izbora u otorinolaringološkoj praksi tokom prethodnih 60 godina. Mikrolaringoskopija omogućava hirurgu do danas neprevaziđen uveličan uvid u glasnice i veoma precizan i komforan rad sa obe ruke na nepokretnom operativnom polju, bez vremenskog ograničenja. Uvođenje i tehnološki razvoj ambulantne endoskopije larinksa i različitih laserskih sistema pružili su hirurgu obilje novih terapijskih mogućnosti, uključujući i operisanje određenog broja pacijenata u vanbolničkim uslovima u lokalnoj anesteziji. Ove ambulantne intervencije su tehnički jednostavne i isplative, angažuju manje medicinskog osoblja, isključuju rizike vezane za opštu anesteziju i zahtevaju mnogo manje vremena za izvođenje. Bez obzira na ove prednosti, smatramo da savremeni laringolog-hirurg treba da poznaje i koristi i klasičnu mikrolaringoskopiju i ambulantne hirurške tehnike, u zavisnosti od kliničkog scenarija.

Ključne reči:
polip glasnice,
mikrolaringoskopija,
ambulantna hirurgija,
laserska hirurgija

Introduction

Vocal fold polyps (VFPs) represent one of the most common benign lesions in the larynx (1). The etiology of VFPs is considered to be unknown, but the typical location of the VFPs on the mid-membranous vocal fold suggests their traumatic origin is caused by poor vocal behavior, including voice overuse, misuse, and abuse (2). Over-excessive collision and repetitive traumatization of the vocal folds during phonation results in epithelial thinning, submucosal exudation, fibroblast proliferation, neoangiogenesis, and remodeling of the superficial lamina propria (1). Additionally, cigarette smoking and laryngopharyngeal reflux are believed to be contributing factors in the pathogenesis of VFPs (1, 3). The main symptom is non-resolving hoarseness, as a result of insufficient closure of the vocal folds during the phonation and the disbalance in the vocal folds' vibration amplitudes and mass.

The clinical finding of VFP on mirror laryngoscopy is of a solitary and unilateral exophytic, well-defined tumor-like mass located at the junction of the anterior and middle third of the free edge of the vocal fold. They can be sessile or pedunculated, with smooth or, less frequently, keratinized surfaces.

Although spontaneous resolution or favorable response of smaller lesions to voice therapy has been reported sporadically (4, 5), VFPs will most likely require surgical removal, followed by correction of known contributing co-factors (6). Surgery aims to completely remove the polyp with maximal preservation of intact surrounding mucosal covering and the layered structure of the vocal fold, in order to restore the physiologic conditions for normal voice production.

Based on the operative setting and the anesthesia type, surgical options for managing VFPs can be broadly classified into two major categories - procedures in general anesthesia performed in the operating room, and office-based procedures in local anesthesia. Depending on the surgical approach, office-based procedures are further subdivided into transoral, transnasal and percutaneous. Regardless of the setting, polyps can be treated either with laser or non-laser technology (including cold-steel excision and intralesional steroid injection), and combinations of these techniques.

Literature search and review

The MEDLINE literature database search was conducted through PubMed for relevant publications on surgical management of VFPs using the following keywords: "vocal fold polyp", "microlaryngoscopy", "office-based surgery", "laser surgery", "steroid injection", "indirect laryngeal surgery", "transnasal flexible laryngoscopy", "flexible fiberendoscopy". The initial reports on specific surgical techniques still in use as well as more recent modifications were selected, and a total of 38 articles were reviewed. After reviewing the articles, the principal characteristics, advantages and drawbacks of each surgical approach were further discussed and summarized in **table 1**.

Procedures in general anesthesia

Microlaryngoscopy and non-laser procedures

Cold-steel excision

Microlaryngoscopy in general anesthesia with cold instrument excision of the VFPs has been originally described in the 1960s (7), and is since considered as the gold standard in surgical treatment of various vocal fold lesions. It provides the surgeon the possibility of operating with both hands with great precision on an immobile and magnified operative field without a specific time limit. After endotracheal intubation, the patient lying supine is placed into the Boyce-Jackson position (neck flexed on

the chest and head extended on the neck). This is followed by introducing the largest possible laryngoscope under direct visual guidance through the patient's mouth, pharynx and laryngeal introitus, with the tip reaching the glottic plane and exposing the pathology of interest. The laryngoscope is then fixed with a holder and chest support, and the operating microscope is placed directly in front of the laryngoscope tube. Under microscopic magnification, the VFP is grasped and pulled medially with microforceps for exposure of its base, and carefully excised with microscissors (**figure 1A**). To maximally preserve the healthy mucosa, local flaps for covering the defect following VFP removal were introduced (8). However, microlaryngoscopy has certain limitations and risks, such as the possibility of iatrogenic trauma to the adjacent tissues, inadequate exposure and subsequent incomplete excision, and general anesthesia-related risks.

Intralesional steroid injection

Corticosteroids are potent anti-inflammatory agents and can be administered via systemic or local routes. They act by inhibiting collagen synthesis and deposition caused by transforming growth factor-beta (TGF-beta), and by inhibiting fibroblastic proliferation with reduction of the extracellular matrix deposition (9). Local and specifically intralesional administration of corticosteroids has been well documented in dermatology and plastic surgery in treatment of keloids and hypertrophic scars (10). Contrary to systemic administration, intralesional injection allows high corticosteroid concentration in target tissue, with negligible risk of side effects. The first reported intralesional steroid application in laryngology was in 1964 when Yanagihara injected dexamethasone in vocal fold nodules (11). During microlaryngoscopy, corticosteroids are rarely injected directly in the polyp, but rather in the vocal fold immediately after cold steel excision to reduce scarring, with reportedly better voice outcomes and lower recurrence rates than excision alone (12).

Laser-assisted microlaryngoscopy

The term 'laser' is an abbreviation for light amplification by stimulated emission of radiation. The fundamental characteristics of a laser beam that are essential for surgery are intensity, coherence, and directionality, meaning the light waves travel in phase and with great energy in a very focused beam without dissipation. The different types of lasers produce beams of specific wavelengths which are absorbed by corresponding target tissues. Based on mediums that define their wavelengths and their target tissues, the surgical lasers are divided into two main groups: cutting (carbon dioxide laser, thulium laser) and angiolytic lasers (pulsed dye laser, potassium titanyl phosphate laser, blue laser). While the effect of cutting lasers practically corresponds to excision with microscissors but with simultaneous hemostasis by thermocoagulation, angiolytic lasers induce gradual involution of the targeted lesion by destroying its blood supply, as their beams are strongly absorbed by intravascular hemoglobin. Each of these lasers can be delivered either transorally in the microlaryngoscopic setting or the office, usually through the working channel of the flexible fiberoptic endoscope.

Microlaryngoscopy and CO2 laser

Although there was some initial concern about treating benign vocal fold lesions due to the potential thermal damage and excessive scarring with the early carbon dioxide (CO2) laser equipment (13), the contemporary CO2 lasers are nowadays used to remove both malignant and benign laryngeal pathology (14, 15). Micromanipulator on the microscope adapter allows controlled, precise and focused delivery of laser beam through the laryngoscope without adverse effects on the surrounding tissues (**figure 1B**). After exposing the endolarynx as for microlaryngoscopy with the cold-steel excision, the endotracheal tube cuff is protected by saline-soaked pledgets, to prevent accidental laser beam damage to the cuff and subsequent airway combustion. The vocal fold lesion to be removed is retracted medially by micro forceps and excised with a laser beam as with the microscissors. The principal advantages of the CO2 laser excision are instant hemostasis, a bloodless and less crowded operative field, with only one instrument used for retraction. Several studies reported similar voice outcomes after CO2 laser surgery for VFPs and other benign lesions to those of cold-steel excision (15, 16). The major disadvantage of CO2 laser surgery is the increased cost of laser equipment installation and maintenance than the classic cold instruments.

Although the use of angiolytic lasers for VFPs in microlaryngoscopy has been reported (17, 18), they are used more often in office-based surgery.

Procedures in local anesthesia: office based-surgery

The development of 70- and 90-degree rigid rod-lens fiberoptic pharyngolaryngoscopes, provided an excellent indirect endoscopic view of the larynx and the vocal folds in the office, far superior to the mirror laryngoscopy. The subsequent introduction of flexible fiberoptic nasopharyngolaryngoscopes greatly improved the examination of the larynx in a completely physiologic position and with less discomfort for the patient, as the endoscope tip passes through the nasal cavity bypassing the gag-reflex triggering zones, but with image quality somewhat inferior to the rigid endoscopy (**figure 1C**) (19). More recently, the flexible nasopharyngolaryngoscopes with distal chip cameras instead of the flexible fibers provided an endoscopic image quality similar to rigid pharyngolaryngoscopes (20). The addition of a working channel in the endoscope sheath greatly facilitated laryngeal operations previously performed transorally with the aid of older flexible scopes. The channel allows the application of the local anesthetic, simple passing of biopsy forceps, laser fibers, or flexible injection needles immediately to the vocal fold lesion to

be treated. The availability of efficient local epimucous anesthetics enabled the laryngologist to remove, coagulate, or inject into different vocal fold lesions under endoscopic guidance in the outpatient setting.

Transoral indirect laryngeal surgery

Cold-steel excision

The first reported removal of VFP was in 1861 Berlin when Victor von Bruns removed the vocal fold polyp from his brother's larynx using the special curved forceps under the indirect visual control provided by the laryngeal mirror (21). The basic principle of the operation remained the same, while the visualization of the larynx during the procedure evolved by using the operating microscope in front of the laryngeal mirror (22), or by connecting the rigid 70- or 90-degree pharyngolaryngoscope to the video camera and TV monitor (23), high-definition camera and endoscope tower (24), or wireless camera and personal computer screen (25). The operation is performed with the patient seated for the routine mirror laryngoscopic examination. After the topical application of the local anesthetic, the patient is instructed to hold his/her's tongue protruding with a piece of gauze instead of the physician. Under the indirect visual guidance provided by the laryngeal mirror or rigid pharyngolaryngoscope held in the surgeon's left hand, the VFP is grasped by the long curved forceps (**figure 1D**) and carefully removed in a single, anterior-to-posterior motion and parallel to the free edge of the vocal fold. In this manner, the layered histologic structure of the vocal fold is respected, and its straight vibratory edge is restored. This simple procedure requires only one physician to perform, carries less risk of trauma to the surrounding anatomic structures, and the rigid pharyngolaryngoscope provides excellent visualization of the anterior commissure, which can occasionally be difficult to expose during the microlaryngoscopy.

It is also considerably cheaper than the microlaryngoscopy, does not require preoperative work-up and hospitalization and is therefore convenient for patients with high risk for general anesthesia.

However, a cooperative patient is required, and those with over-excessive gagging may be better candidates for microlaryngoscopy, or flexible transnasal procedure as an office alternative. Also, manipulating the long curved forceps under the indirect laryngoscopic vision can be technically challenging, and frustrating for a novice surgeon. Transoral procedures can also be performed under flexible fiberendoscopic guidance, but an additional physician to operate the nasopharyngolaryngoscope is necessary (26).

Intralesional corticosteroid injection

Transoral injections in mirror laryngoscopy were originally described for vocal fold augmentation in the treatment of glottal insufficiency, by injecting Teflon in the paralyzed vocal fold (27). Corticosteroids are injected transorally in a similar fashion, with a curved needle under the rigid pharyngolaryngoscopic view instead of laryngeal mirror (28).

Transnasal flexible fiberendoscopic surgery: non-laser procedures

Cold-steel excision

After the application of the nasal decongestant and topically anesthetizing the oral cavity, pharynx and larynx as for indirect procedures, the flexible endoscope operated by the assistant surgeon is passed transnasally into the endolarynx. The additional topical anesthetic solution can be applied through the channel if necessary. The specially designed flexible cup forceps are then introduced through the working channel by the surgeon and used to grasp and excise VFP (29). Transnasal flexible fiberendoscopic surgery can be used in combination with angiolytic lasers, where the polyp is coagulated with a laser just before excision (30, 31). These procedures cause less discomfort to the patient and are convenient for gagging patients. However, a surgeon and an assistant endoscopist are required, and the movement of the forceps is somewhat limited in comparison to the curved transoral forceps. The procedure can be difficult in patients with narrow nasal cavities and therefore preoperative endoscopy should be performed to assess the tolerability of the procedure.

Intralesional corticosteroid injection

Corticosteroids can also be administered with a flexible needle through the working channel of a flexible fiberendoscope (32).

Transnasal flexible fiberendoscopic laser procedures: angiolytic lasers

Due to the principal absorption of their beams by oxyhemoglobin, angiolytic lasers were originally used for the treatment of vascular skin lesions, by inducing thermal damage, thrombosis and destruction of the targeted blood vessels, while keeping the overlying skin and surrounding tissues intact (33). As these lasers can be delivered via small bendable glass fibers through the working channel of flexible endoscopes, these same treatment principles can be applied to vocal fold lesions, including VFPs. The operative setup is similar to flexible fiberendoscopic cold excision, but additional laser precautions such as protective eyewear both for the patient and the medical personnel should be used.

Pulsed-dye laser

Initially used for recurrent respiratory papillomatosis surgery (34), the effectiveness of the pulsed-dye laser (PDL, 585-nm wavelength) in treating VFPs specifically has been evaluated (35-37). After the application of laser

Figure 1. Instrumentation for various intralaryngeal surgical procedures. A - basic microlaryngoscopy set with microforceps, microscissors, and different size laryngoscopes; B - operating microscope with CO2 laser adapter and micromanipulator; C - flexible fiberoptic endoscope (left) and rigid 70-degree pharyngolaryngoscope (right); D - curved forceps for indirect laryngeal surgery with different interchangeable tips.

beams to the polyp, the outcome (partial vs. complete resolution) usually becomes laryngoscopically evident 6 - 8 weeks after the procedure (36). The major disadvantage is the need for repeated laser procedures in cases of incomplete regression with unsatisfactory voice outcomes (36, 38). This can further be addressed by cold steel excision either in the office or in microlaryngoscopy. Additional long-term disadvantages are the high costs of maintenance and replacement of the laser dye medium.

Potassium-titanyl-phosphate laser

Potassium-titanyl-phosphate (KTP) laser has a wavelength of 532nm and was originally described in the treatment of microvascular lesions of vocal folds (17). It is more strongly absorbed by oxyhemoglobin, resulting in superior hemostasis than PDL and less extravasation of blood in the targeted tissue, which reduces the laser beam precision (39). This laser also has the advantages of less cost and less delivery fiber diameter than the PDL. Similar to other angiolytic lasers, the definitive effects become observable several weeks after the procedure, with complete resolution of VFPs reported in 44 postoperative days (40). For earlier effect, concurrent cold steel vocal fold polypectomy through the flexible scope can be performed in the same setting, following initial photocoagulation with the KTP laser (30).

Blue laser

The most recent addition to the family of angiolytic lasers is the blue laser (wavelength 445nm), which also has the cutting properties of a CO2 laser (41). Its utility has been demonstrated in various vocal fold pathology, both in microlaryngoscopy and in the office, as well as for VFPs specifically (41, 42), with results comparable to other angiolytic lasers. The blue laser fibers are more durable, and the whole system is considerably smaller than other lasers, as it weighs just under 3kg (in comparison to 20kg or more), and is therefore convenient for frequent transportation from the office to the operating theater if necessary (41).

Transnasal flexible fiberendoscopic laser procedures: cutting lasers

Table 1. Characteristics and advantages (+) of different surgical approaches in the treatment of vocal fold polyps.

	Surgical approach			
	Microlaryngoscopy	Transoral indirect	Transnasal flexible	Percutaneous*
Magnification	+++	++	++	++
Image quality	+++	++	+/++ (**)	+
Surgical precision	+++	++	+	+
Tolerability	+++	+	++	++
Physiologic conditions	/	+	++	++
Economy	+	+++	++	++
Personel requirements	+	+++	++	++
Technical simplicity	++	+++	+	++
Equipment portability	+	+++	++	++
Risk of injury	+	+++	++	++

*steroid injection only; **endoscopes with distal chip camera have superior image to quality to regular flexible fiberendoscopes, and similar image quality to rigid pharyngolaryngoscopes.

Thulium laser

The thulium laser (Tm: YAG, thulium: yttrium - aluminum - garnet) is a cutting laser with a wavelength of 2013nm and water as a target chromophore similar to CO2, but with reportedly superior hemostasis and delivery through a flexible cable. Originally used for transoral partial laryngeal resections for malignancy (43) and management of other laryngeal pathology in the office (43, 44), Hamdan et al. reported the use of thulium laser for VFP removal in the office, with the laser's non-contact mode for photocoagulation, and contact mode or the glass fiber tip for mechanical removal of the polyp (45).

CO2 laser

Although the majority of the CO2 laser procedures are carried out in the microlaryngoscopy setting, the development of the CO2 laser fibers (46) allowed its use in the office for evaporation of various benign and premalignant lesions, including VFPs, with results comparative to angiolytic lasers (44, 47).

Percutaneous corticosteroid injections

Percutaneous approach for VFPs can be used for patients with prior inadequate microlaryngoscopic exposure or in patients with significant comorbidities and high risk for general anesthesia. It is primarily used for intralesional corticosteroid injections, which can be delivered through the cricothyroid or thyrohyoid membrane, or directly through the thyroid cartilage (48, 49). This procedure does not require specialized instruments and can be performed with a 25-gauge needle and a disposable plastic syringe. The drawbacks of intralesional steroid injection are the delayed therapeutic effect, with laryngoscopically detectable disappearance of the VFP up to three months after the procedure (48), and relatively high rates of late recurrence (50). The other potential pitfall is vocal fold atrophy in cases of repeated procedures or if accidentally injected too deeply into the vocalis muscle.

Conclusion

Although microlaryngoscopy has been used for more than half a century as the treatment of choice for various organic voice disorders, the technological development of ambulatory endoscopy and sophisticated instruments have led to a significant shift of laryngeal surgical procedures from the operating room to the office. Despite the enormous technological progress in all scientific fields, all recently introduced surgical techniques should be properly assessed for optimal visualization of the larynx, their outcomes tested by multidimensional voice and speech computer analysis, and finally compared with microlaryngoscopy as the established practice standard in the surgical treatment of VFPs. Microlaryngoscopy in general anesthesia provides great comfort for the surgeon and an excellent microscopic view of the endolarynx, and at the same time ensures the patient has the maximum therapeutic benefit from this type of surgery.

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