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Review

IS SURGICAL TREATMENT OF VELOPHARYNGEAL INSUFFICIENCY BY MYOMUCOSAL POSTERIOR PHARYNGEAL FLAP A CONTRAINDICATION FOR NASAL INTUBATION? A NARRATIVE REVIEW

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SUMMARY – Velopharyngeal insufficiency is a disorder where the soft palate directs the air through the nose. It is often present in patients with previous cleft or short palate, but also in many other conditions. Symptoms are primarily to be found in speech, with very distinct nasal sound. After clinical evaluation and nasal endoscopy, surgery is considered. Several surgical techniques are in use, with posterior pharyngeal flap pharyngoplasty being most widely used. This method leaves the base of the posterior pharyngeal flap attached to the posterior pharyngeal wall, with two lateral ports on each side of the flap. Permanent nasopharyngeal obstruction is a very challenging pathology for anesthesiologists in case of mandatory nasal intubation since it is a relative contraindication for nasal intubation. Patients with previous palatoplasty will regularly appear in our routine anesthetic practice, in all surgical segments. The high risk of damage to the flap with possible bleeding can put the anesthesiologist in a very unpleasant situation if not aware of the permanent effect of this surgery. During preanesthetic assessment, if there is information on a previous pharyngoplasty, one should consider alternative options for nasotracheal intubation. All nasal insertion procedures must be either avoided or carried out with great caution, under fiberoptic visual control.

Key words: *Velopharyngeal insufficiency; Iatrogenic nasopharyngeal obstruction; Nasal intubation; Airway*

Introduction

Velopharyngeal insufficiency (VPI) is a condition which can be congenital or acquired. In the majority of cases, it can be corrected by speech therapy and surgery. There is a number of surgical techniques, but for an anesthesiologist the most interesting and challenging one is pharyngoplasty with posterior pharyngeal flap (PPF) because it leaves patients with a life-long, permanent complication of iatrogenic nasopharyngeal obstruction. Unfortunately, many anesthesiologists are not acquainted with this surgical technique which results in postoperative irreversible nasopharyngeal obstruction. The aim of this study was to search the available literature and investigate options for possible scenarios that will require mandatory nasal intubation, such as maxillofacial trauma, difficult intubation, etc. If not recognized as a situation with irreversible nasopharyngeal obstruction, during nasopharyngeal intubation serious bleeding due to damage to the flap can occur and compromise the patient's safety. Considering the fact that our hospital is deeply involved

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in treating children and adults with clefts, we thought it would be of great importance to also acquaint other anesthesiologists with this important problem.

Methods

We searched the PubMed database for articles dealing with the treatment of VPI and tried to see what would be the best way to manage the airway in those patients, especially in situations that would demand nasal intubation. We found 35 articles published during the 1980-2022 period, which analyzed VPI from different aspects.

Anatomy

The velopharyngeal sphincter or velopharyngeal port is part of the pharynx which divides its oral (oropharynx) from the nasal part (nasopharynx)[1]. It comprises the soft palate, posterior and lateral pharyngeal walls, which together form a virtual sphincter and ensure division between the two cavities during phonation. Anatomically speaking, it consists of the following six muscles: tensor veli palatini muscle, levator veli palatini muscle, uvular muscle, palatoglossus muscle, palatopharyngeal muscle and superior pharyngeal constrictor muscle. The levator veli palatini muscle serves as the major elevator for the velum. The palatoglossus muscle simultaneously lowers the velum, elevates the tongue upwards and backwards, and depresses the palate for nasal speech. The palatopharyngeal muscle positions the velum and narrows the velopharyngeal orifice by adducting the posterior pillars and constricting the pharyngeal isthmus. This muscle also raises the larynx and lowers the pharynx. The superior pharyngeal constrictor muscle produces medial movement of the pharyngeal walls and assists in drawing the velum posteriorly[1,2]. During phonation, the soft palate (velum) is lifted and pulled backwards in order to come in contact with the posterior pharyngeal wall.

Pathophysiology

Normal anatomic contacts between the described structures lead to a competent function of the velopharyngeal mechanism[3,4]. It is considered that normal aerodynamic flow exists when there is velar opening of 0.05-0.1 cm^2. According to Yang *et al.*, if the opening is greater than 13.34 cm^2, this contact is not adequately achieved and VPI or velopharyngeal dysfunction is then present[5-7]. In patients with VPI, the velopharyngeal sphincter directs the air through the nose instead the mouth creating a typical hypernasal, resonant voice (Fig. 1). The greater the velopharyngeal gap, the greater is nasality[8].

Epidemiology and Etiology

Velopharyngeal insufficiency is a multifactorial disorder of unknown frequency. It can be congenital or acquired. As a result of a connate anomaly, it will

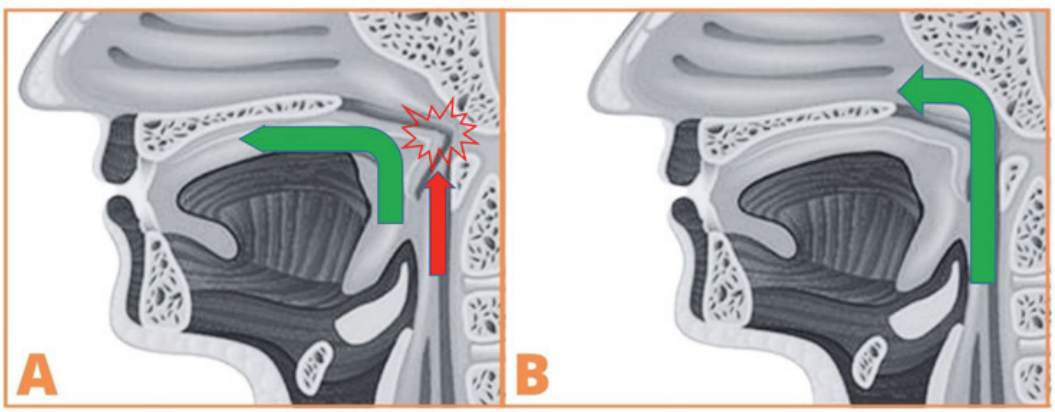

Fig. 1. Normal speech: the velopharyngeal sphincter is competent and when speaking it directs the air through the mouth (A); velopharyngeal insufficiency: the sphincter is incompetent and the air 'runs' out through the nose, which results in a resonant voice (B).

manifest itself right after birth. It can also be of organic origin or functional. In case of organic origin, it can mostly be found in patients with previous cleft palate, recognized or unrecognized submucosal palatal cleft, or in people with short palate. VPI affects approximately 20%-50% individuals who have undergone cleft palate repair[1,9-11], and 5%-10% patients with submucous cleft palate[9,10]. It can also be seen in many different conditions which are not connected to the cleft, e.g., after adenoidectomy, tonsillectomy, neurological disorders (cerebral palsy, stroke), palatal tumors, neurofibromatosis, etc.[1,12] (Table 1).

Velopharyngeal dysfunction is a general term which is used to describe different disorders of the velopharyngeal sphincter. It includes VPI due to abnormal structure (clefts, post adenoidectomy), velopharyngeal incompetence due to abnormal movement (traumatic cerebral injuries, cerebral palsy) and velopharyngeal mislearning, which is due to abnormal sound production when children pronounce voices in the pharynx instead the mouth. The velopharyngeal valve remains open, and the air and sound go through the nose, just like when there is structural VPI present.

Clinical Presentation

Symptoms are primarily to be found in speech, more rarely in swallowing and hearing[12]. Due to extensive passage of the air through the nose, the main symptom is rhinolalia, a hypernasal aspect of the speech. This is a resonance disorder due to the lack of barrier between oral and nasal cavity. Children with VPI often produce audible nasal emissions[13]. Although different from hypernasality, this phenomenon again depends on the size of the opening. The bigger the gap, the less is resistance to flow. Articulation disorders like turbulence are present, as well as delayed speech development and they both present already in early childhood. Very often children are grimacing, as a result of subconscious attempts to inhibit abnormal nasal airflow by constricting the nares. In case of connate VPI, the dysfunction will present very early, already in the neonatal period, as difficulties with sucking, frequent aspirations, attacks of suffocations, repeated pneumonias, vomiting of food or liquids through the nose[13].

In case VPI is part of a syndrome, other symptoms will be noticeable too. For example, in the velocardiofacial (VCF) syndrome, characteristic clinical findings will include unilateral lip palsy, hypernasality, cleft palate, heart anomalies and frequent infections, as part of DiGeorge syndrome. In patients with neurological disorders, low muscle tone will be present[1].

Diagnosis

Diagnosis is established after taking a thorough history and performing routine clinical examination. Intraoral examination should be made, as well as orientative hearing examination. Besides basic diagnostics, additional diagnostic tools are recommended. Today, nasal endoscopy or nasopharyngoscopy stands as the gold standard, introduced by Pigott in the 1970s. With time, thinner fiberoptic endoscopes have been introduced, making them easier to use in the pediatric population[14].

Nasometry measures nasalance, an acoustic phenomenon used to assess treatment results. According to the International Working Group, assessment of the velopharyngeal mechanism should include both nasopharyngoscopy and multi-view video fluoroscopy in at least frontal and lateral views[15].

Magnetic resonance imaging (MRI) is controversial. Its big role in diagnostic algorithms for submucous

Table 1. Causes of velopharyngeal insufficiency

Palatal	Syndromes	Postoperative	Other
Overt cleft palate Submucous cleft palate Occult submucous cleft palate	Trisomy 21 Velocardiofacial syndrome Kabuki syndrome Neurofibromatosis	Adenoidectomy Tonsillectomy CNS surgeries	Neurotrauma Multiple sclerosis Muscular dystrophy ALS Chiari malformation Stroke

CNS = central nervous system; ALS = amyotrophic lateral sclerosis

or occult submucous clefts is recognized, but its value as part of the diagnostic algorithm is still unknown[17].

Therapy

After clinical evaluation and insight into anatomic structures, a decision on further therapy options is made. It is important to be aware that no single specialty can appropriately care for those patients all by itself. Teamwork is essential, and an interdisciplinary velopharyngeal team would be an ideal way for evaluation and managing patients with VPI, in order to obtain maximal functional outcome for these patients[16].

Non-surgical options

There are several non-surgical treatments available today. Speech therapy is considered to be one of the most important therapy strategies. According to the literature, 80% of patients today receive speech therapy[17]. Prosthetic managements include palatal lifts, speech obturators and nasal valves[9,18,19]. Continuous positive airway pressure (CPAP) therapy is also used as a palate-strengthening program which patients practice at home for 8 weeks, 6-days a week[1].

Surgical options

Surgery is indicated in cases when organic VPI implies a permanent situation, when a progressive neurological process can be precluded, or no further therapy benefits can be expected. Although several studies tried to compare one surgical technique to the other, so far there is no consensus regarding the specific choice of one *versus* the other[20]. Holistic approach to a patient is crucial and each case should be handled individually, with a specific type of surgery, tailored to his needs.

Surgery techniques can be divided into four major groups:

- posterior pharyngeal wall augmentations,
- palatal lengthening procedures,
- sphincter pharyngoplasty, and
- posterior pharyngeal flaps (PPF with a base placed superiorly or inferiorly).

Augmentation is a procedure of posterior pharyngeal wall bulking. Palatoplasties are procedures which elongate the palate, like in pushback palatoplasty or by Z-plasty in Furlow technique. Sphincter pharyngoplasty is a group of surgeries named after the authors, which enforce the palate. The first ones were introduced in the 1950s by Hynes and in the 1960s by Orticocea. The first three groups of surgeries are the ones which do not obstruct the airway, while the posterior pharyngeal flap does[1].

In reconstruction surgeries with posterior pharyngeal flaps, an inferiorly or superiorly based myomucosal flap is harvested from the posterior pharyngeal wall and inset with its distal end into the central portion of the velum, thereby permanently obturating the velopharynx and allowing nasal respiration *via* two lateral ports (Fig. 2). With this maneuver, air is diverted towards the mouth[1,12,18,20,21].

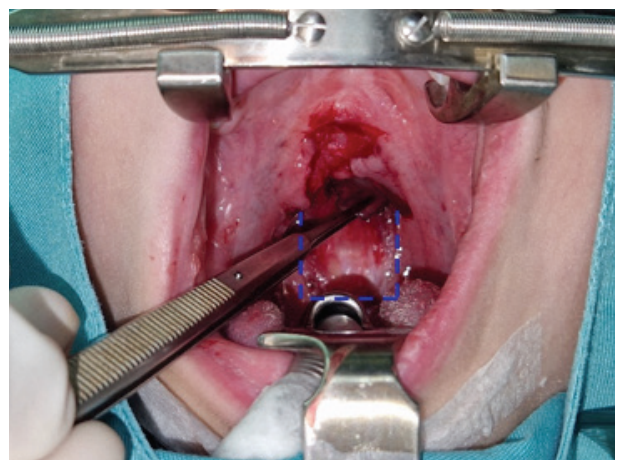

Fig. 2. Posterior pharyngeal flap with a superiorly based myomucosal flap: the flap was harvested from the posterior pharyngeal wall; its base (upper edge) remains attached to the pharyngeal wall, while the apex is attached like an apron to the soft palate.

Many surgeons today use the superiorly based posterior pharyngeal flap as the preferred one. It is shown to be acknowledged and one of the most successful surgical techniques for treating VPI.

Hirschberg showed that after PPF pharyngoplasty, hyperrhinophony became minimal or disappeared *in toto* in 90% of patients[12]. Unfortunately, as already said, its major disadvantage is life-long iatrogenic nasopharyngeal obstruction associated with the risk of airway compromise[5,22].

Acute complications after the surgery are also something to have in mind, but fortunately they are rare. Hirschberg has reported hemorrhage, significant airway obstruction by aspiration of blood or

retroposition of the tongue, detachment of the flap, and obstructive sleep apnea[12]. A study by Swanson *et al*. followed perioperative complications and showed that the overall perioperative complication rate for PPF was only 5.3%. In the first place, there were pulmonary complications in 2.2% and then prolonged mechanical ventilation in 1.3% of cases. Underlying asthma, cardiac risk factors and severe American Society of Anesthesiologists physical status class conveyed a significant complication risk and should therefore prompt greater attention. Cases were extracted from the American College of Surgeons National Surgical Quality Improvement Program Pediatric Database (NSQIP-PEDS)[23]. Although the overall complication rate was very low, one should keep in mind that a history of pharyngeal flap infection, hyponasal voice and upper airway obstruction can suggest a possibly very serious situation during intubation, i.e., port stenosis[24].

Discussion

The importance of pharyngoplasty for an anesthesiologist lies in the fact that depending on the surgical technique used, that patient's airway might be very altered. In the posterior pharyngeal wall augmentation and classic sphincter pharyngoplasty, the central velopharyngeal port is only diminished, but after PPF reconstruction, anatomic relations are more complex. In this case, the base of the PPF remains attached to the posterior pharyngeal wall and creates an artificial obstruction, i.e., an apron between the palate and posterior pharyngeal wall. On both lateral sides of the flap, ports are left open, wide enough for sufficient ventilation or as a possible passage for a soft catheter (suction catheters, nasogastric tube).

Oropharyngeal and nasopharyngeal anatomy after surgical repair of palatal cleft often remains altered, and therefore it increases the risk of difficult nasal intubation[25]. Although surgical narrowing of the velopharyngeal port does not affect maxillofacial growth or deformation, cephalometric investigations showed somehow changed proportions of the facial and oronasal structures. For example, the maxilla and mandible become more retrognathic in the sagittal plane. Mandible also takes a position more down- and backwards[25].

Nasotracheal intubation (NTI) is a common procedure performed in the operating room, especially in patients undergoing oral and maxillofacial surgeries. NTI improves the efficiency of surgical procedures for intraoral pathologic anomalies, structural abnormalities. It is desirable in maxillofacial trauma cases and orthognathic surgery[26–28]. Also, nasopharyngeal tube is a handy tool in situations when unexpected difficult intubation occurs and therefore is sometimes used outside maxillofacial operating theaters, by anesthesiologists who might not be familiar with VPI and its reconstructive techniques (Table 2).

Table 2. Indications and contraindications for nasotracheal intubation

Indication	Contraindication	
	Absolute	Relative
• Intraoral and oropharyngeal surgery • Trismus • ICU – alternative to tracheostomy • Maxillofacial surgeries (trauma, orthognathic surgeries, etc.) • Tonsillectomies • Rigid laryngoscopy • Microlaryngeal surgery	• Epiglottitis • Midface instability • anterior skull base fractures • Bleeding disorder • Epistaxis • Choanal atresia • Head injury + elevated ICP • Recent nasal surgery • Nasopharyngeal obstruction • Thrombolysis • Coagulopathy	• Obstruction of the nasal airway • Recent nasal surgery • Frequent episodes of epistaxis • Neonates, infants, very young children

ICU = intensive care unit; ICP = intracranial pressure

However, although useful, NTI may cause complications if the tube tears the surrounding structures when it passes through the nasopharynx and oropharynx. It carries a risk of damaging the repaired cleft palate[29]. If a pharyngeal flap is present, NTI can cause tear of the flap, which may result in traumatic and massive hemorrhage[30].

Nasotracheal intubation should be performed based on the overall results of preoperative evaluation. If NTI is expected to be difficult, consultations with surgeons are advised in order to decide whether to perform NTI or not and to revise alternative methods. Particular attention should be applied to patients who previously had reconstructive facio-oral surgery, especially cleft palate repair and pharyngoplasty.

Considering all the above, pre-anesthetic consideration should include very detailed history and examination, accompanied by all necessary diagnostic means. The pre-anesthetic evaluation for these patients should be performed within 48 h before surgery and should be documented and recorded[26].

A very important step is detailed preoperative questioning, with special reference to the possible upper airway obstruction assessment and typical symptoms such as nasal speech and language disorders[31]. Surgical notes on the type of surgical correction had been done. This is essential, because approximately up to 25% of cleft repairs also needed pharyngoplasty which could have included PPF[32]. Knowing which type of repair was performed will directly affect the decision on the kind of airway control to be used.

According to Hall and Shutt, additional tests such as nasal endoscopy, x-ray, computerized tomography, and MRI should be performed to identify possible problems with NTI and prepare for alternative methods[28]. Bell *et al.*[33], as well as Hall and Shutt[28] suggest that preoperative nasoendoscopy be performed in patients having previously undergone pharyngoplasty and were now scheduled for NTI.

Also, reconsider the need for nasal intubation. If there was no pharyngoplasty, NTI is safe to perform. But if pharyngoplasty was done, one should reconsider if nasal intubation really is essential, especially in case of expected difficult intubation. Although NTI should be avoided in patients with PFF, if possible, novel methods have been described in the literature which make NTI less traumatic to the flap[34].

Oh *et al.* suggest nasal insertion of the nasotracheal tube. Also, they emphasize the need for utmost careful NTI through the pharyngeal flap ostium, guided by fiberoptic bronchoscope (FOB)[30]. Kopp *et al.* describe a case report of a patient with PPF who was intubated nasally without using FOB. After oral endotracheal intubation, suction catheter was advanced as a guiding catheter through the nose and laterally to the pharyngeal flap. Nasal tube was then guided over the catheter until it passed the velum. Under direct visualization by laryngoscope, the oral tube was removed, and the nasal tube inserted into the trachea[35].

Hee *et al.* report on a hypernasal female patient who had a previous history of palatoplasty due to cleft lip and palate. She was scheduled for elective Le Fort maxillary osteotomy. Since nasal tube could not pass to the oropharynx, it was discovered that the patient had a posterior pharyngeal flap. A suction catheter was introduced through the nose. Over the catheter as a stylet and a finger positioned over the flap guiding the catheter to the port, she was intubated *per primum* through the nose[24]. Takaishi *et al.* describe a similar technique to the one reported by Kopp *et al.*[35], only using FOB for visualization of the ports. First, the patient was intubated orally and only then the nasotracheal tube was placed into the trachea using FOB[36].

Conclusion

Patients with previous palatoplasty will regularly appear in our routine anesthetic practice, in all surgical segments. Not being aware of this surgery permanent effect on the airway, the anesthesiologist could find himself in a very unpleasant situation. In that case, insertion of the nasal or nasogastric tube might be very difficult, if not impossible. In cases where previous pharyngoplasty is not recognized as a cause of oronasal pharyngeal obstruction, there will be a significantly high risk of iatrogenic traumatic lesion of the flap, accompanied by bleeding, compromising the airway and patient's safety.

It is therefore extremely important to accentuate, although nasal intubation is not quite contraindicated in patients with previous palatoplasty, that it must be carried out with great caution. In preanesthetic assessment, if there is a history of previous pharyngoplasty, one must be aware that the nasopharynx of the patient will not be passable and that all procedures which include nasal insertion of tubes and catheters must be

either avoided or carried out in an extremely cautious way, with mandatory fiberoptic visual control.

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Sažetak

KIRURŠKO LIJEČENJE VELOFARINGEALNE INSUFUCIJENCIJE SLUZNIČNO-MIŠIĆNIM STRAŽNJIM FARINGEALNIM REŽNJEM – JE LI TO KONTRAINDIKACIJA ZA NOSNU INTUBACIJU? PREGLEDNI ČLANAK

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Velofaringealna insuficijencija stanje je kod kojega meko nepce zrak usmjerava kroz nos umjesto na usta. Česta je kod bolesnika koji su imali rascjep nepca ili imaju kratko nepce, ali javlja se i u drugim bolestima. Simptomi su primarno govorne prirode, s vrlo izraženim nazalnim prizvukom. Nakon kliničkog pregleda i endoskopskog pregleda nazofarinksa odlučuje se o daljnjoj kirurškoj intervenciji. Danas je nekoliko kirurških tehnika u opticaju, no najčešće se rabi faringoplastika s odizanjem sluznično-mišićnog režnja sa stražnjega zida farinksa. Nakon ovog zahvata baza režnja ostaje pričvršćena za stražnji zid farinksa, sa samo dva otvora sa svake lateralne strane režnja. Trajna opstrukcija nazofarinksa zahtjevna je patologija za anesteziologe u slučajevima koji zahtijevaju nosnu intubaciju, jer nova poslijeoperacijska anatomija predstavlja relativnu kontraindikaciju. Bolesnici kojima je učinjena palatoplastika povremeno budu dio rutinske anesteziološke prakse u svim segmentima kirurgije. Visok rizik za ozljedu režnja uz popratno krvarenje može anesteziologa staviti u neugodan položaj ako nije upoznat s posljedicom koja bolesniku ostaje doživotno nakon operacije. Kao dio anesteziološke prijeoperacijske procjene, ako znamo da je bolesniku učinjena faringoplastika, svakako treba razmotriti alternativne načine intubacije na nos. Svi postupci koji uključuju umetanje predmeta u nos treba ili izbjegavati ili raditi krajnje oprezno, uz obveznu kontrolu fiberoptičkim bronhoskopom.

Ključne riječi: *Velofaringealna insuficijencija; Jatrogena opstrukcija nazofarinksa; Nosna intubacija; Dišni put*