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Diagnostic Instruments and Therapeutic Decisions in Velopharyngeal Dysfunction of Pediatric Patients

SUMMARY

Velopharyngeal dysfunction (VPD) is a disorder of the function of the velopharyngeal valve, whose task is to separate the nasal cavity from the oral cavity during the act of speech, blowing, sucking or vomiting. Incorrect sphincter function can lead to incomprehensible speech (open nasal speech) and leakage of air and fluid into the nasal cavities. The dysfunction also adversely affects the swallowing process and the ventilation of the middle ear.

This study describes the anatomical and pathophysiological basis of this disease and takes into account the difficult diagnostic process as well as the treatment of the described problem. When evaluating patients, both before and after treatment, scales should be used to objectiveize the symptoms presented by children with the described dysfunction. The proposed procedure takes into account the author's diagnostic elements (a selected speech sample), developed by the authors for the needs of treatment of patients with VPD adapted to the Polish language. The proposed diagnostic and therapeutic scheme has been used in practice in the authors' center for several years.

Therapeutic management was described depending on the severity of symptoms, as well as methods of assessing dysfunction and treatment results.

In order to obtain optimal treatment results, close cooperation between laryngologists/pediatric surgeons, phoniatrists and speech therapists is necessary.

Key words: velopharyngeal dysfunction, nasal air escapement, pharyngoplasty, posterior pharyngeal augmentation, cleft palate

INTRODUCTION

Velopharyngeal dysfunction (VPD) is a disorder of the function of the velopharyngeal sphincter (VPS), whose task is to separate the nasal cavities from the oral cavity during the act of speech, blowing, sucking or vomiting (Ruda, Krakovitz, Rose 2012). As a result of incomplete isolation of the above-mentioned structures, air and liquid and/or solid contents leak into the nasal cavities (Ruda, Krakovitz, Rose 2012; Woo 2012, 170–177). Incorrect operation of the VPS causes disturbances in the production of clear speech, negatively affects the correct swallowing process, as well as effective ventilation of the middle ear (da Silva, Collares, da Costa 2010, 225–233).

The aim of the article is to systematize the current knowledge on VPD and to propose a scheme of proceeding using qualitative and quantitative diagnostic tools in the treatment and rehabilitation of patients with velopharyngeal dysfunction.

It is difficult to accurately estimate the prevalence of VPD. Patients with this diagnosis can be divided into several groups. The largest group are people with a cleft defect (Worley, Patel, Kilpatrick 2018, 661–678), which occurs in 1/650 to 1/750 births. VPD affects up to 30% of patients with primary complete cleft palate (Woo 2012; Naran, Ford, Losee 2017).

We also include patients with submucosal cleft palate (SMCP) in this category. SMCP is a heterogeneous disease entity in which clinical symptoms are very diverse – from fully symptomatic to asymptomatic patients. In oligo- and asymptomatic patients, the diagnosis is often made accidentally during the examination of the oral cavity and pharynx. Clinical symptoms do not always correlate with the anatomical deficit, therefore it is impossible to determine the frequency of the disease in the pediatric population (Hortis-Dzierzbicka 2010–2011, 83–92).

The next group consists of patients with VPD revealed after surgery within the oral cavity and oropharynx, most often adenotomy. The occurrence of VPD in this group is described at the level of 1:1500-1:10000 (Kummer 2011, 150–158; Mushi, Mahdi, Upile et al. 2020, 252–255). This group includes the previously mentioned patients with asymptomatic or mildly symptomatic SMCP or another craniofacial defect, e.g. congenital short palate.

A symbolic group are patients with genetic disorders, e.g. Di George Syndrome – 22q11 deletion, Klippel Feil Syndrome, Vater Syndrome, Turner Syndrome or with neuromotor disorders (SMA, stroke patients), as well as patients after oncological treatment[1].

In the literature, we can find several divisions of VPD. The most common is the division taking into account the VPD origin (Kummer 2011; Raol, Hartnick 2015, 1–6).

We distinguish:
- *Velopharyngeal insufficiency* – in which the problem results from a structural deficit and abnormal anatomy (mainly cleft defects, congenital short palate, patients after adenoidectomy or scars after throat procedures);
- *Velopharyngeal incompetence* – caused by disorders in the field of neurophysiology – lack of development or degeneration of neuromotor connections (mainly genetically burdened patients, e.g. SMA);
- *Velopharyngeal mislearning* – which is a functional disorder resulting from an abnormal pattern of work of the muscles involved in VPS, with a completely normal anatomy.

ANATOMY AND FUNCTION OF THE VELOPHARYNGEAL VALVE

Several structures are involved in the proper velopharyngeal occlusion (Perry 2011, 83–92):

- *levators veli palatini*
- *superior pharyngeal constrictor muscle*
  - *Passavant's ridge* – a protuberance on the posterior wall of the nasopharynx, which "seals" the VPV, occurs in about 20% of the population as a result of contraction of the superior pharyngeal constrictor muscle (Raol, Hartnick 2015, 1–6),
- *the muscles of the palatine-pharyngeal arches*.

[1] A special group are patients with cleft palate with oro-nasal fistulas (so-called residual openings), such a situation may occur in up to 15% of patients operated on due to cleft (Hosseinabad, Derakhshandeh, Mostaajeran et al. 2015, 1722–1726; Yang, Li, Wu et al., 2013, 923–928). In this population – despite a similar clinical symptoms (leakage occurs) – we cannot talk about VPD, because the primary cause of the ailment is most often a residual hole. Hence the fact that the proposal of surgical treatment of VPD should be secondary to the end of treatment in the field of plastic/children's surgery (Hortis-Dzierzbicka, 2010–2011, 83–92; Radkowska 2022, 20).

A complementary role is played by the tensors veli palatini, the palatine-lingual arches muscles and the uvula muscle. These structures create a three-dimensional dynamic figure in the shape of a rounded square between the nasal and oropharynx.

There are several types of VPV (Fig. 1), the definition of which is important in making therapeutic decisions in patients with the described state (Raol, Hartnick 2015, 1–6):

- Coronary (or coronal) type – occlusion is made mainly by the movement of the palate towards the posterior pharyngeal wall
- Sagittal type – occlusion is made mainly by moving the lateral walls of the pharynx in the medial direction
- Circular type – is carried out by an even share of the soft palate and the side walls of the throat
- Circular type with Passavant's ridge – as above, but the posterior pharyngeal wall is also involved in the occlusion, on which a sealing fold is formed, additionally the sphincter

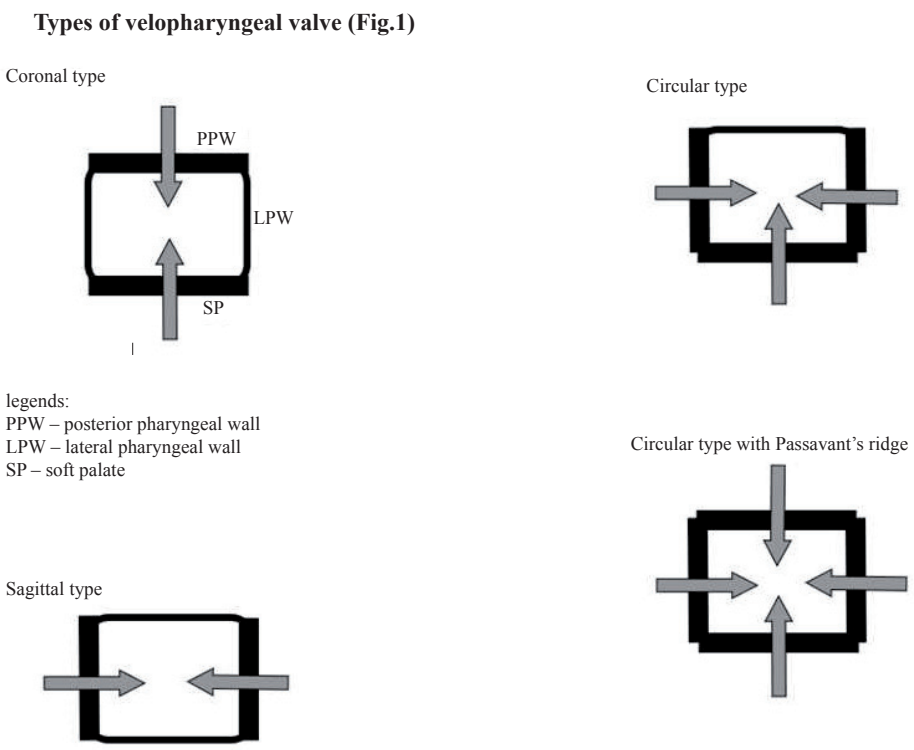

Fig. 1. Different types of velopharyngeal valve; PPW – posterior pharyngeal wall, LPW – lateral pharyngeal wall, SP – soft palate

The proper VPS function determines separation nasal and oral cavities, which is necessary to gain clear speech and also to produce appropriate pressure for blowing or sucking. In addition, it allows swallowing and the subsequent ventilation of the middle ear.

The consequences of an abnormal VPS are diverse and depend on the age of the patient. In the neonatal and infancy period, these are difficulties in feeding the child, regurgitation of liquid and solid contents into the nasal cavity, choking, abnormal weight gain, chronic effusion in the tympanic cavities (da Silva, Collares, da Costa 2010, 225–233). The dominant symptom in older children is impaired speech clarity to varying degrees. Characteristic speech disorders resulting from VPD are (Boyce, Kilpatrick, Morgan 2018, 818–831; Mildinhall 2012, 137–146):

- dissonance – disturbed resonance, nasal overtones of speech,
- nasal air escape and nasal turbulence accompanying the production of consonants,
- reduced intraoral pressure (weakness of pressure consonants),
- reduced speech volume,
- mimic movements within the face – compensatory – to prevent air from escaping through the nose,
- functional changes in articulators,
- compensatory articulation – eg dislocations or dismodalities (Pluta-Wojciechowska 2010, 81).

In our center, we have developed a scheme for dealing with patients from VPD. Diagnostics are carried out in close cooperation between an otolaryngologist, phoniatrician and speech therapist.

DIAGNOSTIC TOOLS

Patients first come to the outpatient phoniatric clinic due to speech disorders. A subjective and objective examination is performed there by a phoniatrician, which takes into account:

– the presence of a complete or submucosal cleft palate and other congenital craniofacial defects or genetic syndromes[2];

[2] An isolated anomaly in the form of a split uvula is considered a variant of the norm (Hortis-Dzierzbicka 2010–2011, 83–92).

– difficulty in feeding – fluid escape through the nose in a child during the neonatal/infancy period;
– the presence of recurrent ear infections;
– previous oropharyngeal procedures;
– the occurrence of articulatory and phonatory speech disorders and the period from which the child has been in speech therapy.

Next, the phoniatrist assesses the patency of the nose; height, mobility and symmetry of the palate during phonation and at rest; visual presence and palpation features of submucosal cleft palate (zona pellucida or split uvula), as well as the presence of residual holes. Otoscopic assessment is required due to frequent eustachian tube dysfunction, and also – checking the condition of the lymphatic tissue of Waldeyer's ring and tooth alignment.

The next step is a speech therapy examination for a child with suspected disorders speech resulting from VPD. In the examination carried out before and after possible the same speech therapist should participate in the intervention to exclude difference in the interpretation of the study. The tests carried out should be objective results and enable quantitative and qualitative assessment of articulation and other disorders before and after treatment.

The most common speech assessment scale in the world literature on VPD is the Pitsburgh Weighted Speech Scale (Table 1) (Rudnick, Sie 2008, 530–535). This is the listening scale. It includes the following elements:

- nasal air escape (right nostril examined separately and left),
- compensatory grimaces,
- nasality,
- phonation,
- articulation.

When performing the test, the speech therapist uses a speech sample prepared in the table 2 and, when necessary, other speech therapy tools and tests, then selects the appropriate result for the patient in the table and counts it scoring.

Table 1. Pitsburgh Weighted Speech Scale. Speech therapy listening scale enabling the objectification of speech dysfunction caused by VPD.

Nasal air emission (0-3)	right	left
Not present	0	0
Inconsistent, visible	1	1
Consistent, visible	2	2
Nasal escape on nasals appropriate – reduced – absent	0 0 0	0 0 0
Audible	3	3
Turbulent	3	3
Facial grimace (0/2)		
Presence	2	
Absence	0	
Nasality/resonance (0-4)		
Normal	0	
Mild hypernasality	1	
Moderate hypernasality	2 / 3	
Severe hypernasality	4	
Mixed: hyponasality - hypernasality	2	
Cul de Sac	2	
Hyponasality	0	
Phonation (0-3)		
Normal	0	
Hoarseness or Breathiness – mild – moderate – severe	1 2 3	
Reduced Loudness	2	
Tension in System	3	
Articulation (0-23; cumulative)		

Table 1 cd.

Normal	0
Developmental Errors	0
Errors from others causes not related to VPI	0
Errors related to anterior dentition	0
Reduced intraoral pressure for the sibilants	1
Reduced intraoral pressure for the other fricatives	2
Reduced intraoral pressure for the plosives	3
Ommision of fricatives and plosives	2
Ommision of fricatives and plosives plus hard glottal attack for vowels	3
Lingual Palatal sibilants	2
Pharyngeal fricatives, plosives, backing, snorts, inhalations or exhalation substitutions	3
Glottal stops	3
Nasal substitutions for pressure sounds	4

Nasal endoscopy and assessment of the type of velopharyngeal occlusion – during the examination, the patient repeats a selected speech sample developed by a speech therapist, which allows to clearly visualize VPS problems (Table 2).

Table 2. The table presents a selected speech sample developed by a speech therapist for the diagnostic needs of patients with VPD treated at Children's Hospital in Bydgoszcz. It enables optimal visualization of the VPS during speech.

	ma ma ma / na na na	
	pa pa pa / pi pi pi	
	ta ta ta / ti ti ti	
	ka ka ka / ki ki ki	
	Ssss… / Wwww… / Sowa /Wasyl	
	Pepa, Bobo, Tytus, Dodo, Kajko, Aga, Fela, Wowa, Susel, Zuza, Cecyl, Ciocia, szyszka, Dżoki, rura, lala , ala – ala ; Fibi , wije, Gili, Diki ; **mapa domu, moja misa, nowy samochód**	
	Po polu biega Bobi	
	Kajko myje gogle.	

Table 2 cd.

	Tutaj dom Dodo	
	Wowa ma fokę.	
	Sos u Zuzy i Cecyla.	
	Zosia siedzi cicho.	
	Dżip Dżokeja Czesia. (6+)	
	Żaba szuka żuka (6+)	
	Mama Niny nie ma wody.	

modalność \ lokacja	dwuwargowe	wargowo zębowe	przedniojęzykowe zębowe	przedniojęzykowo dziąsłowe	środkowojęzykowe	tylnojęzykowe
zwarte	P P' B B'		T T' D D'			K K' G G'
szczelinowe		F F' W W'	S Z	SZ Ż	Ś Ź	H
zwarto-szczelinowe			C DZ	CZ DŻ	Ć DŹ	
zwarto-otwarte (półotwarte)			Ł	L L' R	(J)	
(w tym) nosowe	M M'		N		Ń	

DZWIĘCZNE / BEZDŹWIĘCZNE

Simplified classification of consonants of the Polish language for a doctor based on: Dyszak A., Laskowska E., Świecicka M. *Phonetic and Phonological Description of Contemporary Polish* [18]

The table is also dedicated to the doctor performing endoscopic examination of VPS. It contains a whole range of characteristic sounds for the Polish language – plosive sounds, slotted and compact-open ones, including nasal ones, which enable precise analysis functioning of the VPS. Extracting a speech sample that represents the full picture the phonetic range of a given language is necessary because only adapter linguistically, the range of sounds allows us to visualize all deficits in this scope.

While creating the speech sample, international English-language tools used in VPD diagnostics were suggested, mainly on Standardization for the Reporting of Nasopharyngscopy and Multiview Videofluoroscopy: A Report From an International Working Group (Goldinq-Kushner, Argamaso, Cotton et al. 1990, 337–348). Particular attention was paid to the representation of sounds that require the creation, maintenance and use of appropriate pressure in the oral cavity for normative articulation. The combination of the above-mentioned sounds with the vowel /a/ - requiring the smallest VPS and the vowel /i / - requiring the strongest VPS and consonants /s/ and /v/ extreme for VPS were taken into account (Obrębowski

2012, 156). For children over 6 years of age a group of sibilant sounds characteristic of the Polish language /sz, ś, cz, dż/ was taken into account. The tests are in the form of syllables, words, phrases and sentences to assess the degree of VPD in speech sequences of various lengths. The presented speech sample is a proposal of conduct. During endoscopy, the doctor may decide on the quality of the samples depending on the degree of VPD, the age of the child and his psychophysical abilities. The issue of the overall assessment of articulation is left to the speech therapist. Her detailed diagnosis, in relation to the endoscopy results described by the laryngologist, is performed during a separate visit. In addition to the assessment of articulation and phonation, myofunctional efficiency, language and communication competences and auditory functions are also examined.

Speech testing in children up to 9 years of age is carried out using the standardized KOLD test (Gruba 2017) used in speech therapy practice. Additionally, a graphically updated, modernized Demel Picture (Word) Questionnaire is used to assess articulation (Demel 1996). The diagnostic questionnaires 'MFT 4-8 sTArs or MFT 9-99 sTArs according to A. Kittel (Kittel 2016) are used for myofunctional diagnosis.

In the next stage, nasal endoscopy is performed by a team of doctors: a phoniatrician and an otolaryngologist along with an assessment of the type of velopharyngeal closure – during the examination, the patient repeats a selected, prepared speech sample by a speech therapist, which allows to highlight ZPG problems (Table 2).

The endoscopic examination should be objectified using a scale. There are several scales available in the literature to objectify the endoscopic examination of the nasopharynx [24]. The Golding-Kusher scale is used in the authors' center (Tieu, Gerber, Milczuk et al. 2012, 923–928). At the authors' center the Golding-Kusher scale is used (Goldinq-Kushner, Argamaso, Cotton et al. 1990, 337–348). It is a quantitative and qualitative scale (Tab. 3) in which we assess the movement of the palate, lateral walls of the pharynx and the posterior wall of the pharynx and the Passavanta shaft (if present). The size, shape and nature of occlusion have a direct impact on treatment decisions. It is also an excellent tool for comparing the results before and after the intervention.

Table 3. The Golding-Kushner scale objectifying the endoscopic examination of the nasopharynx in terms of VPD

NASOENDOSCOPY – Golding Kushner scale

Velar movement
- qualitative
  - symmetry; if asymmetry which side is prefered
  - intersyllabic and intrasyllabic consistency
  - presence of sound specific VPD or sound specific closure
  - velar-adenoidal or velopharyngeal closure? Or both?
  - does uvula flip up into the VPS?
- quantitative
  - scale 0.0 ratio (during rest) – 1.0 ratio (velum touches posteriori pharyngeal wall/adenoid)

Lateral Pharyngeal Wall Movement
- qualitative
  - symmetry, if asymmetry – which side moves better
  - discrepancy in vertical height of motion
  - presence of sound specific VPD or sound specific closure
  - direction of movement for each side described as medial/posteromedial/anteromedial/outward
- quantitative
  - right side 0.0 ratio (during rest) – 1.0 ratio (opposite lateral wall is reached)
  - left side 0.0 ratio (during rest) – 1.0 ratio (opposite lateral wall is reached)

Posterior Pharyngeal Wall and Passavant's Ridge
- qualitative
  - presence of adenoid/location relative to the midline/shape/compact or diffuse/smooth or jagged
- quantitative
  - soft palate motion 0.0 ratio – 1.0 ratio

Completion of the diagnostic process is tantamount to gathering a multispecialist consultation and determining further treatment of the patient. Decisions on surgical treatment concern patients with significant articulation and phonation dysfunction and in whom rehabilitation possibilities have already been used or in whom an anatomical defect precludes the ability to produce acceptable speech even after intensive rehabilitation. If the patient achieves a progressive improvement in speech as a result of rehabilitation, he is subject to further observation of the treatment results and is not qualified for treatment.

An alternative to endoscopy of the nose and nasopharynx to assess function and VPS may also be:

- *multi-plane videofluoroscopy* – the examination consists in taking a series of X-ray images in several planes evaluating ZPG while pronouncing a selected speech sample

– *cephalometric examination* – also requiring a series of X-ray images, by means of which it is possible to determine the anatomical conditions of ZPG

An additional technique to assess voice and nasal air escape is *nasometry*: the test allows for separate and simultaneous measurement of the acoustic energy transmitted during speech through the oral and nasal cavities. The proportions are evaluated and the results are expressed as percentages. The result allows for the assessment and comparison of the results before and after the procedure, but does not allow for a qualitative assessment of VPS and the size of the deficit (Domeracka-Kołodziej, Maniecka-Aleksandrowicz, Zielnik-Jurkiewicz et al. 2007, 135–141).

TREATMENT DECISIONS

DPG requires a thorough assessment of the tests performed and, at a later stage, presenting the patient with a therapy proposal. There are surgical and non-surgical ways to help patients. Their common denominator is the reduction of leakage into the nasal cavities.

Speech therapy

A „very high correlation between the mobility of the palate and the degree of VPS fullness" has been shown, therefore, in each case of VPD diagnosed before the planned surgery, it is important to activate the muscles of the palate through intensive speech therapy. The aim of these interventions "is to be to improve and increase the range of movements of the muscles involved in VPS and, importantly, to adapt and use the resulting movements in speaking" (Pluta-Wojciechowska 2010, 147–149). Normative articulation depends on the generation of proper intraoral pressure, which is impossible or difficult for a patient with DPG before and often after surgery (Pluta-Wojciechowska 2010, 147–149), therefore palatal stimulation that activates the work of all structures forming the palatine-pharyngeal mechanism (Banaszkiewicz 2022, 22, 24–26) is essential.

The therapy uses exercises without articulation and exercises combined with articulation, introducing them gradually. The proposed set can be found in the studies of prof. Pluta-Wojciechowska [26]. In addition to the breathing and phonation exercises already described, jaw, tongue and lip exercises, articulation and auditory exercises, including phonemic and phonemic hearing, are also intro-

duced. All exercises must be adapted to the individual needs and abilities of the child (Banaszkiewicz 2022, 22, 24–26).

One of the useful and effective methods is electrostimulation of the palate, „consisting in stimulating the so-called motor points on the palate using a special intraoral electrode" (Radkowska 2022, 20; Radkowska 2020, 6–7).

The speech therapist, apart from the aforementioned intensive therapy preceding surgical treatment, plans and conducts therapy after the procedure, taking into account the information received and indications from the surgeon.

Not too intense exercises can be started not earlier than 2 months after the procedure. Breathing exercises are the most important during this period. „Basic speech therapy, which is aimed at activating the palate, can be started after 8 weeks, after the surgeon's decision" (Radkowska 2022, 20).

In the first stage after the procedure, gentle breathing exercises, hearing exercises, not too intense exercises of the tongue and lips, massage or electrostimulation of the face are performed. The second stage (2-3 months after the procedure) is a continuation of the exercises from the first stage and the introduction of gentle exercises that activate the soft palate. In the third stage (4-6 months after the procedure), stronger soft palate exercises, electrostimulation, extending the expiratory phase and phonation exercises are performed. At the last 4th stage, in addition to the previous exercises, isometric exercises are introduced to improve the muscles of the side walls of the throat (Radkowska 2020, 6–7).

To assess the prognosis regarding the possibility of removing the deficit during the therapy proces or prepare the patient for surgery if the prognosis is abnormal structural are negative, an intensive, problem-oriented speech therapy.

When nasalization is structural, no speech therapy methods can replace the tissue deficiency. In the case of functional nasalization without structural disorders or neurological deficits or borderline insufficiency, intensive speech improvement seems to be the most appropriate method of management (Hortis-Dzierzbicka, Dudkiewicz, Stecko 2000).

The earlier the causes of abnormal PEP are removed and effective therapy is implemented, the lower the risk of consolidating faulty articulation habits in the form of motor stereotypes, which, despite removing the causes, may still occur without the possibility of spontaneous resolution.

It is difficult to clearly define the time of speech therapy for a child, both before and after the procedure. It depends on many variables, including the patient's age, the degree of consolidation of the dysfunction, the quality and quantity of defective articulation habits in the form of compensation and dislocation of sounds, disease couplings, as well as the psychophysical capabilities and motivation of the child and his parents/guardians to cooperate with the therapist, the frequency of exercises in the office and the quantity and quality of performance recommended

exercises at home. Time for intensive speech therapy is needed to assess the prognosis as to the possibility of removing the deficit in the therapy process or to prepare the patient for surgery if the prognosis due to structural abnormalities is negative. As long as the therapy progresses, its conduct is justified.

Obturators

Among the non-surgical methods, obturators are also available, which, by reducing nasal flow, have some potential to improve speech (Reed, Birch, Coward 2022). However, obturators have numerous disadvantages: the need to put them on and remove them from the oral cavity, adjusting and replacing the equipment along with the development of the facial skeleton, easy loss, mismatch and lack of comfort, and above all, they do not eliminate the cause of the problem. The above disadvantages translate into limited tolerance and acceptance of this solution by patients. In foreign centers, this method is considered when surgical treatment is impossible (Kummer 2020).

Surgery

Among the surgical methods of treatment, we distinguish procedures such as:

- augmentation of the posterior pharyngeal wall,
- double plasty from the soft palate (so-called Furlow plasty),
- sphincter pharyngoplasty,
- pharyngeal flap.

In each case of a surgical decision, the risk of obstructive sleep apnea due to the limitation of airflow through the upper respiratory tract should be considered (Bennett, Robinson, Kasten et al. 2017; Zhao, Liu, Dang et al. 2021, 3196–3211). The available literature shows that the problem affects 5 to 10% of patients undergoing VPD surgery. It is advisable to strive to lower these values so as to avoid creating further medical problems for the patient (Zhao, Liu, Dang et al. 2021; Bohm, Padgitt, Tibesar et al. 2014, 216–221).

Augmentation is the creation of a bulge on the posterior pharyngeal wall to seal the ZPG. The material used for the procedure is usually the patient's own tissue – fat, synthetic materials such as hydroxyapatite or Teflon can also be used. A bulge imitating the Passavant shaft is formed on the back wall. This procedure is proposed for patients with a small or very small air leak and for patients with a coronary or circular occlusion (Naran, Ford, Losee 2017; Brigger, Ashland, Hartnick 2010).

Double „Z" plasty – involves the reorientation of the palatal muscles in patients with SMCP. It should be remembered that in patients with SMCP, as well as with complete cleft palate, there is no deficit in the VPS muscles. This means that careful reconstruction of their arrangement so that they form a fan-shaped structure connecting at the midline could theoretically restore their normal anatomy and function. The double Z-plasty also extends the soft part of the palate. On the other hand, typical surgical complications – scars, fibrous hyperplasia of the operated site and loss of elasticity may significantly reduce the effectiveness of the procedure. It applies to patients with a medium-sized shunt, including sagittal, coronary and circular VP closure (Belcher, Deshpande, Goudy 2016, 156–161; Chim, Eshraghi, Iamphongsai, Gosain 2015, 517–524).

Sphincter pharyngoplasty aims to bring the lateral walls of the throat closer together. The treatment is dedicated mainly to people with medium or large leakage with the coronal and circular occlusion type - in the absence or slight movement of the lateral walls of the throat, with preserved front-back movement. When two pedunculated flaps are made, they are sewn in a horizontal line at the height of the Passavanta embankment. The beds after the panels are sewn together. The pedunculated flaps additionally create a bulge on the posterior pharyngeal wall, sealing the VPS (Naran, Ford, Losee 2017; Chim, Eshraghi, Iamphongsai, Gosain 2015, 517–524).

Flap pharyngoplasty consists in creating a flap from the posterior pharyngeal mucosa and upper pharyngeal sphincter bands, and then sewing it into the nasal surface of the soft palate. At the level of the sphincter, two smaller openings are formed, which are closed by the movement of the lateral walls of the pharynx. The flap acts as an obturator, significantly reducing the leakage area. It is recommended for patients with circular or sagittal PE (Naran, Ford, Losee 2017; Belcher, Deshpande, Goudy 2016, 156–161; Chim, Eshraghi, Iamphongsai, Gosain 2015, 517–524).

The expected effects of surgical treatment

In 2016, Yomaguchi (Yamaguchi, Lonic, Lee et al. 2016) presented a paper in which he describes a significant improvement in the VPS function, on average by 86% in patients qualified for double Z-plasty of the palate and pharyngoplasty with a pedunculated flap. A slightly greater improvement in symptoms was observed in the pharyngoplasty group than in the Z-palatal plasty. Very similar results are reported by Instrum et al. (Instrum, Dzioba, Dworschak-Stokan et al. 2022), who achieved significant improvement in 75%, 66% and 94% (85% on average) of patients, respectively, using Z-plasty, sphincter pharyngoplasty and pharyngoplasty with a pedunculated flap.

The authors' own material is currently insufficient or too short observation of some patients in order to obtain valid statistical data.

SUMMARY

Patients with speech disorders in the field of VPD come to each otolaryngology outpatients clinic for children. Their treatment is an interdisciplinary problem conducted by speech therapists, otolaryngologists, phoniatrists and pediatric surgeons. DPG diagnostics is carried out by phoniatricians/speech therapists, while surgical treatment is performed by pediatric otolaryngologists or pediatric surgeons, depending on the centre.

Due to the multidisciplinary nature of the disease and the complexity of symptoms, it is not easy to develop a management plan for a child with VPD - briefly presented in Figure 2. It is also not easy to objectify and systematize the child's problems, the assessment of which is subjective (speech disorders and defects, liquids getting into the nose, the nature of the occlusion, etc.). Unification of diagnostics and therapy as well as objectivization of the assessment of treatment results will greatly facilitate therapeutic decision-making, exchange of experience and comparison of treatment results between the few centers dealing with this problem in our country.

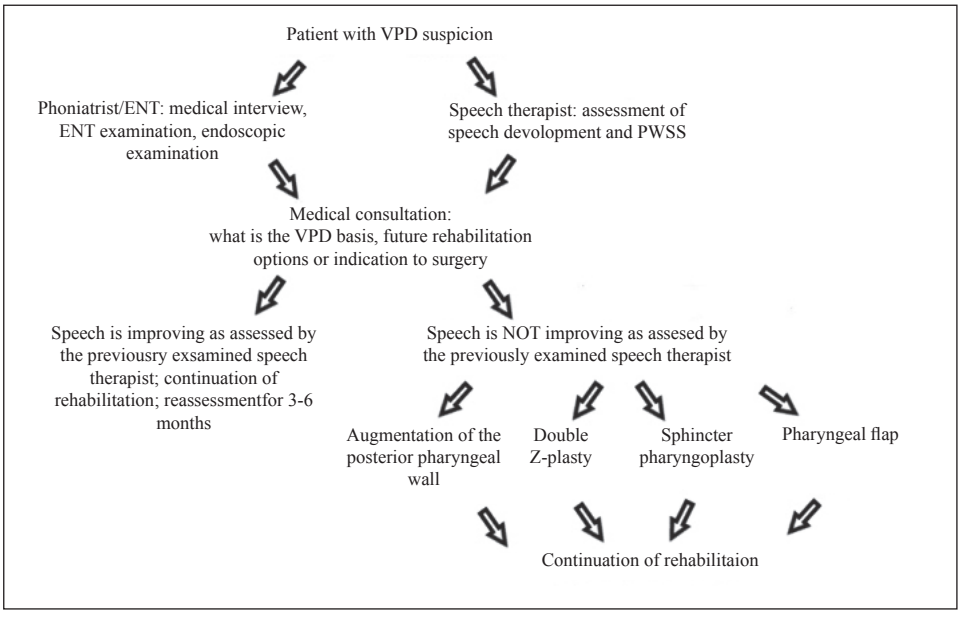

Fig. 2 Managment plan for VPD patient

The diagnostic process requires close cooperation and dialogue between an otolaryngologist or a plastic or pediatric surgeon and a speech therapist. A speech therapist must assess articulation, but is unable to perform endoscopy of the nose, an otolaryngologist can diagnose occlusion, but is unable to assess the degree of speech articulation disorders or the results of treatment. In everyday practice, establishing good communication between specialists is not easy and this is the biggest problem today. This problem must be solved in centers dealing with the treatment of DPG, which due to their complexity should have a referential character.

Recently, several foreign collective studies have been published (Young, Spinner 2022), however, there is still no unified scheme of management in patients with VPD in Poland. There is also no formula for speech assessment by speech therapists, containing all the phonetic possibilities of the Polish language, such a formula has been developed and proposed in this study.

The diagnostic methods used and developed in this article made it possible to obtain the necessary data to offer patients therapeutic options. The tool used allows to determine the main cause of the occurring dysfunction, its severity and the type of occlusion, which significantly affects further treatment suggestions. In addition, the proposed scales allow for both functional and anatomical objectification of patients and reliable assessment of treatment results.

Other diagnostic methods are also found in the literature, such as videofluoroscopy, nasometry and functional magnetic resonance imaging (Naran, Ford, Losee 2017). These methods can be a valuable supplement to diagnosis. In our opinion, however, they are not necessary to carry out the diagnostic and therapeutic process. Videofluoroscopy enables obtaining a two-dimensional image – anterior-posterior and lateral, which translates into the accuracy of the assessment of the type of PE. However, it carries an additional cost for the patient, i.e. exposure to radiation and intranasal administration of a contrast agent (barium), which is particularly important in patients at developmental age. Nasometry is an objective method of assessing nasal air leakage, but it does not specify the location of the leak - whether it is a VPD or an oronasal fistula. In recent years, the literature also mentions the use of magnetic resonance imaging. It allows very precisely in two, and after computer processing, even in three dimensions, to determine the leakage. It makes it possible to show the static and dynamic structure of the VPD. There is no risk of radiation. However, its greatest limitation is still the limited possibilities of cooperation and often access to examination equipment, as well as the limited experience of radiologists in this field. They should be treated as a complementary test to the diagnostic techniques described in the article. Nasofiberoscopy and speech therapy assessment remain the most precise method of VPD assessment.

VPD has been a well-known and complex unit on the borderline of several fields of medicine - pediatric surgery, plastic surgery, laryngology and phoniatrics. Due to the multidimensionality of this disease, there is still a lack of unambiguous findings regarding the management of patients with VPD. This pathology, apart from significant pathophysiological changes, also significantly reduces the quality of life of patients (Barr, Thibeault, Muntz, de Serres, 2007, 224–229; Skirko, Weaver, Perkins et al. 2015, 857–864). The described article proposes a number of diagnostic tools, including proprietary ones, for the diagnostic algorithm that allows to objectify the therapeutic problems of children with VPD. These tools are intended to facilitate therapeutic decision-making and monitor treatment outcomes for patients with VPD.

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