Resonance Disorders & Velopharyngeal Dysfunction: Assessment and Intervention

Ann W. Kummer, PhD, CCC-SLP
Cincinnati Children’s Hospital Medical Center

Normal Resonance

- Resonance for speech results from the modification of the sound that is generated from the vocal cords through selective enhancement of the frequencies
- Resonance provides the quality of perceived sound during speech
- Resonance is determined by:
  - Size and shape of the cavities of the vocal tract
    - Shorter/smaller cavities: enhance higher formants
    - Longer/larger cavities: enhance lower formants
  - Function of the velopharyngeal valve
- Resonating cavities: pharynx, oral cavity, nasal cavity
- Resonance is affected by the following:
  - Length and volume of pharynx
  - Size and shape of oral cavity
  - Configuration of nasal cavity
- Vowels are “resonance sounds.” They are produced by altering the shape of oral cavity and thus, the resonance of the voiced sound.

Resonance Disorders

Hypernasality
- Occurs when there is too much sound resonating in the nasal cavity during speech
- Usually due to velopharyngeal insufficiency/incompetence or an oronasal fistula
- Is most perceptible on vowels, because these sounds are voiced, relatively long in duration, and produced by altering oral resonance
- Voiced oral consonants become nasalized (m/b, n/d, ñ/g) which is an obligatory distortion
- Other consonants may be substituted by nasals (i.e., n/s), which is a compensatory production
- Severity depends on the size of the opening, the etiology, and even articulation
Hyponasality
- Occurs when there is not enough nasal resonance on nasal sounds (m, n, ŋ)
- Due to nasal cavity obstruction (nasal congestion, enlarged adenoids, deviated septum, stenotic nares, nasal polyps, or maxillary retraction which restricts pharyngeal cavity space)
- Nasal phonemes sound similar to their oral cognates (b/m, d/n, g/ŋ)
- Also noted on vowels
- Intermittent hyponasality can be due to timing errors in lowering the velum for the production of nasal sounds (as in apraxia)

Cul-de-Sac Resonance
- Occurs when the sound resonates in a cavity (oral, pharyngeal, or nasal cavity), but cannot get out due to obstruction
- Voice sounds muffled and low in volume
- Three types: Oral, nasal and pharyngeal cul-de-sac resonance

Oral Cul-de-Sac Resonance
  - Sound is mostly in the oral cavity
  - Due to small oral cavity size or small mouth opening (microstomia)
  - Parents describe speech as “mumbling” (which is not opening the mouth very much)

Nasal Cul-de-Sac Resonance
  - Sound is mostly in the nasal cavity
  - Due to VPI and nasal obstruction (deviated septum, stenotic nares, etc.)
  - Common with cleft palate and craniofacial anomalies

Pharyngeal Cul-de-Sac Resonance
  - Sound is mostly in the pharynx
  - Common in patients with very large tonsils, which block sound transmission to oral cavity
  - Has been called “potato-in-the-mouth” speech (Enlarged tonsils are the “potatoes”)

Mixed Nasality
- Occurs when there is hypernasality and/or nasal air emission on oral consonants, and hyponasality on nasal consonants
- Cause includes any form of nasopharyngeal obstruction (such as enlarged adenoids) and velopharyngeal dysfunction, or apraxia
Normal Velopharyngeal Function

Structures Active in Velopharyngeal Closure
- **Velum (soft palate)** - The velum moves in a superior and posterior direction and has a type of “knee action” as it bends. It moves to contact the posterior pharyngeal wall or lateral pharyngeal walls during closure.
- **Lateral Pharyngeal Walls (LPWs)** - The lateral pharyngeal walls move medially to close against the velum or just behind the velum.
- **Posterior Pharyngeal Walls (PPW)** – The posterior pharyngeal wall moves anteriorly toward the velum. In some speakers, there is a muscular contraction on the posterior wall during phonation, forming a Passavant’s ridge. It is usually below the area of velopharyngeal closure so it may not contribute to closure.

![Velum at Rest and Velum during Speech](image)

Velopharyngeal Muscles
- **Levator Veli Palatini** – acts as a sling to pull the velum up and back toward the posterior pharyngeal wall.
- **Tensor Veli Palatini** – opens the Eustachian tube during swallowing.
- **Musculus Uvulae** – forms the velar eminence on the nasal surface of the velum, adding bulk in the midline to assist with closure.
- **Superior Constrictor** – constricts the pharyngeal walls against the velum.
- **Palatopharyngeus** - narrows the pharynx by pulling the lateral pharyngeal walls upward and medially.
- **Palatoglossus** – brings the velum down for nasal consonants.
Patterns of VP Closure among Normal Speakers

The relative contribution of the velum, LPWs, and PPW varies from person to person, as a result of different basic patterns of closure. These basic patterns are as follows:

- **Coronal Pattern** – Closure occurs with movement of the velum and PPW. There is little contribution of the LPWs.
- **Sagittal Pattern** – Closure occurs with medial movement of the LPWs. There is little contribution of the velum or PPW.
- **Circular Pattern** – All structures contribute to closure, which occurs in a “purse string” or sphincter-type pattern. Often includes a Passavant’s ridge.

Variations in VP Closure

- **Non-Pneumatic Closure** - swallowing, gagging, and vomiting
  Closure is high in the nasopharynx and is exaggerated.

- **Pneumatic Closure**
  - Positive (+) pressure: blowing, whistling, speech
  - Negative (-) pressure: sucking, kissing

- Closure may be complete for non-pneumatic activities and some pneumatic activities, but may be insufficient for speech.

- **Blowing and sucking are not the same as speech. Therefore, don’t use these for therapy!!!**

Effects of Velopharyngeal Dysfunction on Speech

Velopharyngeal dysfunction can cause any of the following general characteristics:

1. Hypernasality (involves sound) (See above.)
2. Nasal air emission (involves airflow) (See below.)
3. Dysphonia (involves sound) (See below.)

Nasal Air Emission

- Air leaks through the valve during consonant production
- Occurs on high pressure consonants (plosives, fricatives, affricates), particularly **voiceless consonants**
- Occurs with or without hypernasality
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- **Small VP opening**: This usually causes an inconsistent *nasal rustle*, which is also called *nasal turbulence* (although the sound is actually produced by *bubbling of secretions* as air is forced through the small opening). The distortion is loud and distracting. There is no effect on the strength of consonants or utterance length. It usually does not occur with hypernasality.

- **Large VP opening**: There is little impedance to the flow so the nasal emission may be low in intensity or even inaudible. Also, hypernasality masks the sound of nasal emission. The loss of air pressure causes:
  - **Weak or omitted consonants**: The greater the nasal air emission, the weaker the consonants will be due to loss of oral air pressure.
  - **Short utterance length**: The leak of air causes need to increase respiratory effort and take more frequent breaths. Therefore, utterance length becomes shortened.
  - **Nasal grimace**: There is a contraction seen at side of nose or at nasal bridge as an overflow muscle reaction to effort in achieving closure.
  - **Compensatory articulation errors and obligatory distortions**: See below.

**Compensatory Articulation Errors**

Compensatory errors for VPI:
- **Glottal stop**: The vocal cords adduct and then open suddenly, resulting in a voiced plosive that sounds like a grunt. This can be co-articulated with oral placement.
- **Pharyngeal plosives**: The base of the tongue articulates against the posterior pharyngeal wall. This is usually substituted for velars (k, g).
- **Glottal fricative**: The air is forced through the open glottis to produce an /h/ sound.
- **Pharyngeal fricative**: The tongue is retracted so that the base of the tongue approximates the pharyngeal wall. The friction sound occurs as the air is forced through the small opening between the base of the tongue and pharyngeal wall. The air stream is released through the velopharyngeal port, resulting in nasal air emission.
- **Posterior nasal fricative**: The back of the tongue articulates against the velum (as an /ŋ/ placement). Air pressure builds in the pharynx and is released through the velopharyngeal valve. This results in a loud, bubbling-type sound, which is similar to a nasal rustle.
- **Nasal sniff**: The sound is produced by forcible inspiration through the nose. This is usually substituted for sibilant sounds, particularly the /s/, in the final word position.

Compensatory errors for an oronasal fistula:
- **Velar plosives**: The back of the tongue articulates against the velum (as in /k/ or /g/) before air is lost through the fistula. This is also called “backing.”
- **Velar fricatives**: The back of the tongue is in the same position as for the production of a /j/ sound. Friction occurs as air is forced through the small opening between back of tongue and the velum. This is also called “backing.”
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- **Palatal-dorsal production (mid dorsum palatal stop):** The dorsum of the tongue articulates against the fistula in order to prevent the leak of air into the nasal cavity during production of anterior sounds.

Compensatory errors for anterior oral cavity crowding:
- **Palatal-dorsal production (mid dorsum palatal stop):** The dorsum of the tongue articulates against the palate. This can be substituted for the lingual-alveolars (t, d, n, l) and/or sibilant sounds (/s/, /z/, /ʃ/, /ʒ/, /ʧ/, /ʤ/).

**Obligatory Distortions due to VPI**
- Distortion occurs to a structural anomaly rather than abnormal articulation
- Includes hypernasality, nasal emission, nasalized plosives (i.e., m/b, n/d, ŋ/g)
- Cannot be corrected with speech therapy

**Dysphonia**
- Characterize by hoarseness, breathiness, low intensity, glottal fry and/or abnormal pitch
- Causes:
  - Vocal nodules as a result of strain in the vocal tract to achieve closure
  - Laryngeal anomalies with craniofacial syndromes
- Compensatory strategy: Breathiness and low volume mask hypernasality and nasal emission.
Causes of Velopharyngeal Dysfunction

There are several types of VPD, based on the underlying cause. These are as follows:

**Velopharyngeal Insufficiency (VPI)**
Caused by anatomical defects, such as the following:
- History of cleft palate or submucous cleft (overt or occult)
- Short velum or deep pharynx (cranial base anomalies)
- Irregular adenoids
- Enlarged tonsils

Following surgery or treatment:
- Adenoidectomy
- Maxillary advancement (Le Fort or distraction)
- Treatment of nasopharyngeal tumors (surgical or radiation)
- Cervical spine surgery through the mouth

**Velopharyngeal Incompetence (VPI)**
Caused by a neurophysiological disorder:
- Cranial nerve damage causing velar paralysis or paresis
- Central neurological dysfunction
- Injury (head trauma, cerebral palsy, stroke)
- Neuromuscular disorder (i.e., myasthenia gravis, muscular dystrophy, etc.)

Neurophysiological disorder may cause:
- Hypotonia
- Dysarthria due to a central insult. Primary characteristic is hypernasality.
- Apraxia due to congenital or acquired neurological causes
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Velopharyngeal Insufficiency

Velopharyngeal Incompetence

**Velopharyngeal Mislearning**
- Hearing loss
- Secondary to VPI: Learned compensatory productions because of VPI
- Secondary to mislearning: Misarticulations that cause nasal emission unrelated to a VPI

**Hypernasality due to Misarticulations**
- High vowels can be nasalized if the back of tongue is too high. Often occurs on the vowel /i/.
- Substitution of nasal consonants for oral consonants (i.e., η/l, η/r) causes perception of hypernasality in connected speech.

**Nasal Emission due to Misarticulation**
- Due to use of pharyngeal or posterior nasal fricatives, which results in an open VP valve
- Causes *phoneme-specific nasal air emission* (PSNAE)
- Usually occurs on sibilants, particularly s/z

**Recommendations for VP Mislearning**
- Speech therapy (not surgery!) because this is a speech sound (articulation) disorder
- Differential diagnosis is very important!

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**Perceptual Evaluation of Velopharyngeal Dysfunction**

**Need to determine:**
- Compensatory errors versus obligatory distortions
- Presence of nasal emission or nasal rustle
  - Consistent, inconsistent or phoneme-specific
  - Effect on pressure-sensitive consonants and utterance length
- Cause of a nasal rustle
  - If due to abnormal structure, will occur inconsistently on all pressure-sensitive phonemes. Often increases with utterance length or fatigue
  - If due to misarticulation, will occur consistently on certain sounds, most often sibilants, particularly /s/
- Effect of a fistula versus VPI: Compare the degree of nasal air emission for anterior sounds (i.e., /p/, /t/) with posterior sound (/k/) in repetitive syllables
- Type of resonance (normal, hypernasal, hyponasal, cul-de-sac, mixed)
Speech Samples
- Single word articulation test is NOT good.
- Prolongation of sounds
  - Oral sound to test hypernasality: vowels, particularly /a/ and /i/
  - Oral sounds to test nasal emission: prolonged /s/
  - Nasal sounds to test hyponasality: /m/, /n/
- Repetition of syllables
- Use pressure-sensitive phonemes with a low vowel and then a high vowel (pa, pa, pa, and pi, pi, pi, etc.) to evaluate for hypernasality and/or nasal emission
  - Oral sounds to evaluate for hypernasality (ma, ma, ma and na, na, na, etc.)
  - Counting
    - From 60-70 to evaluate for hypernasality and/or nasal emission
    - From 90-99 to evaluate for hyponasality
  - Repetition of sentences
    - p/b: Popeye plays baseball.
    - t/d: Take Teddy to town. Do it for Daddy.
    - k/g: Kate eats the cake. Go get the wagon.
    - f/v: Fred has five fish. Drive the van.
    - s/z: I see the sun in the sky.
    - j: She went shopping.
    - ŋ: I ride a choo choo train.
    - dʒ: John told a joke to Jim.
    - r: Run down the road. I have a red fire truck
    - l: Look at the lady.
    - blends: splash, sprinkle, street

Supplemental Methods:
- Use straw or listening tube to listen for hypernasality or nasal emission during production of oral sounds
- Determine stimulability with change in articulation, particularly if nasal emission is phoneme-specific

Straw

Listening Tube
Intra-Oral Exam
- Can evaluate oral structure and function, but not velopharyngeal function because it is above the oral level
- Have the child say /æ (as in “hat”) and stick the tongue out and down as far as possible

Look for:
- Dentition and occlusion
- Oral cavity size
- Position of the tongue tip relative to the alveolar ridge
- Presence of a fistula
- Signs of a submucous cleft
- Position of the uvula during phonation
- Size of the tonsils
- Signs of upper airway obstruction
- Signs of oral-motor dysfunction

Instrumental Assessment

Nasometer (KayPENTAX)
- Analyzes acoustic energy from the oral cavity and nasal cavities during the production of speech
- Computes an objective nasalance score (ratio of oral/total (oral + nasal) energy
- Ratio is called (the acoustic correlate of perceived nasality) and is displayed as a percent, with higher percentages representing increased nasalance.
- Nasalance score can be compared to normative data for a particular speech passage

Pressure-Flow Technique
- Uses aerodynamic instrumentation (pressure transducers and flow transducers)
- Can be used to measure air pressure and airflow changes during production of a small speech segment (usually the /mp/ in the word “hamper”)
- Gives an estimate velopharyngeal orifice size during speech production
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**Videofluoroscopy**
- A multi-view, radiographic procedure which usually includes lateral, frontal and base views to assess velopharyngeal closure during speech
- Studies are interpreted by both a radiologist and a speech pathologist

**Nasopharyngoscopy**
- An endoscopic procedure that allows the examiner to view the nasal surface of the velum and the entire velopharyngeal port during speech
- Requires a flexible fiberoptic nasopharyngoscope. Best to also have a camera, monitor, and video recorder
- Can be done by a physician or speech pathologist who is trained in this procedure
- Interpretation should be done by speech pathologist and the surgeon

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Nasal surface of velum.

_Note the Eustachian tube on the left (patient’s right) side._

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**Treatment of Velopharyngeal Dysfunction**

**Surgery**

**Pharyngeal augmentation**
- Injection of a substance in the posterior pharyngeal wall
- Can use fat, collagen or Radiesse (hydroxyapatite)
- Good for small, localized gaps or irregularities of the posterior pharyngeal wall

**Furlow Z Plasty**
- Often used as a primary palate repair but can be used as a secondary repair to lengthen velum
- Appropriate for narrow, coronal gaps

**Pharyngeal flap**
- Flap is elevated from the posterior pharyngeal wall and sutured into the velum to partially close the nasopharynx in midline. Lateral ports are left on either side for nasal breathing
- Good for midline gaps or deep (anterior-posterior) gaps
Sphincter Pharyngoplasty
- Posterior faucial pillars, including the palatopharyngeus muscles, are released at their base, brought posteriorly, and sutured together on the posterior pharyngeal wall to form a sphincter
- Good for lateral gaps (due to bowtie closure) or narrow coronal gaps

Prosthetic Devices

Palatal Lift
- To raise the velum when velar mobility is poor (velopharyngeal incompetence)
- Commonly used with dysarthria

Palatal Obturator
- To close or occlude an open cleft, palatal defect or fistula

Speech Bulb Obturator (Speech Aid)
- To occlude nasopharynx when the velum is short (velopharyngeal insufficiency)
- Can be combined with a palatal obturator

Limitations of a Prosthetic Device
- Requires insertion and removal
- Has to be redone periodically due to growth
- Can be lost or damaged
- May be very uncomfortable
- Compliance is often poor
- Doesn’t permanently correct the problem
Most centers use only if surgery is not possible

Speech Therapy: See handout entitled: Speech Therapy Techniques: for Errors related to Cleft Palate or Velopharyngeal Dysfunction (VPD)

Referrals: Refer to a cleft palate or craniofacial center with specialists in the area of VPI—not to a community ENT or surgeon.

For more information:
Speech Therapy Techniques:
for Errors related to Cleft Palate or Velopharyngeal Dysfunction (VPD)

Ann W. Kummer, PhD, CCC-SLP
Cincinnati Children’s Hospital Medical Center

Velopharyngeal dysfunction (VPD) refers to a condition where the velopharyngeal valve does not close consistently and completely during the production of oral sounds. There are three types of VPD:

- **Velopharyngeal insufficiency (VPI)** is used to describe an anatomical or structural defect that prevents adequate velopharyngeal closure. Velopharyngeal insufficiency is the most common type of VPD because it includes a short or abnormal velum, which occurs in children with a history of cleft palate or submucous cleft.
- **Velopharyngeal incompetence (VPI)** refers to a neurophysiological disorder which results in poor movement of the velopharyngeal structures. This is common in individuals with dysarthria due to cortical damage or velar paresis due to cranial nerve damage.
- **Velopharyngeal mislearning** refers to a lack of velopharyngeal closure on certain sounds due to the use of sounds in the pharynx as a substitution for certain oral sounds.

Children with VPI may demonstrate **hypernasality** (too much sound in the nasal cavity), **nasal air emission** (leakage of air during consonant production) and **compensatory articulation productions** (abnormal articulation productions in the pharynx to compensate for a lack of oral air pressure due to VPI). Children with velopharyngeal mislearning may produce pharyngeal sounds as a substitute for oral sounds (even without a history of VPI). This causes nasal emission due to the placement of production. Differential diagnosis is very important in order to determine appropriate treatment. VPI (both types) requires physical management (i.e., surgery or a prosthetic device if surgery is not an option. Velopharyngeal mislearning (including the continual use of compensatory productions after surgical correction of VPI) requires speech therapy.

**Indications for Speech Therapy**

- Speech therapy cannot change abnormal structure and therefore, cannot correct hypernasality or nasal emission due to VPI—even if there is only a small gap! VPI requires physical management (surgery, or a prosthetic device if surgery is not an option).
- Speech therapy can correct placement errors (abnormal function) that cause nasal emission or hypernasality, including the following:
  - Compensatory articulation productions secondary to VPI that continue to cause nasal emission after the VPI repair because they are produced in the pharynx
  - Misarticulations that cause phoneme-specific nasal emission or hypernasality
  - Hypernasality or variable resonance due to apraxia
  - Hypernasality or nasal emission following surgical correction. This is because changing structure does not change function. The child may need to learn to use the corrected velopharyngeal valve through auditory feedback.
Speech Therapy Techniques
Ann W. Kummer, PhD

The following are specific therapy techniques that have been effective at Cincinnati Children’s.

**Speech Therapy with Uncorrected VPI**
If the child has VPI but surgical correction is being delayed due to airway concerns, work can still be done on articulation placement. However, articulation placement is very difficult to learn without adequate oral air pressure. Therefore, a nose plug should be used in therapy, and worn at home during practice and play as much as possible.

**Speech Therapy after VPI surgery**
Following surgery, the child may continue to have hypernasality or nasal emission, despite normal articulation. This is because changing structure does not change function. The child may need to learn how to use the new structure through auditory feedback. Auditory stimulation and imitation is the “natural” way to learn speech sound production and VP function.

Work on the speech sounds in repetitive syllables with different vowels (i.e., pa, pa, pa, pa; pee, pee, pee, pee, etc.). Start with the consonants in Group 1. (See groups below.) Make sure the child is mostly successful in eliminating nasality (as hear through a tube) before moving to Group 2, and later to Group 3.

- Group 1: /p, t, k/
- Group 2: /b, d, g/
- Group 3: /f, s, ʃ, ʧ, ʤ/

- Using a “listening tube” (even a bending straw), have the child put one end of the tube in the entrance of a nostril and the other end near his ear. When nasality occurs, it is heard loudly through the tube. Ask the child to try to reduce or eliminate the sound coming through the tube as he produces oral sounds and then words.
- Put the end of the listening tube in the front of the child’s mouth and the other end at the child’s ear. Have the child try to increase the oral pressure on oral sounds to hear it loudly through the tube.
**Oral & Nasal Listener**¹ (ONL)  
The Oral & Nasal Listener¹ (ONL)™ is more effective than a simple tube or straw because it allows both the speech-language pathologist (SLP) and the child to hear the sound at the same time and at the same volume. This makes it much easier to give appropriate feedback to the child. The ONL is also very effective for home practice because it allows the parent and the child to easily distinguish normal from abnormal productions.  
- Put the end of the tube in the child’s nose for feedback about nasality.  
- Put the funnel of the ONL in front of the child’s mouth to provide feedback about oral resonance, oral airflow, and oral pressure.

**Nasometry**  
- If available, the Nasometer² provides excellent visual feedback of hypernasality and nasal emission.

**Therapy for Placement Errors**  
After surgery for VPI, the child may continue to use compensatory productions, which result in continued nasal emission.  
- In therapy, begin with awareness of the abnormal production versus the target sound. Give as many clues as possible using visual, tactile and auditory feedback.  
- In all cases described below, use a straw, listening tube, or the ONL periodically for auditory feedback.

**Glottal Stops**  
A glottal stop is like a grunt sound that is co-articulated with oral sounds, particularly plosives.  
1. Make the child aware of the glottal stop versus the target as follows:  
   - While in front of a mirror, have him watch the contraction in his neck when producing the glottal stop versus an /m/sound  
   - Have him place his hand on his neck during the productions of a glottal stop to feel the “jerk” versus the smooth voice onset during production of a vowel or the /m/ sound.  
   - Have him listen to the difference between the glottal stop and a /g/ sound.
2. Have the child produce isolated voiceless plosives—without the vowel—while feeling his neck or watching in a mirror. (For voiceless sounds, the glottal stop does not occur until transition to the vowel.)

3. Have the child produce the voiceless plosive /p/ and then a vowel preceded by an /h/. For example, /p...ho/ for /pa/ and /p...ho/ for /po/. This keeps the vocal folds open during transition to the vowel and prevents the production of the glottal stop. Gradually, decrease the transition time from the consonant to the vowel until the syllable is produced without the glottal stop.

4. Once voiceless consonants are produced, move to voiced plosives. Have the child produce the voiced sound slowly with a breathy voice. Gradually add “smooth” voicing and transition to the vowel with an inserted /h/. Have the child feel his neck for feedback.

Nasalized Vowels or η/l Substitution
Nasalized plosives or vowels can persist after surgical correction of VPI. Nasalized vowels can also occur in children with no history of VPI. This is usually due to an abnormally high posterior tongue position during production of high vowels, particularly /i/ (as in “feet”). This faulty articulation placement causes “phoneme-specific” hypernasality. In addition, some children have phoneme-specific hypernasality due to substitution of η/l. The nasal for oral sound makes connected speech sound somewhat hypernasal.

1. Ask the child to produce a big yawn, which pushes the back of the tongue down and the velum up. Make him aware of the stretch in the back of his mouth.

2. Have the child coarticulate the nasalized sound (vowel or /l/) with the yawn, while feeling the stretch in the back of the mouth.

3. For auditory feedback at the same time:
   - Have the child use a listening tube or the ONL.
   - Have the child alternately pinch and open the nose during production of the sound. Have the child try to produce the sound so that there is no difference between the two productions.

Nasalized /ɚ/
The final /ɚ/ sound is a continuant sound that is produced by articulating the sides of the back of the tongue against the gum behind the molars. The mid portion of the tongue forms a boat-like shape through which sound enters and resonates. If the child raises the entire back of the tongue, the sound becomes an η/ɚ, which is a nasal substitution for an oral sound.

1. Using your hand, show the child how the shape of the tongue forms a “boat” when producing final /ɚ/. Note that the back of the tongue has to touch the gums behind the back teeth.

2. With a tongue blade, stimulate both sides of the tongue towards the back. Then stimulate the upper gum ridge behind the molars. Tell the child that these come together for /ɚ/.

3. Ask the child to make a wide smile while “backing up the boat” to make the tongue touch the gums on each side.
4. Assist the child with posterior tongue elevation by pushing up against the base of the chin with your middle finger while squeezing his cheeks with your thumb and forefinger. If you feel his tongue push down under the chin, have him relax it so you can push it up.

5. If the child continues to raise the entire back of the tongue for /a/ resulting in an /ŋ/, have him close his nose during production. That will make the /ŋ/ sound impossible to produce.

6. Once final /a/ is established, show the child how the tongue tip moves forward for initial /r/. Have the child put his hands on his face while producing the /r/. Tell him to move his tongue forward, but not move his face.

Pharyngeal Plosives
Pharyngeal plosives are usually substituted for k/g. They are produced with the back of the tongue against the pharynx.

1. Establish placement for velar plosives (/k/ and /g/) by starting with an /ŋ/. If the child can’t produce an /ŋ/, put a tongue blade on the middle of the tongue and push down and back OR firmly press your thumb under the base of the child’s chin to push the back of the tongue up. (This is effective in establishing /k/ and /g/ in other cases as well.)

2. Once /ŋ/ placement is established, have the child achieve the position and then drop the tongue. Work on the up and down movement of the back of the tongue to replace the back and forth movement which occurs with the pharyngeal plosive.

3. Have the child take a breath and place his tongue in an /ŋ/ position. Have him hold and then drop the tongue. This will produce a /k/ sound. (If necessary, pinch his nose closed and then have him drop the tongue.)

4. Once the child can produce the /k/, have him add voice for the /g/.

Pharyngeal (or Posterior Nasal) Fricatives
Pharyngeal or posterior nasal fricatives can be compensatory productions due to VPI (and remain after surgical correction), or they can be learned misarticulations that cause phoneme-specific nasal air emission. Regardless of the original cause, the methods for correction are the same.

Start with /s/:
1. Have the child produce a loud /t/ sound.
2. Then have the child produce the /t/ with the teeth closed. This will result in /ts/.
3. Have the child prolong the production until it becomes /tssss/.
4. Have the child note the position of the tongue and the air stream flowing over the tongue tip during production.

5. Finally, eliminate the tongue tip movement for the /t/ component.
   - For /tʃ/, following the above procedure, but make the lips round. You can also have the child try to produce this sound as a loud sneeze with the teeth closed.
   - For /dʒ/, following the above procedure, but add voicing.
   - For /ʃ/, follow steps 1-4 with rounded lips.
Straw Technique:
1. Place a straw at the point of your own central incisors during production of a sibilant sound. Note the sound of the airflow through the straw.
2. Have the child put a straw in front of his incisors and try to push the air through the straw during production. If necessary, have him start with a /t/ sound and progress to an /s/. Make sure he hears the air through the straw.

Cul de Sac Technique:
- Have the child produce the sounds with the nostrils occluded and then open to get the feel for oral rather than pharyngeal airflow.

Palatal-Dorsal Productions
Palatal-dorsal productions (AKA mid-dorsum palatal stops) can be substituted for lingual-alveolars (/t/, /d/, /n/, /l/) and velars (/k/, /g/, /ŋ/). This placement can also be used for sibilants (/s/, /z/, /ʃ/, /ʒ/, /ʧ/, /ʤ/), resulting in a lateral lisp. Palatal-dorsal productions are often compensatory errors as a result of crowding of the tongue tip. This can occur due to an anterior crossbite or Class III malocclusion.

For lingual-alveolars or velars:
1. Have the child bite on a tongue blade so that it is between the canine or molar teeth. Make sure it is back far enough to depress the middle part of the tongue, which prevents a dorsal production.
2. Have the child produce lingual-alveolar sounds (/t/, /d/, and /n/) in front of the tongue blade and velar sounds (/k/, /g/, and /ŋ/) behind the tongue blade.

Or
Have the child achieve placement and then prolong a nasal sound (/n/ or /ŋ/).
1. Have the child work on achieving that placement and then dropping the tongue. This can be done silently.
2. Have the child take a deep breath, achieve that placement, hold it, and then release to produce the plosive. Pinch the nose closed if necessary.

For sibilants:
1. Place a straw at the front of your own closed incisors and produce an /s/. Listen to the air stream as it goes through the straw.
2. Place a straw at the front of the child’s closed incisors during production of the /s/ and note the lack of air stream through the straw.
3. Move the straw to the side of the child’s dental arch during production of the /s/, and find the place where the air stream can be heard through the straw.
4. Have the child put the straw at the front of his closed incisors and produce a /t/ while keeping the teeth closed. Tell the child to push the air into the straw at the front of his teeth. Have him prolong the sound until it is a /tssss/.
5. Have the child feel the air flow over the tongue tip and hear the air through the straw.
6. Then have the child achieve that position and prolong the /s/ without using the /t/.
7. Transition to the syllable by inserting an /h/ between the /s/ and vowel.
8. Once the /s/ is established, the same techniques can be used to achieve other sibilant sounds.
General Principles

- **Do not use blowing exercises, sucking exercises, velar exercises or oral-motor exercises!** The problem is rarely muscle weakness and these exercises do not work!!!
- **Do not PINCH the nose to try to improve velopharyngeal function.** Closing the nose actually makes it impossible for the velum to go up.
- Use general articulation procedures to establish correct placement. In some cases, this may result in the establishment of oral airflow.
- Remember, motor learning is dependent on feedback. Motor memory is dependent on practice. Make sure the child practices frequently at home. Success depends on the frequency and consistency of practice between sessions!
- If progress is not being made, discontinue therapy and refer the child to a craniofacial team (not a general ENT) for further evaluation of velopharyngeal function. Surgical intervention or surgical revision may be necessary.

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**Timetable for Intervention**

**Ages 0 – 3:** Concentrate on **quantity** (language)
- Home program with emphasis on language
- Start language therapy if indicated

**Ages 3 - 4:** Begin evaluating **quality** (speech and resonance)
- Evaluate speech and velopharyngeal function- Refer to a craniofacial specialist as needed.
- Start speech therapy or consider surgery as indicated

**Goal of Treatment:** Normal (not just “acceptable”) speech and resonance

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**Resources:**

1. The Oral & Nasal Listener (ONL) by Super Duper®, Inc. [www.superduperinc.com](http://www.superduperinc.com)
2. The Nasometer by KayPENTAX. [www.kayelemetrics.com](http://www.kayelemetrics.com)

**For more information:**

Talking About … Velocardiofacial Syndrome

What is velocardiofacial syndrome (VCFS)?
Velocardiofacial Syndrome (VCFS) is a genetic syndrome that can affect speech, hearing, language and learning. It can also cause certain physical characteristics and some medical conditions. VCFS is a genetic syndrome that is also known as Shprintzen syndrome, DiGeorge syndrome, or 22q11.2 syndrome.

What causes velocardiofacial syndrome?
Velocardiofacial syndrome is caused by deletion of genes on chromosome 22q11.2. VCFS can occur for the first time in a family for unknown reasons. However, each individual with the diagnosis of VCFS has a 50% chance of passing on this syndrome to each of his or her children. In other words, half of the affected individual’s children are likely to also have the syndrome.

What are the characteristics of velocardiofacial syndrome?
The basic characteristics of velocardiofacial syndrome involved the soft palate (also called “velum” and thus “velo”), heart (“cardio”) and facial features.

- **Velo**: A condition called “velopharyngeal dysfunction (insufficiency or incompetence)” can cause hypernasal speech. There may also be a cleft of the soft palate or a submucous (under the skin surface) cleft.

- **Cardio**: The individual with VCFS may have a history of a heart murmur or minor cardiac anomalies. These may include ventriculoseptal deviation (VSD), atrial septal defect (ASD), or patent ductus arteriosis (PDA). There may also be some vascular anomalies, such as pulmonary stenosis, tetralogy of Fallot, right sided aortic arch, displaced internal carotid arteries, and abnormal retinal arteries.

- **Facial**: There are often facial characteristics, such as narrow eye openings, a long face, a bulbous nasal tip, a small jaw, or minor ear anomalies.

- **Learning and Cognitive Problems**: Some individuals with VCFS have learning disabilities, or mild to moderate mental retardation.

- **Communication Problems**: Hypernasality and abnormal voice quality is common with VCFS. In addition, there may be misarticulations (often due to a motor speech disorder called “apraxia”), language disorder, and hearing loss.

- **Other Common Physical and Medical Characteristics**: Some individuals with VCFS have long slender digits, short stature (usually below the 10%ile), and hernias.
• Other Common Functional Problems: VCFS can cause early feeding problems, gross and fine motor delays, social disinhibition, and some psychiatric problems in adolescence.

Although there are many characteristics of this syndrome, there is a great deal of variability in what characteristics are expressed. Some individuals have many of the typical characteristics and others have only a few. Abnormal speech is the most common characteristic of this syndrome, however.

What is the treatment for velocardiofacial syndrome?
Because velocardiofacial syndrome has characteristics that affect different parts of the body and different functions, a team approach to management is very important. A cleft palate team, with the help of other professionals, is usually best to be able to manage these characteristics. Treatment of speech may include a combination of surgery and speech therapy.

Website on velocardiofacial syndrome:
• Cleft Palate Foundation: http://www.cleftline.org/
• American Cleft Palate – Craniofacial Association: www.acpa-cpf.org

For more information, please contact the Division of Speech Pathology at (513) 636-4341 or visit our website at www.cincinnatichildrens.org/speech.