Speech Evaluation and Treatment for Patients With Cleft Palate[1]

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This compendium has been written in conjunction with a cleft lip and palate surgical mission that took place in Villahermosa, Mexico, February 4–9, 2001. Fifty children, 10 per day, received lip or palate surgery. This report, available in both English and Spanish, is intended as a practical and concise guide to basic aspects of evaluation and treatment of speech disorders associated with cleft palate. More detailed and comprehensive sources dealing with this topic are available and have been reviewed by D. P. Kuehn and K. T. Moller (2000).

Key Words: cleft palate, evaluation, treatment, Mexico

Although the information contained in this report arises from a specific mission in Mexico, it is of more general clinical interest because there may be many similar situations in other developing regions and countries. Even in the United States there may be many speech practitioners who are largely unfamiliar with basic information pertaining to speech management of individuals born with cleft palate. Moreover, because Spanish is a major language in the United States, the information in this report, available in Spanish, may be useful to treatment providers and caregivers who are involved with individuals in need of treatment who speak Spanish as their primary language.

We used an automatic text translator (*Babel Fish*; http://babelfish.altavista.com/) to assist with the Spanish translation. Our experience with the text translator was that it performed well with simple and somewhat complex sentences, but was less accurate with more complex sentences. In addition, many technical terms were not translated by Babel Fish. It was necessary to proofread the document carefully to correct mistranslations or contextually inappropriate word choices.

The authors of this report interacted extensively with the local speech-language pathologist at the children's hospital in Villahermosa, where all evaluation and treatment was performed during the mission. The speech-language pathologist with whom the authors worked does not speak English. It became clear early in the interaction that the speech-language pathologist had general experience concerning hospital-based care for individuals with speech disorders but was not familiar with approaches used specifically in the evaluation and treatment of individuals with cleft palate. Instrumental assessment, including radiographic procedures, had never been used at the hospital for diagnosing speech problems in relation to cleft palate. On the second day of the mission, the authors initiated the use of lateral-view still X rays at the hospital for patients with cleft palate. These radiographs were used to great advantage in decisions regarding types of surgical treatment. More sophisticated diagnostic procedures, such as videofluoroscopic studies and nasendoscopy, however, were not available to us during the mission.

Glottal stops in patients are rarely encountered at our clinic at Carle Foundation Hospital in Urbana, IL. In striking contrast, however, glottal stops were universal among the linguistically mature children seen in Villahermosa during the mission. The difference likely was due, in large measure, to the delayed or late primary palatal surgery for the Villahermosa patients.

It is important to conduct cleft palate missions in other countries, especially developing countries, in part for the obvious reason that surgical care for these individuals is often not available. Beyond that, however, information about speech treatment in relation to such missions is important, because often only surgery is provided, without satisfactory accompanying speech evaluation or follow-up. This is particularly true if the treatment team consists only of surgeons who are not trained in speech, or speech specialists who are not well versed in cleft palate.

[1] A link to the Spanish version of this article is available at http://professional.asha.org/resources/journals/AJSLPFeb03TOC.cfm

The purpose of this report is to discuss basic principles of evaluation and treatment of speech disorders in individuals born with cleft palate. This report is intended as a practical and concise guide for use by speech-language pathologists and other professionals involved in the care of patients with cleft palate. More detailed and comprehensive sources dealing with cleft palate issues have been reviewed by Kuehn and Moller (2000).

Primary Surgery

Early primary surgery to repair the hard and soft palate is preferred for speech purposes (Kemp-Fincham, Kuehn, & Trost-Cardamone, 1990). Primary palatal surgery that is performed before 12 months of age is more likely to prevent compensatory articulatory behavior, such as the production of *glottal stops* (see *Treatment for Glottal Stops* section), compared to palatal surgery that is performed when the child is older (Ysunza et al., 1998). At Carle Clinic, we typically operate on the lip by 3 months of age and on the hard and soft palate as a single operation between 9 and 12 months of age. Additional surgical procedures, referred to as *secondary surgery*, may be necessary to treat lingering speech problems related to the cleft palate condition. These secondary procedures are discussed later in this report. The details of several different primary and secondary surgical procedures can be found in Bardach and Morris (1990).

Speech and Language Development

Infants and young children with cleft palate should be given normal language stimulation (Kuehn & Moller, 2000). Parents should talk to their children frequently and listen to them. Parents should avoid using nonsense words and should speak clearly, using correctly formed words and short phrases. Infants with cleft palate should be allowed to babble freely and naturally. Children should be encouraged to communicate using speech. Even though the speech sounds of children born with cleft palate will be nasally produced before primary palatal surgery, these sounds are preferred over glottal stops. Orally produced sounds, or attempts at orally produced sounds, should be reinforced (rewarded) even though they are nasalized as well. Glottal stops should be ignored and not reinforced. Once glottal stops become habitual, they may be difficult to change with treatment as the child grows older. However, there are methods for treating glottal stops (Golding-Kushner, 2001), and these are discussed later.

Evaluation for Velopharyngeal Inadequacy and Nasal Blockage

The soft palate (also called the *velum*, used hereafter) normally elevates for non-nasal speech sounds and lowers for nasal speech sounds (Figure 1). For vowels, the positioning of the velum depends to a considerable extent on adjacent speech sounds (Moll & Daniloff, 1971). If vowels are surrounded by non-nasal consonants (such as in the word *cooked*), the velum will normally tend to be elevated, leading to *velopharyngeal closure* throughout the word (Figure 2). Velopharyngeal closure refers to contact of the velum with the posterior and lateral pharyngeal walls so that airborne sound exits through the mouth rather than through the nose. In contrast, if vowels are surrounded by nasal consonants (such as in the word *mama*), the velum will normally tend to be lowered, leading to *velopharyngeal opening* throughout the word. In such cases, airborne sound will exit from the mouth and the nose during the vowels but through the nose during the nasal consonants.

Even following primary palatal surgery, approximately 20%–30% of individuals born with cleft palate develop speech that is *hypernasal* (McWilliams, 1990). Hypernasality implies that too much sound energy emerges through the nose. Thus, there is an oral/nasal resonance imbalance. This lingering speech disorder typically is attributed to *velopharyngeal inadequacy*, or VPI. With VPI, incomplete velopharyngeal closure may result in hypernasality during vowel segments and nasal emission of air during non-nasal consonant segments. For example, in the word *baby*, there may be abnormal nasal emission of air during production of the non-nasal /b/ consonant segments and hypernasality during production of the /i/ vowel segments.

In contrast to hypernasality, if there is blockage of the velopharyngeal port or the nasal passages, this may result

FIGURE 1. Illustration of normal velar positioning. (a) At rest and during nasal speech sounds, the velum is lowered, allowing air to exit through the nose. (b) During production of non-nasal speech sounds, the velum elevates and makes contact with the posterior pharyngeal wall, leading to velopharyngeal closure.

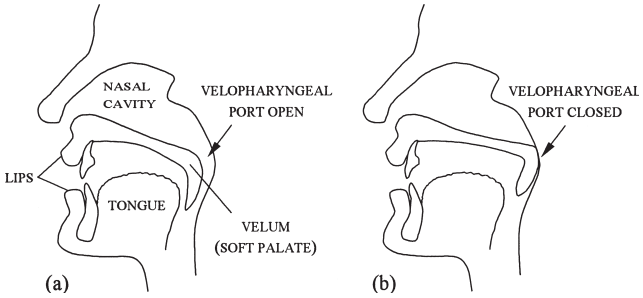
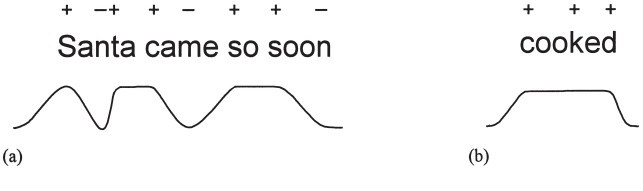


FIGURE 2. Velar position and movement during speech. The plus and minus symbols above the words indicate velar position; + is elevated and – is lowered. The lines below the words represent velar movement. (a) For sequences that include nasal and non-nasal consonants, the velum would be expected to rise and fall during the sequence. (b) For words that contain no nasal consonants, the velum would be expected to rise and stay elevated.



in *hyponasality* (also called *denasality*) during production of nasal speech sounds. Hyponasality implies that there is too little sound energy emerging through the nose. For example, in the word *mama*, there would be too little sound energy emerging through the nose during the production of the nasal consonants /m/. Thus, hyponasality is also an oral/nasal resonance imbalance, but in the opposite direction from that of hypernasality.

It is important to properly diagnose the type of velopharyngeal impairment (hyper- vs. hyponasality), and also the degree of impairment, to determine the type of treatment to be provided. Hypernasality due to VPI can be corrected surgically, or possibly with speech treatment, as discussed later. Hyponasality due to blockage must be treated with physical management and cannot be corrected with speech treatment. Evaluation procedures will be discussed next, followed by a discussion of treatment types.

Noninstrumental Tests

Mirror tests and nostril-pinching tests are used together to evaluate the patient's ability to close the velopharyngeal port and to determine whether a patient's airflow through the nasal passages is adequate for speech and breathing. Two diagnostic word categories are used in both mirror and nostril-pinching tests—those that do not contain nasal consonants (Appendix A) and those that contain only nasal consonants (Appendix B). The evaluation procedures are described below and summarized in Table 1.

Evaluation for VPI. When evaluating for VPI, mirror and nostril-pinching tests are used with words that do not contain nasal consonants. Non-nasal words are used because they normally cause sustained velopharyngeal closure, with airborne sound exiting through the mouth only. Therefore, non-nasal words are useful for evaluating the patient's ability to close the velopharyngeal port.

Mirror Test. Any small mirror, such as a dental mirror, may be used. However, we recommend a *Detail Reflector*, which can be purchased from Bruce Medical Supply (in the United States, 1-800-225-8446). Use words without nasal consonants (Appendix A) to evaluate the patient's ability to close the velopharyngeal port. Place the mirror under the nostrils and watch for mirror fogging during non-nasal consonants, such as /p, t, k, b, d, g, s, z/. Mirror fogging during these consonants is abnormal and indicates that the velopharyngeal port is not closing properly. It should be noted that normal nasal air emission may occur at the onset and offset of the word or sentence. Therefore, care must be taken not to confuse these natural and normal occurrences with mirror fogging during actual sound production of the speech samples.

A fistula might be observed upon direct inspection of the inside of the patient's mouth. A fistula is an opening into the nasal passages through the hard or soft palate. The mirror can be used to help determine whether the fistula is "communicating" with the nasal passages; that is, whether there is a functional connection through the hard or soft palate to the nasal passages. If the fistula is communicating and if it is large enough, it can prevent the build-up of sufficient air pressure in producing non-nasal consonants such as those in Appendix A. In that case, the fistula would have to be closed surgically. As a gross measure in determining the size and influence of the fistula on speech, words containing the consonants /p/ and /k/ can be used. For example, the words "puppy" and "cookie" can be spoken repeatedly, or the patient can simply repeat the syllables /papapa…./ and /kakaka…./. If mirror fogging is detected on /papapa…./, the air leakage might be via the fistula or through the velopharynx, because the lip closure for /p/ is located anterior to the fistula. However, production of /k/ causes the tongue to contact the hard palate in the back part of the oral cavity, typically posterior to the location of the fistula. Therefore, if the mirror fogs during /p/ but not during /k/, this suggests that the fistula is communicating and that the air leakage is through the fistula rather than through the velopharynx.

Nostril Pinching. Have the patient produce the non-nasal words again (Appendix A), this time while pinching the nostrils. Listen for a change in perceived quality of the words. There should be no change in perceived quality if the words are being produced normally. If there is a change in perceived quality, this indicates that the velopharyngeal port is open, which is abnormal.

Evaluation for Nasal Blockage. The mirror test and nostril-pinching test are used with words that contain only nasal consonants. Nasal words are used because they normally cause velopharyngeal opening, with airborne sound exiting through the nose during the nasal consonant, and are therefore useful for evaluating airflow through the nasal passages.

Mirror Test. Use words with nasal consonants (Appendix B) to evaluate a patient's ability to produce these sounds and to determine whether a patient's airflow through the nasal passages is adequate for speech and breathing. Place the nasal mirror under the nostrils and watch for mirror fogging during the production of nasal consonants, such as /m, n/. Mirror fogging *should* be observed. Lack of fogging indicates inadequate nasal flow during nasal consonant

TABLE 1. Summary of noninstrumental tests for evaluation of velopharyngeal inadequacy (VPI) and nasal blockage.

Evaluation type	Diagnostic word category used	Mirror test	Nostril-pinching test
VPI	Non-nasal consonants (Appendix A)	Mirror fogging abnormal; indicates VPI	Change in perceived quality of words abnormal; indicates VPI
Nasal blockage	Nasal consonants (Appendix B)	Mirror fogging normal; lack of fogging indicates nasal blockage	Change in perceived quality of words normal; no change indicates nasal blockage

production. Then ask the patient to breathe through the nose with the lips closed. Place the mirror under the nostrils and watch for mirror fogging, which is normal. Inadequate mirror fogging or labored breathing with lips closed is abnormal and indicates partial nasal blockage. In rare cases involving total nasal blockage, the patient would obviously not be able to breathe with the lips closed.

Nostril Pinching. Have the patient again produce the words with nasal consonants (Appendix B), this time pinching the nostrils. A change in quality should be perceived. For example, the word *Mom* should change to sound like *Bob* when the nostrils are pinched closed. If there is no change in perceived quality, this indicates inadequate nasal resonance for these sounds. This might be related to blockage at the velopharyngeal port, possibly due to an enlarged adenoid mass or an excessively wide pharyngeal flap; or blockage farther downstream in the nasal passages, possibly due to a deviated nasal septum or enlarged nasal turbinates.

It is possible that a patient might have VPI and blockage in the nasal passages at the same time. In this case, speech may sound muffled (*cul-de-sac* resonance). There may be some mixed hyper- and hyponasality. An example of this would be vowels such as /i, u/ that sound hypernasal but nasal consonants such as /m, n/ that sound hyponasal (denasal). Instrumental procedures are very useful in such situations, enabling the functioning of the velopharyngeal mechanism to be evaluated independently from possible blockage downstream in the nasal passages.

Instrumental Procedures

Instrumental measures may not be readily available unless there is a hospital or specialty clinic that is accessible to the patient and treatment provider. However, if available, instrumental assessment can be very useful in providing information about the specific type of treatment to be recommended. For example, as discussed below, the size of the velopharyngeal opening and whether the velum or pharyngeal walls provide the primary movements toward velopharyngeal closure may be very important in relation to the type of treatment provided.

Still X Ray (Cephalometry). Ideally, it would be better to obtain motion X rays (see below) in multiple projections. However, facilities enabling motion X rays may not be readily available. If motion studies are not possible, still X rays can be obtained to provide a gross measure of the ability of the velum to elevate during the production of sustained speech sounds. Obtain a lateral-view (side-view) X ray of the patient's head while he or she produces a sustained non-nasal consonant such as /s/. Because this procedure is designed to evaluate the ability of the velum to elevate normally during the production of non-nasal consonants, it is critical that the patient sustain the non-nasal sound while the radiograph is being taken. The X-ray technician should be alerted to this fact. The velum should normally elevate and make firm contact against the posterior pharyngeal wall during production of the non-nasal consonant (Figures 1b, 3a). A gap between the velum and the posterior pharyngeal wall is abnormal and indicates that the velum is not elevating properly, or possibly that the pharynx is too deep (Figures 1a, 3d, 3e). In general, the larger the gap, the greater will be the hypernasality and possibly the nasal emission of air.

Motion X Ray (Videofluoroscopy). Obtain lateral-view (side-view) X-ray images during connected speech. Include sentences that contain no nasal consonants. Examples of such sentences are included in Appendix C (under the heading *Non-Nasal Sentences*). Production of these sentences will allow the determination of whether the velum can be maintained in an elevated position with firm contact against the posterior pharyngeal wall or whether a gap might occur between the velum and the posterior pharyngeal wall (Figure 3). In general, if there is a gap observed, the larger the prevailing velopharyngeal gap, the greater will be the hypernasality and possibly nasal emission of air during speech.

In addition, sentences containing some interspersed nasal consonants also should be produced. Examples of such sentences are included in Appendix C (under the heading *Combination of Nasal and Non-Nasal Sounds*). Production of these sentences will allow the determination of whether the velum can be alternately elevated and lowered without the velopharyngeal musculature becoming fatigued. The velum should make contact with the posterior pharyngeal wall when it elevates for non-nasal consonants.

If a fistula has been detected, it is sometimes difficult to determine, based on direct visual inspection alone or using the mirror test as described above, whether the fistula is "communicating" with the nasal passages as a functional connection. Instillation of barium in the nasal passages (see below) and swallowing barium from a cup can be helpful in more clearly delineating whether there might be a functional connection directly through the hard or soft palate. If there is a direct connection, the fistula may have to be repaired surgically so that sufficient intraoral air pressure can be achieved for speech purposes. Also, if the fistula is large enough, it may result in fluids or even solid particles of food being forced into the nasal passages during swallowing.

After obtaining the lateral-view X ray, the patient should be rotated 90 degrees and a videofluoroscopic frontal-view examination performed using the same sentences (Appendix C). Before producing the sentences, however, barium must be introduced into the nasal passages with the patient's head tilted backward and side-to-side to coat the pharyngeal walls. A soft feeding-tube catheter can be used to instill the barium into each nasal passage. The frontal-view examination will allow determi-

FIGURE 3. An illustration of Enemark's classification system of rating velopharyngeal competency (Van Demark, Kuehn, & Tharp, 1975). (a) indicates a tight velopharyngeal seal, (b) indicates velopharyngeal closure with approximately 2 mm of contact, (c) indicates touch closure, (d) indicates a velopharyngeal space of less than approximately 2 mm, and (e) indicates a velopharyngeal space greater than 2 mm.

nation of the extent to which the lateral pharyngeal walls move during speech. The lateral pharyngeal walls normally should make contact with the elevated velum. Other views, such as the *basal view* and the *Towne view*, also might be obtained to visualize the velopharyngeal port in a transverse plane. Both of these views also require the instillation of barium to coat the upper pharynx. In the basal view, the patient's head is tilted backward (hyperextended) and the X-ray beam passes upward through the velopharyngeal port area. In the Towne view, the patient's head is bent downward (flexed) and the X-ray beam passes downward through the velopharyngeal port area. In both of these views, the circumferential margins of the velopharyngeal port can be viewed to determine whether the pharyngeal walls as well as the velum are moving properly.

Nasendoscopy. The velopharyngeal port can be viewed from above using a flexible endoscope, if available, that is inserted through one of the nasal passages. The scope should be inserted through the nasal passage that is more open, which can be determined during the mirror test. Although not absolutely necessary, anesthetization of the nasal passages will enable the patient to be more comfortable during scope insertion. The same speech samples as those used for videofluoroscopy can be used for nasendoscopy as well (Appendix C). The advantage in using nasendoscopy is that it does not involve radiation, so there is no biological risk to the patient. Therefore, if available, nasendoscopy should be the first choice, rather than videofluoroscopy, for evaluating velopharyngeal motion. The disadvantage in using nasendoscopy is that it is uncomfortable and may not be tolerated very well, especially by small children or if the patient has a nasal deviancy, such as a significantly deviated nasal septum or nasal bone spurs. Typically, children 6 years of age and older tolerate the procedure reasonably well, although younger, cooperative children may tolerate the procedure also. If nasendoscopy is not possible, videofluoroscopy should be performed as the method for evaluating dynamic velopharyngeal functioning.

Depending on the diagnosis, speech treatment, secondary surgery, or a combination of both will be necessary. It might be observed that the patient exhibits articulation errors that are not inherently related to the cleft palate condition. These can be treated using traditional articulation treatment procedures. Other problems, such as glottal stops, are directly related to the cleft palate condition. Special treatment procedures are required for these disorders. Treatment for glottal stops is discussed below. Hypernasality or nasal emission of air might occur concurrently with glottal stops but must be treated separately. Treatment for hypernasality is described in the section titled *Treatment for VPI*.

Treatment for Glottal Stops

The production of glottal stops is a problem in which non-nasal consonants are abnormally articulated in the larynx (bottom of the throat) by forcefully approximating the vocal folds instead of stopping the airflow in the mouth in a normal fashion. Glottal stops are perceived as a brief choking or popping sound in the throat during speech. *Obstruent* (stop, fricative, or affricate) consonants, such as /p/ or /s/, require a buildup of intraoral air pressure behind the normally produced oral constriction. However, if there is an abnormal velopharyngeal opening during production of the obstruent consonant, then air pressure cannot be built up in the oral cavity. Therefore, in the presence of VPI, there is a natural tendency for individuals to build up air pressure below the glottis, which is the region between the vocal folds. In this case, the vocal folds are forcefully and abnormally brought together. Glottal stops can be heard clearly with words containing non-nasal consonants, such as *kitty, baby, taco, tick-tock, chicks* (Appendix A). Almost all cleft palate children have this problem if not treated appropriately early in life.

Ideally, every child born with cleft palate should be evaluated for language and speech development by at least 8 months of age and preferably sooner (Golding-Kushner, 2001, p. 46). If glottal stops begin to emerge during the first few months of life, in most cases these can be eliminated by working with the caregiver in a home-based treatment program (Golding-Kushner, 2001, p. 54). Glottal stops are easier to eliminate initially than to treat subsequently if they become established in the child's phonetic and phonologic repertoire. If glottal stops are established in the child's speech behavior, direct articulation treatment likely will be needed to eliminate the disorder. Speech treatment for eliminating glottal stops should begin as soon as the young child will cooperate for behavioral treatment, which can be as early as about 2 years of age. At that age, the speech-language pathologist typically works with both the child and the child's caregiver (Golding-Kushner, 2001, p. 55). Speech treatment should continue until the glottal stops have been eliminated. The details of this treatment approach can be found in Golding-Kushner (2001, pp. 69–84). An abbreviated version appears below. The first exercise, *Breaking the Glottal Stop Cycle*, focuses on directing airflow through the mouth instead of the nose. The second set of exercises, *Generalizing Correct Production to Other Speech Sounds*, is designed to help the patient learn to produce non-nasal sounds correctly by building on nasal sounds that he or she can already produce. Sustained speech sounds are indicated by repeating the character. Thus, for example, *hhh....* indicates a sustained /h/ sound.

Speech Treatment Procedure to Eliminate Glottal Stops

Breaking the Glottal Stop Cycle.

1. Have the patient open the mouth and exhale or sigh onto the hand or mirror.
2. Have the patient make a sustained /h/ sound.
3. Have the patient make a sustained /h/ followed by a sustained vowel such as /a/, thus *hhhaaa*.
4. Have the patient say *aaahhhaaa* (sustained /a/ followed by sustained /h/ followed by sustained /a/).
5. Have the patient say *hhhaaapaaa*, making a light /p/ contact.

Generalizing Correct Production to Other Speech Sounds. Add other sounds, alternating with the *aaahhhaaa* word from the first exercise. The child can build on nasal sounds that he or she can already produce and can actually feel the correct sound being produced when the nostrils are pinched closed.

1. Have the patient say *aaammmaaa* with the nostrils open. Then repeat *aaammmaaa* with the nostrils pinched closed (it will then sound like *aaabbbaaa*). Then ask the patient to say *aaabbbaaa* on his/her own, with nostrils open and sound coming from the mouth and not from the nose.
2. Repeat #1, this time using *aaannnaaa* (nostrils open), then *aaannnaaa* with nostrils pinched closed. This will sound like *aaadddaaa*. Then try *aaadddaaa* with nostrils open, asking the patient to try to make the word come from the mouth and not from the nose.
3. Have the patient say *aaaŋŋŋaaa* with the nostrils open. Then repeat the word with the nostrils pinched closed (it will sound like *aaagggaaa*). Ask patient to say *aaagggaaa* with the nostrils open, telling him/her to have the sound come from the mouth and not from the nose.

Treatment for VPI

Hypernasality due to VPI may exist independently of glottal stops or other compensatory articulations, whether or not these compensatory articulations have been eliminated through speech treatment. It has been well documented that nonspeech exercises, such as blowing up balloons and blowing various objects across a table, are not effective in treating VPI (Tomes, Kuehn, & Peterson-Falzone, 1997). Common procedures for treating VPI, depending in part on the degree of severity, are described in this section. As described below, more severe cases of VPI should be treated with a secondary surgery procedure such as *pharyngeal flap* or *sphincter pharyngoplasty*. Less severe VPI might be treated successfully with behavioral treatment such as *continuous positive airway pressure* (CPAP). Any of these procedures can be performed as soon as a consistent and stable speech sample can be obtained from the child, usually at about 3 to 4 years of age.

Secondary Surgery Procedures

Sloan (2000) provided a review of the two most commonly used surgical procedures to treat VPI, posterior pharyngeal flap and sphincter pharyngoplasty, and discussed criteria for selecting the specific surgical procedure. Our criteria, used at Carle Hospital and stated below, are consistent with the criteria discussed by Sloan.

Superiorly Based Posterior Pharyngeal Flap. This is a commonly used surgical procedure to treat velopharyngeal inadequacy if there is moderate to severe hypernasality. At Carle, we perform this operation if (a) there is a rather large velopharyngeal gap, greater than about 4 mm, between the nasal surface of the velum and the posterior pharyngeal wall (Figure 3e); (b) the velum is not very mobile; and (c) there is adequate lateral pharyngeal wall movement. Lateral pharyngeal wall movement can be evaluated using frontal-view, basal-view, or Towne-view videofluoroscopy or nasendoscopy.

Sphincter Pharyngoplasty. Recently, surgeons have begun performing this operation to treat VPI. At Carle, we perform this procedure if (a) the velopharyngeal gap is smaller (less than about 4 mm, Figure 3d) than that for pharyngeal flap, (b) the velum moves fairly well but does not contact the posterior pharyngeal wall, and (c) the lateral pharyngeal walls may not be very mobile. This operation is relatively conservative compared to the more extensive surgery required for posterior pharyngeal flap.

Other Surgical Procedures. Other surgical procedures might be used to treat VPI as well, such as a *V-Y* (Wardill-Kilner) veloplasty or a *Furlow* surgical procedure. This is especially appropriate if it is suspected that the primary surgical procedure did not sufficiently dissect muscle fibers away from their attachment to the hard palate and rotate those muscle fibers across the midline in the velum. Further discussion of these issues can be found in Kuehn and Moller (2000).

Behavioral Treatment

CPAP Treatment. CPAP treatment (Kuehn, 1997) or a similar resistance exercise approach to strengthen the velopharyngeal musculature might be used if (a) the velopharyngeal gap is small (less than about 2 mm, Figure 3c or 3d), (b) the velum moves fairly well, and (c) hypernasality is mild to moderate. In this case, surgery might be avoided. Also, CPAP treatment might be used following a pharyngeal flap or sphincter pharyngoplasty procedure if hypernasality persists. CPAP treatment has been shown to be effective for some patients with cleft palate exhibiting mild to moderate hypernasality (Kuehn et al., 2002). Although several other behavioral treatment approaches for treating VPI have been advocated, efficacy data to support these procedures are largely lacking (Tomes et al., 1997; Yorkston et al., 2001).

Team Management

Whenever possible, each patient born with cleft lip or palate should be managed by a team of professionals who are experienced in evaluating and treating individuals born with a cleft. The team should consist of at least the following specialists: speech-language pathologist, surgeon, and dental specialist (particularly an orthodontist). Information about team management can be obtained from the American Cleft Palate–Craniofacial Association (e-mail: cleftline@aol.com; Web site: www.cleftline.org). Several pamphlets are also available from that organization, some of which are available in Spanish.

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Appendix A

Words Without Nasal Consonants

Production of these words should maintain elevation of the velum and will help determine whether the velum can remain elevated throughout a non-nasal word. These words do not contain nasal sounds such as *m* or *n.* They also avoid *l* and *r* sounds, which can be difficult under normal circumstances for children to pronounce.

badges	cupcake	pipe
batch	dishes	safety
boat	ditch	seafood
cab	face	sheep
cage	fifty-five	sheet
cake	foot	shoes
cash	jeeps	sixty-six
cast	jokes	socks
cat	juice	stop
catch	just	suit
cheap	keeps	Susie
chicks	kitty	tack
chips	packages	teeth
choose	past	tick-tock
city	pat	tooth
coast	patches	top
coat	path	type
cookie		

Appendix B

Words With All Nasal Consonants

The velum should remain in an almost fully lowered position (i.e., approaching rest position) with air escaping from the nose during the production of these words. These words will help determine if the patient has adequate airflow through the nose for speech. Inadequate airflow can be caused by velopharyngeal port obstruction due to enlarged adenoids or nasal blockage due to a deviated nasal septum, enlarged nasal turbinates, or other physical problems.

amen	men	name
an	menu	nanny
any	mine	nine
in	mini	no
mama	minnow	none
mane	moan	noon
many	mom	noun
mean	money	omen
memo	moon	

Appendix C

Sentences Used in Evaluating Dynamic Velopharyngeal Functioning

Non-Nasal Sentences

She wore blue shoes.
Cookies are good to eat.

Combination of Nasal and Non-Nasal Sounds

Santa came so soon. (see Figure 2)
Nancy is a nurse.