Articulatory Additions to the Classical Description of the Speech of Persons with Cleft Palate

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Three types of *compensatory articulation* used by speakers with cleft palate and velopharyngeal inadequacy are described: the pharyngeal stop, the mid-dorsum palatal stop, and the posterior nasal fricative. These articulatory characteristics have not been previously reported in the literature. Each is defined radiographically to depict deviant place of production. Each is also described in terms of perceptually distinct speech characteristics. Production features of these articulatory compensations are contrasted and compared with those of the glottal stop and pharyngeal fricative. The use of compensatory articulation as replacements for target phonemes is distinguished from their occurrence as aberrant co-articulations with target phonemes. Additionally, phonetic symbols for use in narrow phonetic transcription are presented, and implications for speech remediation are discussed.

KEY WORDS: articulation, compensatory articulation, cleft palate

Introduction

Throughout the literature on cleft palate, the deviant speech characteristics associated with impairment to the velopharyngeal valve have included four chief stigmata: hypernasality, nasal air emission, weak pressure consonants, and compensatory articulation.

Hypernasality is the resonance disturbance which accompanies vowels and vocalic consonants, the glides or liquids, and gives rise to deviant voice quality in speech production. *Nasal air emission* is the nasal airflow which accompanies production of pressure consonants—the stops, affricates, and fricative phonemes. It is most often characterized in the literature as an audible speech sound distortion. Several authors have commented on the variable auditory perceptual qualities associated with nasal air emission with the result that many labels have been applied to this phenomenon. These have included "nasal snort" (Backus, *et al.*, 1943), "hissing noise" (Van Riper and Irwin, 1961), "distortion-nasal" and "substitution-nasal" (VanDemark, 1964), and nasal emission as distinguished from "nasal turbulence" (McWilliams and Philips, 1979). Although this assortment of labels implies variable expression of nasal emission with respect to articulatory contributors to air turbulence or audible resistance, specific articulatory gestures associated with nasal escape of air have been neither documented nor agreed upon among clinicians. Van Riper and Irwin (1961) alluded to posteriorly generated frication in their description of the "nasopharyngeal snort," and Peterson (1975) noted aberrant lingual posturing to be associated with nasal emission that is confined to production of sibilant fricatives and affricate phonemes. McWilliams (1980) has commented on "posterior distortions" stating that these occur " . . . when the sound is produced through a channel created by the blade of the tongue articulating with the hard palate well behind the maxillary arch or with the soft palate." (p. 408). The third feature, *weak pressure consonants*, like nasal emission, occurs secondary to the open velopharyngeal port. It has its direct consequence upon manner of production, that is, upon the stop-continuant feature dimension of articulatory valving. Although these two aspects of speech

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Material included in this report was presented, in part, at the 1978 American Cleft Palate Association annual meeting in Atlanta, Georgia, April 5–8 and also at the 1978 Convention of the American Speech and Hearing Association, San Francisco, November 18–21.

impairment are derived from the same structural or valving inadequacy, each has a different impact upon speech. Nasal air emission distorts or replaces the target phoneme, whereas reduced intraoral pressure diminishes plosive power and often renders even a correct labial or lingual articulatory gesture ineffective. *Compensatory articulations* comprises the fourth variety of speech deviation. Within this group, the glottal stop and the pharyngeal fricative have been given substantial therapeutic and research attention. Bzoch (1971b) included the velar fricative in this category.

As its name implies, the glottal stop is a plosive consonant produced by vocal fold valving. The pharyngeal fricative, as will be illustrated later in this report, results from the narrowing of the pharyngeal airway by linguapharyngeal articulatory constriction. The velar fricative is a linguavelar articulation made in the approximate place of /k/ and /ɡ/. This third variety of articulatory deviation has a high rate of occurrence in dysarthric speakers because of the neuromotor involvement of the posterior tongue. The resulting velar fricative for the velar stop substitution is often aggravated by co-existing velopharyngeal incompetency.

The Nature of Compensatory Articulations

Several studies have demonstrated that, in most instances where compensatory articulations are substituted for target phonemes, the correct manner of articulation is preserved while correct place of articulation is sacrificed (Counihan, 1956, 1960; Spriestersbach, *et al.*, 1961). The frequently observed glottal stop substitutions for stop consonants and pharyngeal fricative substitutions for sibilant fricatives and sometimes for affricates are compatible with the foregoing reports. Interestingly, the extreme anterior fricatives /f, v, ð, θ/ do not show similar vulnerability.

Findings from studies employing cineradiographic and videofluoroscopic procedures have revealed a consistent tendency for lingual place targets to be shifted posteriorly in speakers with cleft palate (Powers, 1962; Brooks, *et al.*, 1965, 1966; Lawrence and Philips, 1975). A tendency toward backed lingual contacts in general is clinically evident, as demonstrated in the 1979 audiotape presentations of McWilliams and Philips, and has been identified by Dalston and Trost (1979) through phonetic transcription analyses of young speakers with cleft palate.

Several authors have viewed both the glottal stop and the pharyngeal fricative as the speaker's attempt to valve the articulators where the most success can be obtained. This place occurs below the level of defect (Bzoch, 1971a; Morris, 1971; Lawrence and Philips, 1975). Little has been stated about the compensatory role(s) of the velar fricative in speakers with cleft palate and no systematic data have been reported in the literature. In the author's opinion, the velar fricative occurs sometimes as a homorganic substitution for the back velar stops /k/ and /ɡ/ because of loss of the stop quality resulting from the velopharyngeal valve leak. It can also be speculated that speakers with velopharyngeal inadequacy often use the back of the tongue to aid in velopharyngeal valving so that it becomes obligatory for lingual articulatory maneuvers to be shifted posteriorly. Such compensatory adjustments could underlie velar fricative substitutions for sibilant fricatives and affricates.

Clinically, there are other frequently observed compensatory articulations which are different from the classical descriptions of the glottal stop, pharyngeal fricative, and velar fricative. These are the *pharyngeal stop*, *middorsum palatal stop*, and *posterior nasal fricative*. The purpose of this report is to describe perceptual and physiological aspects of these additional compensatory articulations and to comment on their implications for diagnosis and remediation.

Procedure

Listener judgment data on the six types of compensatory articulation discussed in this report show that these productions are perceptually identifiable and distinct from one another. Six speech pathologists, three experienced in craniofacial disorders and three inexperienced in this area, served as judges. After a one-hour training session, each judge listened to audio-tape recordings of 24 patients producing sentence pairs. Order of sentence pairs was randomized for presentation. Each sentence contained one to several occurrences of the compensatory articulation to be identified and some sentences contained other

types of articulatory errors as well. Listeners were asked only to identify the compensatory articulation type used by the speaker in underlined segments of the sentence and were not required to do narrow phonetic transcription. The percentage of correct identification of compensatory articulation types ranged from 66.7% to 96.3% correct, with a mean percentage of correct responses of 86.8. When the poorest listener was excluded, the scores ranged from 85.2% to 96.3% with a mean percentage correct of 90.8. Analysis of re-presentations of sentence pairs included in the task yielded an intrajudge reliability of 1.0 for five of the judges and of only .33 for the sixth judge. Interestingly, this was the same judge who achieved only 66.7% correct identification. Overall, these data provide objective support for the perceptual distinctiveness of these compensatory productions.

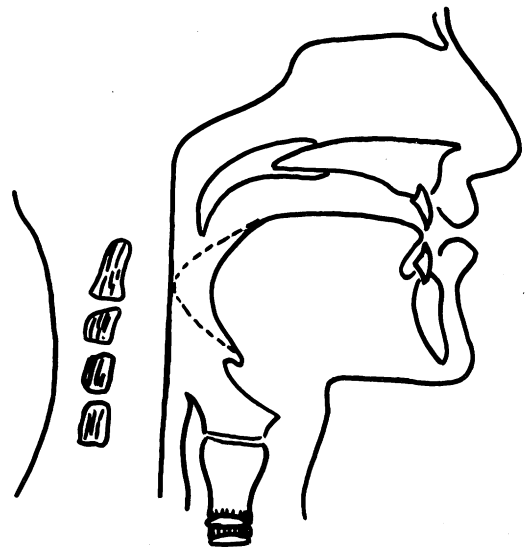

FIGURE 1. Lateral view schematic illustration of pharyngeal stop compensatory articulation with broken line showing lingual configuration and placement.

Description of The Compensatory Articulations

The Pharyngeal Stop

The pharyngeal stop is illustrated diagramatically in Figure 1. As can be seen, this is a linguapharyngeal stop consontant production. It is used as a compensatory substitution for /k/ or /ɡ/. Perceptually, the pharyngeal stop is best described as a /k/ or /ɡ/ produced with the tongue positioned posterior and inferior to its normal target place. Radiographic data and perceptual features show that this form of articulation can occur at different points along the pharyngeal tube. For example, "high" pharyngeal stops may be described as occurring at or near the level of anticipated velopharyngeal closure. They are perceived as higher in frequency as compared to "low" pharyngeal stops, which occur closer to the glottis.

Figure 2a shows patient D.O., a four-year-old who has a pharyngeal flap, in resting posture. Figure 2b illustrates the linguapharyngeal contact of the pharyngeal stop production. In this instance, the area of stop contact is high in the pharynx. Of note here also are the convex configuration of the posterior tongue (L.B.) as it backs into the pharyngeal wall, the tip-down lingual posture with overall tongue retraction, and the slightly excessive mouth opening. By contrast, as seen in Figure 2c, D.O.'s production of a pharyngeal fricative, as a substitution for /s/, reveals a concave configuration of the base of the tongue.

Figures 3a and 3b show adult patient E.B. wearing a pharyngeal extension appliance. In Figure 3a, the resting posture is seen, while Figure 3b shows the pharyngeal stop articulation. Here the linguapharyngeal contact is executed at a lower point in the pharynx. As with D.O., however, the lingual base configuration is convex, with tongue tip down and retraction of the mass of the tongue. This lingual posture appears to be characteristic of the pharyngeal stop.

High versus low pharyngeal stop contacts give rise to perceptually distinguishable productions, and pharyngeal stops are heard as clearly distinct from glottal stops. The normal speaker can simulate a pharyngeal stop by first producing a /k/ and then backing and dropping the place of articulation to assume successively lower valving points within the pharyngeal tube. In its least deviant placement, the pharyngeal stop is heard as a backed /k/ or /ɡ/.

Using cineradiography and spectrography, Honjow and Isshiki (1971) noted some instances of pharyngeal stop articulation in one adult patient with velopharyngeal insufficiency. Their radiographic description of the linguapharyngeal contact is compatible with

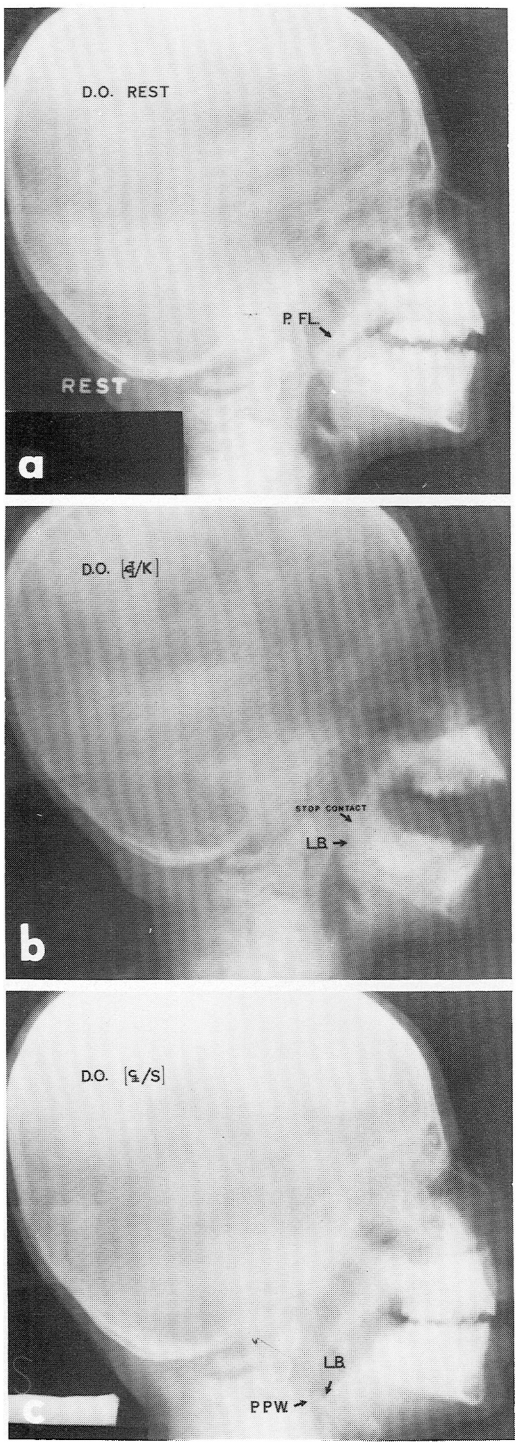

FIGURE 2. (a) Lateral view radiographic illustration of four-year-old patient D.O., at rest, with repaired secondary palate cleft and pharyngeal flap (P.FL.); (b) Lateral view radiographic illustration of D.O. producing pharyngeal stop substitution for /k/, demonstrating a *high* point of *stop* contact and marked convexity of lingual dorsum and base (L.B.); (c) Lateral view radiographic illustration of D.O. producing pharyngeal fricative substituion for /s/ and showing concave configuration of lingual base (L.B.), as it approximates posterior pharyngeal wall (P.P.W.).

those contained in this report. By contrast, however, Honjow and Isshiki appear to err in concluding that the pharyngeal stop is perceptually acceptable as a normal /k/ and does not, therefore, warrant speech remediation. Their comments that this deviant stop articulation has a low frequency of occurrence among the speech errors seen in association with cleft palate and that it does not occur with production of contiguous front vowels are at odds with the clinical observations reported here and require more systematic study.

The Mid-dorsum Palatal Stop

The mid-dorsum palatal stop is a stop consonant made in the approximate place of the glide /j/. Figure 4 is a schematic illustration of this oral stop consonant. This substitution is used to replace /t/, /d/, /k/, or /ɡ/. Perceptually, the phoneme boundaries between /t/ and /k/ or between /d/ and /ɡ/ are lost. Voiceless production of the mid-dorsum stop is perceived equally as like /t/ and as like /k/; voiced production sounds equally like /d/ and like /ɡ/. Phonetic value is, therefore, determined by semantic or grammatical context or both.

Patient B.F., shown in Figure 5a, is a young adult with a repaired bilateral complete cleft and a pharyngeal flap. She also has a pseudo-Class III malocclusion and mild openbite. Figure 5b depicts B.F.'s production of a mid-dorsum palatal stop. The mid-palatal lingual contact with tongue tip down is seen on the radiograph. This deviant articulation may represent a place compromise as the cleft palate speaker attempts to maintain *oral* articulatory contacts for the tip-alveolar and back velar stops. For purposes of comparison, Figure 5c shows B.F.'s production of a pharyngeal fricative. The point of linguapharyngeal constriction is well below the hyoid, and the lingual dorsum concavity is prominent.

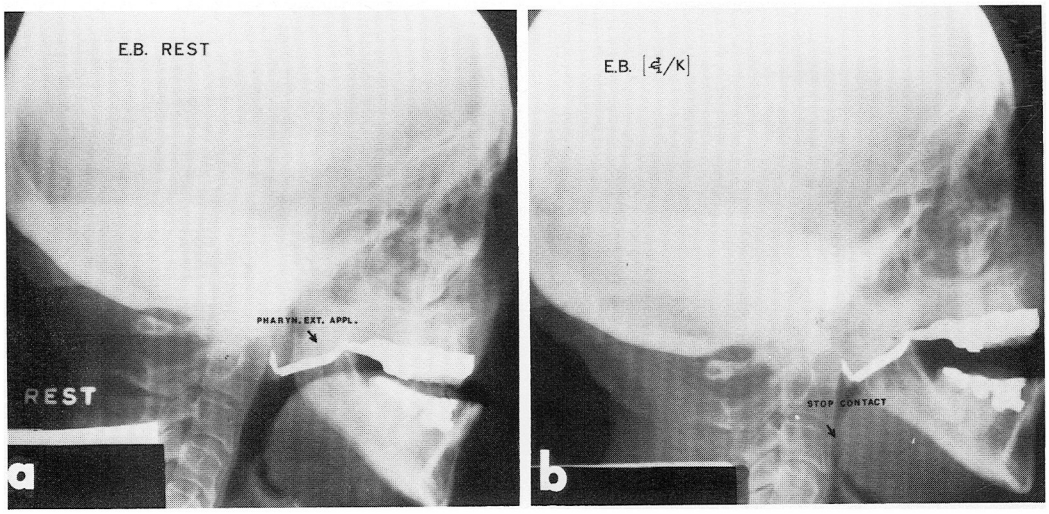

FIGURE 3. (a) Lateral view radiographic illustration of adult patient E.B. who has a repaired complete unilateral cleft, wearing pharyngeal extension appliance, at rest; (b) Lateral view radiographic illustration of E.B. producing pharyngeal stop substitution for /k/, revealing *low* point of *stop* contact and marked convexity of lingual base (L.B.).

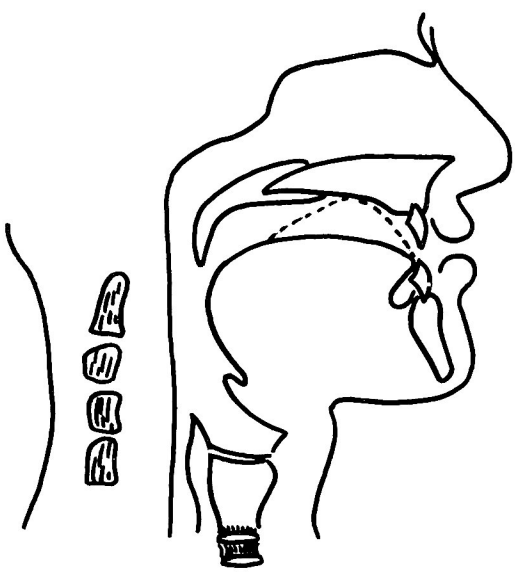

FIGURE 4. Lateral view schematic illustration of mid-dorsum palatal stop, with broken line showing lingual configuration and placement.

The Posterior Nasal Fricative

Radiographic data obtained during patients' productions of sustained fricatives suggests that the articulatory gestures that underly this articulation are variable. In some cases, the frication or air turbulence appears to be generated at the velopharyngeal port. There is an airway constriction as the velum approximates the pharyngeal wall, but there is no velopharyngeal seal, and the air is released nasally. The speech consequence is an audible frication with associated nasal air emission. This velar articulation can be seen radiographically as a blurring of movement or a *velar flutter* (VF), as indicated in Figure 6 by broken lines. The gesture might well be termed a "velopharyngeal fricative." In some patients, simultaneous linguavelar articulation is observed as the tongue attempts to provide *lingual assistance* (see L in Figure 6) to compensate for impaired velar movement. The posterior nasal fricative with simultaneous lingual assistance posturing is observed in some persons with submucous clefts. It has a notable occurrence in non-cleft velopharyngeal disorders, including the neurogenic problems of the dysarthrias and phoneme-specific velopharyngeal inadequacy. This last term is used by the author to define the occurrence of nasal air emission and audible posterior frication on certain pressure consonants only. That is, this abnormal pattern of airflow occurs in the absence of any hypernasal resonance, and the remainder of the pressure consonants are produced with adequate closure. Posterior posturing of the tongue, lingual-assistance to velopharyngeal closure, or both appear common in this subgroup of velopharyngeal inadequacies.

The child patient shown in Figures 7a and

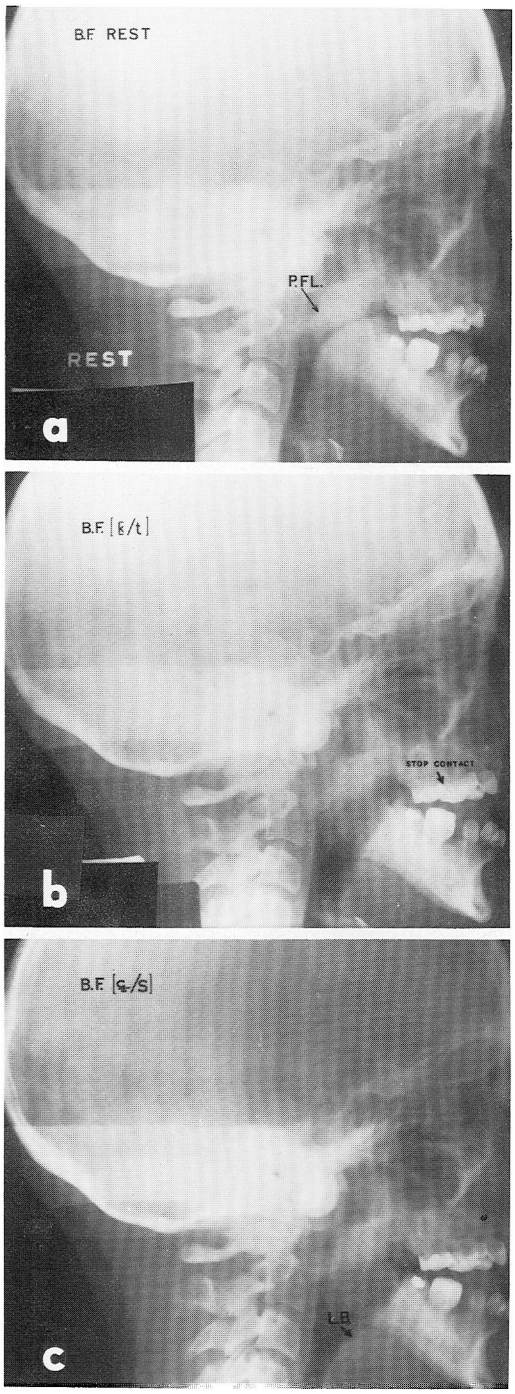

FIGURE 5. (a) Lateral view radiographic illustration of patient B.F., who has a repaired complete bilateral cleft and pharyngeal flap (P.FL.), at rest; (b) Lateral view radiographic illustration of patient B.F. producing mid-dorsum palatal stop substitution for /t/, showing tip-down and retracted lingual configuration and placement; (c) Lateral view radiographic illustration of patient B.F. producing pharyngeal fricative substitution for /s/, showing *low* point of linguapharyngeal *constriction* and concave configuration of posterior tongue.

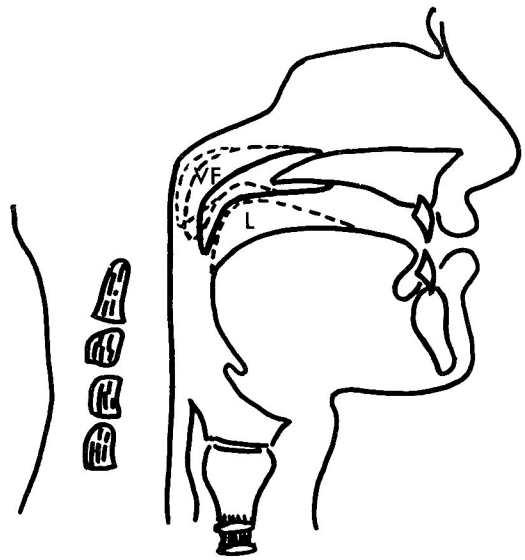

FIGURE 6. Lateral view schematic illustration of posterior nasal fricative with broken lines depicting lingual configuration and placement (L) and velar flutter/frication activity (VF).

7b has produced a posterior nasal fricative as a substitution for /s/. Figure 7b illustrates the lingual assistance to closure (LA), and the blurred image of the posterior velum denotes the presence and location of velar frication (VF). The patient shown in Figures 8a and 8b has a neurogenic velopharyngeal problem and also has reduced back-tongue valving. In her attempt to produce the target fricative /s/, she has produced /s/ + a simultaneous or co-articulated posterior nasal fricative. Compatible with the reduced range of posterior tongue movement, she demonstrates only the velar-uvular frication gesture, with no assistance from the tongue.

Posterior nasal fricatives are observed in some patients with palatal clefts after pharyngeal flap surgery. In this population, the lateral ports appear to comprise the point of posterior frication. In these cases, the posterior nasal fricative occurs secondary to flap inadequacy or to the patient's attempts to persist in directing the airstream nasally.

Typically, some degree of nasal emission is obligatory in production of the posterior nasal

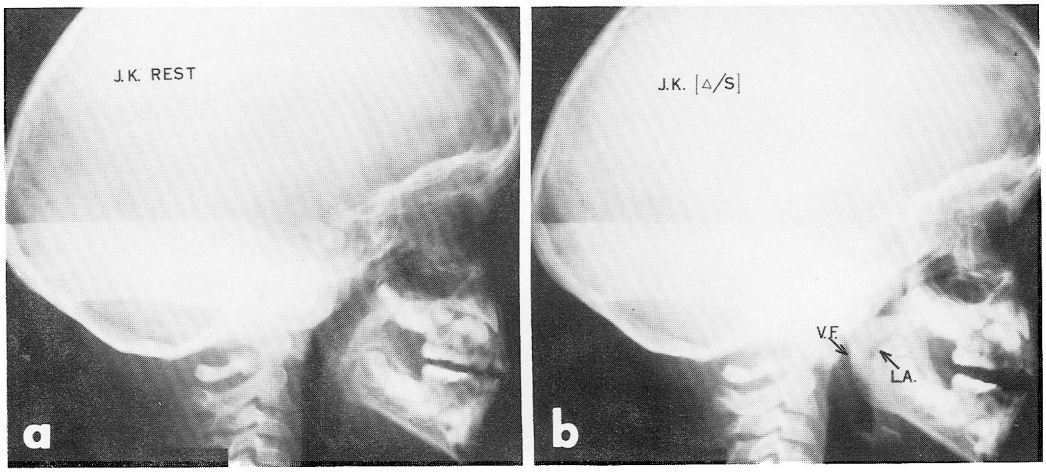

FIGURE 7. (a) Lateral radiographic view of child patient J.K. who has phoneme-specific inadequacy, at rest; (b) Lateral view radiographic illustration of patient J.K. producing posterior nasal fricative substitution for /s/, demonstrating lingually assisted posturing (L.A.) and velar flutter/frication (V.F.).

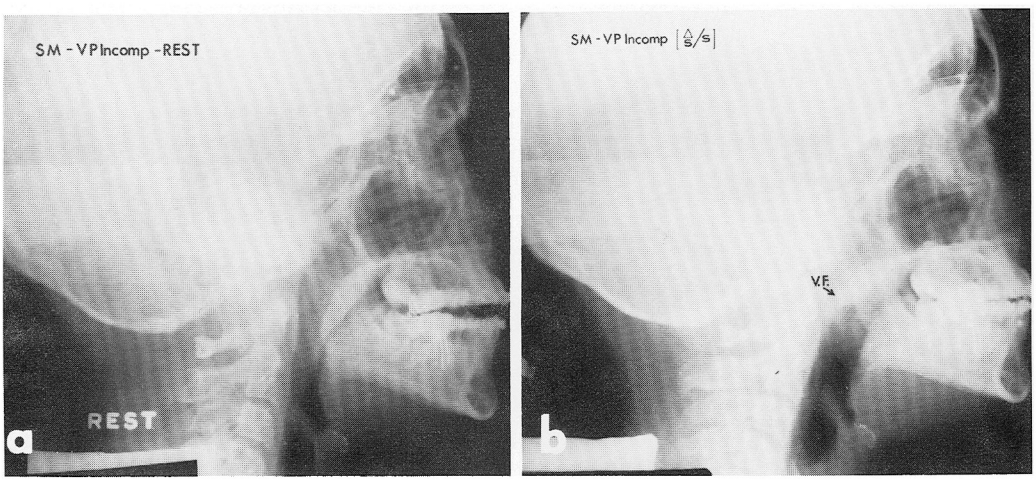

FIGURE 8. (a) Lateral resting radiograph of patient S.M., who has velopharyngeal incompetency; (b) Lateral view radiographic illustration of patient S.M. producing co-articulation of /s/ + posterior nasal fricative, /Δ/, and demonstrating velar flutter (V.F.) simultaneously with lingual placement for /s/.

fricative. Perceptually, this posterior fricative is distinguishable from nasal emission alone. This is because these two phenomena have different loci of turbulence or resistance to airflow. With nasal emission alone, any audible resistance to airflow must be intra-nasal as compared to the velopharyngeal port locus of the posterior nasal fricative. Clearly, when there is complete blockage of the nasal passages or in patients with obstructive pharyngeal flaps, nasal emission is minimal or absent, and only the posterior nasal fricative may be heard. Thus, in targeting for pressure consonants, speakers with velopharyngeal inadequacy may generate only nasal air emission, or nasal air emission simultaneous with posterior nasal fricatives, or only posterior nasal fricatives. It is perhaps this variability in combinations of occurrence that has led to the numerous labels applied to identify the nasal airflow deviations heard in persons with velopharyngeal impairments.

Clinically, the posterior nasal fricative has been observed as a substitution for the phonemes (s, z, ʃ, ʒ/. This posterior fricative also exists as an abnormal co-articulation by oc-

curring simultaneous with a fricative, affricate, or stop consonant. The speaker postures the articulators so as to produce simultaneously an oral pressure consonant and a posterior nasal fricative. In speakers with phoneme-specific velopharyngeal inadequacy where only selected oral consonants reveal nasal airflow, the posterior nasal fricative, with or without nasal air emission, may be the only perceptually deviant speech characteristic.

Phonetic Transcription of Compensatory Articulations

Table 1 summarizes all six types of compensatory articulations and the corresponding phonetic symbols that can be used in narrow phonetic transcription. Symbols are provided for voiced and unvoiced productions except for the voiced glottal stop and the unvoiced posterior nasal fricative. New symbols are provided for the pharyngeal stop, mid-dorsum palatal stop, and posterior nasal fricative. The symbols for glottal stop and velar fricative should be familiar to persons acquainted with the International Phonetic Alphabet (IPA). Symbols denoting the cognate pair of pharyngeal fricatives have been modified by the author from IPA notation in order to simplify phonetic notation. Likewise, for the mid-dorsum palatal stop, the unvoiced symbol /ƈ/ is drawn to represent the underlying compromise in articulatory gestures, /t/, and /k/, while its voiced counterpart /ɟ/ is an orthographic blending of the /d/ and /ɡ/ phonemes. The symbol for posterior nasal fricative was developed in 1978 by Dalston who has referred to it as a "flap fricative" because of its occurrence in post-pharyngeal flap cases. The symbols characterizing the pharyngeal stop cognate pair are designed to represent the length of the pharyngeal tube with the rounded portion, also seen in the pharyngeal fricative, depicting the articulatory gesture of "tongue backing into the posterior pharyngeal wall." The symbols for the pharyngeal stop versus the pharyngeal fricative are intended to distinguish production features of stop versus continuant, as the upper portion of the pharyngeal fricative symbol remains open.

TABLE 1. Six types of compensatory articulation and corresponding phonetic symbols for unvoiced and voiced productions.

Compensatory Articulation	*Phonetic Symbol*	
	Unvoiced	*Voiced*
Glottal Stop		/ʔ/
Pharyngeal fricative	/ħ/	/ʕ/
Velar fricative	/χ/	/ɣ/
Mid-Dorsum Palatal Stop	/ƈ/	/ɟ/
Posterior Nasal Fricative	/ʌ/	
Pharyngeal Stop	/ʡ/	/ʢ/

Compensatory Articulations As Substitutions and Co-Articulations

For ease of discussion, Table 2 provides an empirically derived listing of how compensatory articulations tend to be distributed as a) target sound *substitution/replacement* only, as in /ʔ/ for /p/, or b) *co-articulation* as in /ʔp/. As used here, the term co-articulation denotes atypical simultaneous articulatory maneuvers. As shown in the example above, it is characterized by *one manner* of production, stop, with simultaneous valving at *two places* of production, glottal and bilabial. It is emphasized that these are clinically observed trends and do not, to date, have the scientific support of systematic data. That clinicians are aware of this aberrant type of co-articu-

TABLE 2. Empirically derived listing of target phoneme classes that are substituted for, replaced by, or co-articulated with compensatory articulation.

Compensatory Articulation	*Target Phoneme Class*	
	Substituted/Replaced	*Co-articulated*
/ʔ/	Stops, occasionally affricates	Stops, affricates
/ħ, ʕ/	Fricatives, predominantly sibilants	Fricatives (sibilants)
/ʡ,ʢ/	Back velar stops	None
/ʌ/	Sibilant fricatives	All pressure consonants
/χ,ɣ/	Back velar stops/sibilant fricatives	None
/ƈ,ɟ/	Tip alveolar stops/back velar stops	None

lation is supported by the observations of McWilliams and Philips (1979).

Based on observations reported here, the pharyngeal stop, velar fricative, and mid-dorsum stop occur more typically as phoneme replacements, while the glottal stop, pharyngeal fricative, and posterior nasal fricative occur either as phoneme replacements or as co-articulations. These observed patterns of distribution may relate simply to motor speech mechanics in that with /ʔ/, /Δ/, and /ʢ, ɬ/, the tongue is freer to make simultaneous, more anterior contacts or approximations. Clearly, systematic research data are needed so that more reliable and valid conclusions can be drawn regarding patterns of compensatory articulations used by speakers with cleft palate and velopharyngeal inadequacy.

Implications for Treatment

The remarks offered here are not research findings and are intended to serve only as guidelines to assist the clinician in thinking through and planning the patient's treatment needs, based upon the total composite of speech diagnostic findings. At the outset, the clinician must determine that velopharyngeal structure and functional potential are adequate to control resonance and airflow, or must understand the treatment limitations posed by varying degrees of inadequacy in the mechanism. An inadequate velopharyngeal valving mechanism does not preclude working on selected components of articulation, particularly place deviations of the speech impairment. Often, in fact, diagnostic therapy wisely precedes decisions regarding the need for further surgical or prosthetic management.

For articulation assessment in both single words and connected speech, the clinician should do whole word narrow phonetic transcription to delineate the presence and the types of compensatory articulations and to define overall error patterns, including errors of substitution versus those of co-articulation. All correct phoneme productions should be noted by context for purposes of defining pretreatment phoneme production repertoire.

Errors that are derived from aberrant lingual valving postures or faulty placement are probably the most common type of error observed in persons with palatal clefts. Indeed, with the exception of the velar fricative for velar stop substitution and some occurrences of /Δ/ articulation, most of the compensatory articulations seen in this population involve errors in place of production. Exclusive of substitution of the mid-dorsum palatal stop for the back-velars /k/ and /ɡ/, these place errors represent posterior or *backed articulation patterns*. The therapeutic goal is to bring the articulatory placements more forward.

Auditory modeling, alone, is generally unsuccessful in shifting compensatory articulation postures. Some form of diagramatic or other visual representation of desired targets for contrast with faulty placements is a useful technique. A simple, unlabeled lateral drawing, like that shown in Figure 9a, can be used to visualize a patient's error postures relative to correct targets. Both errors of substitution and of co-articulation can be represented, and children as young as four years can benefit from this type of approach. For example, Figures 9b and 9c are illustrative of the substitution of a pharyngeal stop for /k/ and of the co-articulation of a glottal stop + /t/, respectively. The clinician can contrast the patient's incorrect versus the correct productions, can relate these auditory perceptual models to diagramatic representations, and can begin to work toward establishment of the new target place. On the basis of this author's experience, it is best to work on establishing correct *place* of production *only*, in the absence of other features. In this way, the stop or fricative manner, so strongly associated with the aberrant place, is temporarily "left behind." In eliminating /ʔ/ as a substitution, or as a co-articulation with a stop consonant, it is often best at first to attach the fricative manner to the new place before establishing the stop manner. Again, this approach appears to be successful in dissociating the strongly habituated aberrant place + stop pattern.

Summary

Compensatory articulations used by speakers with cleft palate and velopharyngeal inadequacy have been described radiographically and with respect to perceptual characteristics and articulatory gestures. These productions have been discussed in relation to the more familiar glottal stop, and pharyngeal

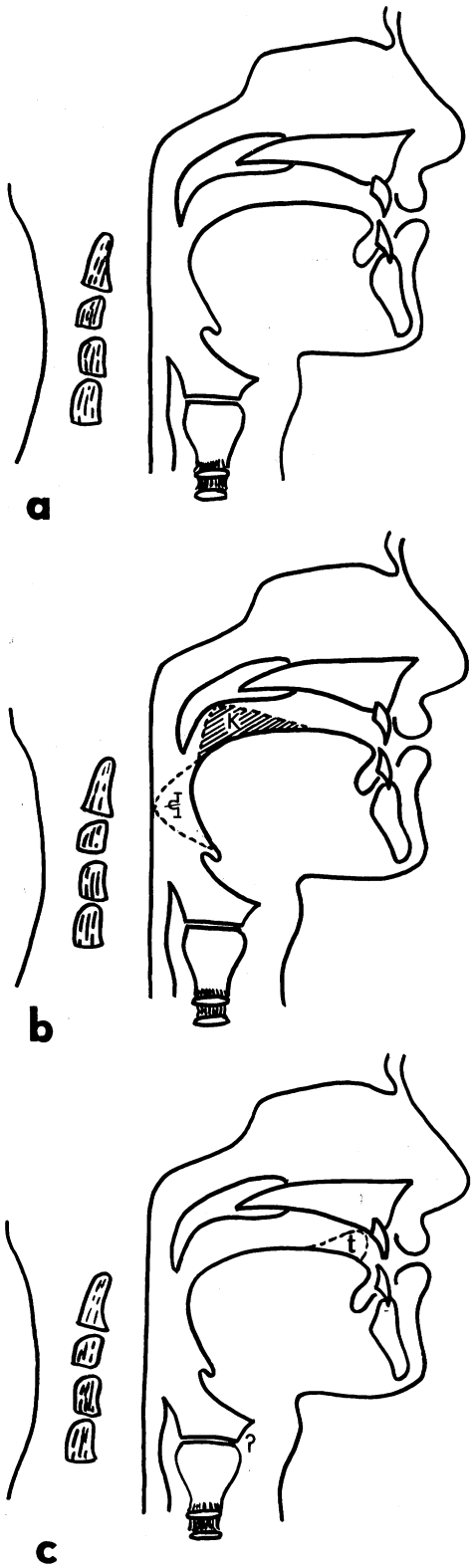

FIGURE 9. (a) Unlabeled lateral line drawing for use in noting deviant or correct articulatory valving postures for speech; (b) Lateral line drawing contrasting correct place for /k/ articulation with its incorrect place substitution, unvoiced pharyngeal stop, /ʡ/; (c) Lateral line drawing depicting places of simultaneous articulation used in co-articulation of /t/ and glottal stop, /ʔt/

and velar fricative productions. In addition, symbols for phonetic notation have been introduced for the pharyngeal stop, mid-dorsum palatal stop, and posterior nasal fricative, and guidelines for speech remediation have been offered. In our continuing efforts to understand the articulatory adjustments mandated by palatal clefts and other disorders related to velopharyngeal incompetency, there is need for systematic study of these types of compensatory articulations. Hopefully, such research will yield objective and quantifiable definitions of the physiologic and acoustic characteristics of these speech patterns. Clinicians are encouraged to establish early diagnostic speech intervention programs for cleft palate babies. Early evaluation would enable development of protocols for identification of age(s) of onset of these deviant articulatory patterns. Such information might contribute to more valid determination of a communicatively optimal age for palatopharyngeal surgery and should serve to upgrade speech management of persons with palatal clefts and related velopharyngeal impairments.

Acknowledgment: The author acknowledges Penny Wheeler Davis, M.A., who preceded her at the Cleft Palate Institute and who, upon vacating her post, suggested that the author pay attention to a type of "mid-dorsum articulation" she had noticed in youngsters with clefts. Appreciation is also expressed to Maryann Culbertson for careful assistance in preparation of this manuscript.

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