The Influence of Head Position Upon Velopharyngeal Closure

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There is general agreement in the literature to the effect that the ability to achieve velopharyngeal closure is highly correlated with speech adequacy in patients with cleft palate (*8–11*). Brandt and Morris (*1*) have suggested that "as velopharyngeal opening increases, the number of articulation errors increases in a proportional or perhaps linear manner". On the other hand, clinicians are often faced with the dilemma of a patient who has perceptible hypernasality in his speech but whose cine-radiogram in lateral view would indicate that closure is being achieved. One possible explanation for this condition is that there is velopharyngeal opening at sites other than those visible on the radiogram. A second possibility is that there is variation in the ability of the structures to close off the nasal port and that the position of the head may contribute to that variation. The work of Lloyd, Pruzansky, and Subtelny (*3*) suggests that the extended head position results in a somewhat deeper pharynx than when the head is in the Frankfort plane. This being true, velopharyngeal closure viewed from an upright lateral position may yield results valid only for that position. Inability to achieve closure in other positions may be related to hypernasal speech.

The question posed in this study was: Will modifying the head position in such a way as to impose greater demands upon the velopharyngeal mechanism yield additional information about the integrity of function?

Procedure

SUBJECTS. Subjects were 101 children with surgically repaired cleft palates. They ranged in age from three years, two months, to fifteen years, four months, with a mean age of eight years, ten months. There were 32 females with a mean age of nine years, one month, and 69 males with a mean age of eight years, ten months. Bilateral and left and right unilateral clefts of the lip and palate, incomplete clefts of the hard and soft palate, and clefts of the soft palate only were included in the sample. This information is summarized in Table 1.

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TABLE 1. Number, cleft type, and mean age (in years and months) of the 101 subjects.

Cleft type	*hypernasal speakers*				*speakers with normal quality*				*total*				*sexes combined*	
	females		*males*		*females*		*males*		*females*		*males*			
	mean		*mean*		*mean*		*mean*		*mean*		*mean*		*mean*	
	N	*age*	*N*	*age*	*N*	*age*	*N*	*age*	*N*	*age*	*N*	*age*	*N*	*age*
lip and palate														
bilateral	6	10–6	13	9–7	5	11–0	10	8–9	11	10–9	23	8–14	34	10–5
left unilateral	6	8–9	6	10–1	4	8–10	17	10–11	10	8–10	23	10–6	33	9–8
right unilateral	1	15–10	5	9–0	1	8–9	5	8–4	2	12–4	10	8–8	12	10–6
palate only														
incomplete, hard and soft	0	—	3	5–10	8	8–9	8	8–10	8	8–9	11	7–4	19	8–1
soft palate only	1	13–4	1	8–3	0	—	1	8–7	1	13–4	2	8–5	3	10–11
totals	14	9–8	28	8–5	18	7–6	41	9–1	32	10–10	69	8–10	101	9–11

The 101 children were divided into two groups on the basis of the presence or absence of hypernasality, as judged by the plastic surgeon and at least one speech pathologist. (The children represented a group about whom the surgeon and the speech pathologist, rating the subjects independently, agreed as to the presence or absence of hypernasality.) For purposes of this study, information relating to *degree* of hypernasality was not utilized. Fifty-nine subjects were judged to have normal voice quality. Forty-two were judged to be hypernasal (Table 1).

METHOD. Each child was studied tele-radiographically, a technique which has been described elsewhere (*6*). The televex examination consisted of asking the child to perform a number of speech tasks (Figure 1) while in an upright lateral position and then to repeat certain of the tasks again while the head was in a flexed and, following that, in an extended position.

The video-tapes were judged by three speech pathologists on a seven-point scale, with a rating of *one* representing total blending of structures and *seven* representing no movement in the direction of closure. This scale has been described previously (*5*). A radiologist served as a consultant but only occasionally entered into the judging procedures.

Coefficients of reliability were computed for two of the speech pathologists on a sample of 67 children: .92 for upright; .83 for extension; .92 for flexion. When a third speech pathologist joined the staff of the Center, her ratings were correlated with those of the other two on a sample of 25 children; the correlation coefficients ranged from .83 to .94. These levels of inter-judge reliability, summarized in Table 2, were considered high enough to permit any of the judges to rate examinations independently. However, since it was usually possible to use more than one of the three judges for an evaluational session, the closure rating finally assigned to a particular child was the mean of the number of ratings obtained.

speech task	*upright*	*head position flexion*	*extension*
1. Counting 1–10	x		
2. My name may mean money	x		
3. Sissy sees the sun in the sky	x		
4. Give Gary the cake	x		
5. Put the baby in the buggy	x		
6. /ɑ/, /s/, /i/	x	x	x
7. /mɑ/, /mi/, /kɑ/, /ki/, /sɑ/, /si/	x	x	x

FIGURE 1. Head positions which were used with the various speech tasks.

TABLE 2. Coefficients of reliability for three judges rating televex studies.

	judge B				*judge C*			
	number subjects rated	*upright*	*head position extension*	*flexion*	*number subjects rated*	*upright*	*head position extension*	*flexion*
judge A	67	.92	.83	.92	25	.83	.94	.89
judge B					25	.90	.86	.92

TABLE 3. Velopharyngeal closure achieved by the 101 subjects in upright, flexed, and extended head positions.

	speakers with normal voice quality	*hypernasal speakers*	*total*
closed in all three positions	50	13	63
closed only in upright	3	4	7
closed only in upright and flexion	3	5	8
closed only in upright and extension	2	0	2
closed only in extension and flexion	1	0	1
never achieved closure in any of the three positions	0	20	20
total	59	42	101

Analysis of Data

VELOPHARYNGEAL CLOSURE IN THE UPRIGHT POSITION. Data derived from evaluations of velopharyngeal closure in upright, flexed, and extended positions are summarized in Table 3.

Fifty-eight, or 98%, of the 59 speakers with normal voice quality were judged from the televex study to have velopharyngeal closure in the upright position. This would offer evidence to the effect that velopharyngeal closure in the upright position is associated with speech that sounds normal, so far as nasal resonance is concerned. A total of 22 of

TABLE 4. Differences in velopharyngeal closure for 59 cleft palate speakers with normal voice quality and 42 cleft palate speakers with hypernasality, according to the three head positions. Significant chi square values are asterisked.

	number closing	*number failing to close*	*total*
closure achieved in upright head position			
speakers with normal voice quality	58	1	59
hypernasal speakers	22	20	42
total	80	21	101
chi square	29.64*		
closure achieved in upright and flexed head positions			
speakers with normal voice quality	53	5	58
hypernasal speakers	18	4	22
total	71	9	80
chi square	2.385		
closure achieved in upright and extended head positions			
speakers with normal voice quality	52	6	58
hypernasal speakers	11	11	22
total	63	17	80
chi square	15.796*		
closure achieved in all three positions			
speakers with normal voice quality	50	9	59
hypernasal speakers	13	29	42
total	63	38	101
chi square	29.310*		

the 42 hypernasal speakers, or 52%, also achieved closure in the upright position; the difference between the two groups, evaluated by chi square, was found to be significant (Table 4). However, since over half of the hypernasal speakers achieved closure on the video tapes taken with the head in the upright position, closure in such a position might also be stated as a characteristic of the hypernasal speakers.

Regarding the judged type of closure, for those subjects showing closure, hypernasal or normal-voice quality, total blending of the palate and wall, which has frequently been observed in normal speakers, was never achieved by any of the subjects studied here. Partial blending, also seen in normal speakers, was found in only seven of the subjects who achieved closure. Touch closure, found in 73 of these subjects, was seen most frequently and would seem to be characteristic of these cleft palate children who achieved closure. It should be noted that this type of closure is also occasionally seen in normals.

VELOPHARYNGEAL CLOSURE IN FLEXION. Of the 22 hypernasal speakers who achieved closure in an upright position, four failed to close in flexion. Five out of the 58 cleft speakers with normal voice quality who achieved closure in an upright position also failed to show closure in

flexion. The difference between the two groups was not significant (Table 4); failure to retain closure in the flexed position appeared not to differentiate between nasal and nonnasal speakers, and so is not considered further in this paper.

VELOPHARYNGEAL CLOSURE IN EXTENSION. Fifty-two of the 58 normal speakers who achieved closure in the upright position retained it in extension, while 11 of the 22 hypernasal speakers who closed in the upright position failed to do so in extension. The difference between the two groups is significant (Table 4) and leads us to conclude that the hypernasal and normal quality groups are drawn from different populations so far as demonstrating velopharyngeal closure in extension is concerned. Figure 2 presents tracings from televex tapes of a repaired cleft speaker with normal voice quality achieving closure during phonation in both upright and extended positions. Figure 3 shows a nasal speaker closing during phonation in an upright position, and the same speaker failing to close in extension.

Reference to Table 4 indicates that 50 of the 59 cleft palate speakers with normal voice quality, or 85%, demonstrated velopharyngeal closure in the three head positions studied. Only 13 of the 29 hypernasal speakers, or 45%, showed closure in all three positions; that difference was found to be significant. The chi square of 29.31 was significant. The 13 hypernasal speakers who achieved closure in the three positions are considered in further detail later in the paper.

Discussion

This study suggests that velopharyngeal closure, as viewed from an upright position, is achieved significantly more often in cleft palate

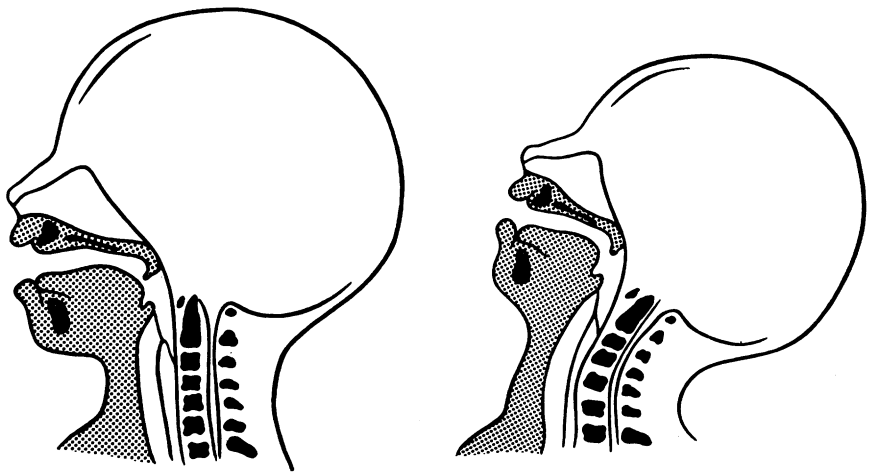

FIGURE 2. A tracing from televex tapes showing a speaker with a repaired cleft palate achieving velopharyngeal closure in the upright position, left, and in extension, right.

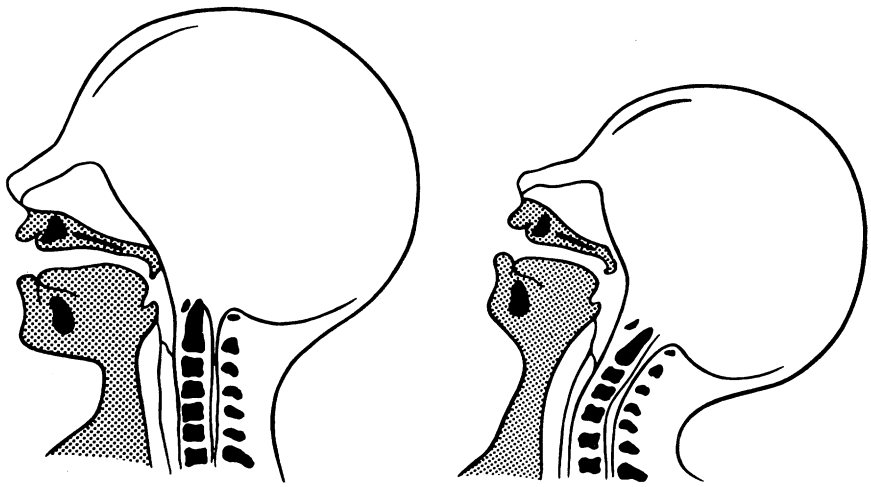

FIGURE 3. A tracing from televex tapes showing a speaker with a repaired cleft palate achieving velopharyngeal closure in the upright position, left, but not in extension, right.

speakers with normal voice quality than it is in cleft palate speakers with hypernasality. Furthermore, hypernasal speakers who achieve closure in an upright position have a tendency to lose the ability to close when placed in extended positions. Since it is possible to identify a significantly higher proportion of inadequate mechanisms if radiographic studies are carried out with the head in the extended position, it seems clear that the traditional lateral technique, with the head in the upright position, is probably not the most effective means of deriving complete diagnostic information. Rather, the upright view in combination with extension views may offer useful information to the clinician and to the researcher.

The need for velopharyngeal integrity is supported further by individual analysis of the children who deviated from group trends. For example, nine of the cleft palate speakers who were judged to have normal voice quality *failed* to achieve closure in all three positions. For seven of these cases, inspection of the televex ratings revealed that the judges disagreed as to whether closure was achieved or not, indicating the possibility of error judgment. In only two cases of normal voice quality did the judges see unquestionable evidence of failure to *close*. One of these was a view in flexion, the other, in extension. Both cases appear to be in close approximation to closure, indicating an extremely narrow opening between the velum and the pharyngeal wall.

Understanding the basis for the presence of hypernasality in the 13 speakers who achieved closure in all three positions is difficult. However, upon re-examination of original data, reasonable explanations for the initial impression of hypernasality can be provided in most cases.

Six of the 13 cases had mild fricative distortions suggestive either of a nasal leak, or possibly of the type which Morley (7) refers to as the palatal /s/ and which Greene (2) calls the lateralized /s/. Greene suggests that such errors seem to occur in speakers as velopharyngeal competence increases. It is hypothesized here that these distortions may result from hidden velopharyngeal incompetence in a palate making contact with the pharyngeal wall but with insufficient force to effect a true seal. Another explanation may be that there is an airway not visible on a lateral study. A third possibility is that these are laterally emitted fricatives not unlike those sometimes seen in noncleft speakers with articulation disorders of different or unknown origin.

Two of the 13 hypernasal speakers who achieved closure in all three positions had such severe articulation problems, including fricative distortions, that it is easy to see why they might be labelled as hypernasal. However, re-examination of pre-televex clinical notes indicates that closure was predicted for them even though the speech was seriously defective.

For each of the five remaining children of the original 13, there was a different explanation for the clinical impression of hypernasality. In one case, an unusually bulky orthodontic appliance was noted as an encumbrance that probably seriously affected sibilant articulation. For a second child, the impression of hypernasality was attributed to glottal stops that were inserted between the consonant /s/ and vowels. Still another child had a severe articulation problem combined with a 'nasal snort'. When he was recalled for further study, it was noted that he had a sizable anterior slit-like fistula, previously undetected, through which oral air pressure apparently leaked during the production of /s/. This resulted in audible nasal resonance accompanied by nasal emission, in the presence of velopharyngeal closure. (Plugging the opening confirmed the suspicion that the problem was an anterior one, and the leak was prevented as a result of treatment.) In the fourth case, it was observed that the child *could* close the velopharnygeal port but that she did so inconsistently.

The fifth apparently hypernasal speaker who achieved closure in all three positions had accurate placement during consonant articulation. However, she demonstrated a very mild but notable overall hypernasality. Nothing to explain the lack of agreement between the speech endproduct and the radiographic analysis could be found. It was the clinical conclusion that this patient had velopharyngeal insufficiency although it could not be visualized by any of the techniques available. The term *hidden* velopharyngeal inadequacy was, therefore, tentatively applied to this condition; and a pharyngoplasty utilizing teflon implant was carried out. Since this procedure resulted in dramatically improved speech, the diagnosis appeared to be an accurate one.

Summary

Lateral, still x-ray films, taken in the upright, flexion, and extension positions, were obtained for 101 children with surgically, repaired cleft palate. Subjects were assigned to either of two groups: hypernasal and normal voice quality. Differences between the voice quality groups according to presence and judged-type of velopharyngeal closure for the three head positions were investigated. The following conclusions seem warranted. Velopharyngeal closure is essential to the achievement of speech which is not hypernasal in quality. The children in this study who achieved velopharyngeal closure usually demonstrated touch-type closure. Traditional lateral cine-radiographic or televex studies with the head in an upright position may not be sufficiently discriminating to reveal velopharyngeal inadequacy in borderline mechanisms. Lateral radiographic views with the head in extension appear to offer additional diagnostic information. No conditions other than closure problems may contribute to the auditory impression of hypernasality.

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