A Clinical Investigation of the Efficacy of Primary Nasopalatal Pharyngoplasty

RODGER M. DALSTON, Ph.D.
ORION H. STUTEVILLE, M.D., D.D.S.
Evanston, Illinois 60201

Since the inception of pharyngeal flap surgery in 1875 (*29*) numerous authors have addressed the issue of the relative efficacy of this technique in all its various forms. The procedure has been employed with concomitant retropositioning of the velum (*22*, *27*) or without it (*11*, *34*). It has been done as a secondary procedure for those cases in whom initial repair proved inadequate (*27*, *35*) or as a primary procedure at the time of initial palatal closure (*5*, *12*, *34*). The flap itself has been raised so as to effect a superior pedicle (*4*, *39*), an inferior pedicle (*13*, *26*) or a "medial" pedicle with a "chevron" configuration (*17*), the intent of the latter procedure being to maintain continuity between the superior constrictor and its innervation.

The avowed purpose of all these procedures is to create an anatomic and physiologic environment that will prove conducive to the development of normal speech. However, as has been pointed out by several authors (*25*, *46*), there is a remarkable lack of systematic speech analysis in a large proportion of the investigations pertaining to these procedures. The definition of success has varied from "speech improvement" over the pre-operative condition, with no specification of the time interval between surgery and speech assessment, (*2*, *10*, *13*) to "acceptable speech" (*7*, *31*). The speech assessments have been made by lay persons (*11*, *18*), by the attending surgeon (*1*, *16*, *43*) or by a speech pathologist trained in the area of cleft palate (*2*, *21*, *28*). Finally, the clinical population operated upon often has not been studied in terms of various factors that might be expected to affect the speech result.

Procedure

SURGERY. Selection of patients to receive what is termed here nasopalatal pharyngoplasty was made by the surgeon, once the team and the family agreed upon surgery as the method of choice. Cleft width and cleft type were never factors involved in this initial determination. If the surgeon, on the basis of clinical examination, determined that the palatal tags were

Dr. Dalston is Assistant Professor, Department of Communicative Disorders, 2299 Sheridan Road, Evanston, Illinois 60201.
Dr. Stuteville is Professor Emeritus, Northwestern University Medical School.
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too short and/or velar and lateral wall movement too slight to ensure adequate correction with only a Dorrance or modified Wardill-Kilner closure of the cleft, he would inform the team that he planned to perform nasopalatal pharyngoplasty. In recent years, subjects selected for this procedure had their tonsils and adenoids removed approximately 1 month before palatal surgery, the intent being to preclude the necessity of having to resect the flap to remove the adenoid at some later date. Thirty-eight percent of the subjects reported on here received a T&A prior to surgery while 62% did not, thus enabling an analysis of the effect that the T&A had upon the speech result.

The basic surgical procedure employed has been described previously (*36*, *37*) and is reiterated here. General oral endotracheal anesthesia was used. A Dott mouth gag with a grooved tongue depressor was employed to prop the mouth open, depress the tongue and hold the intratracheal tube firmly in position. Rectangular mucosal flaps were turned down on a distal base, from the nasal surface of the soft palate. The incisions extended from the junction of the hard and soft palate in the central areas, to 5 mm. from the lateral pharyngeal wall and up at 90° to the posterior pillars. This left a cuff of mucosa on each lateral aspect, which prevented the flaps from being tethered to the lateral pharyngeal wall. The flaps were then turned down along the posterior pillars.

A broad-based pharyngeal flap, including the mucosa and the muscle down to the prevertebral fascia, was raised from below. It was based high towards the cranial base, with care being taken to avoid injury to the Eustachian tubes. If mesial movement was judged to be good, 5 mm. of mucosa on the lateral aspect of the posterior pharyngeal wall was allowed on either side of the flap; if not, 3 mm. of mucosa was allowed on each side. The donor site of the flap was closed, taking care to anchor the stitches through the prevertebral fascia. The flap was attached to the raw surface of the nasal aspect of the soft palate without tension. Then the mucosal flaps that had been turned down from the nasal aspect of the velum were sutured across the raw surface of the flap. The central portion of the cleft area was then closed, giving a complete mucosal coverage of the flap with the exception of a small area in the center at the posterior wall. The lateral pharyngeal walls were packed with Gelfoam and buccal cheek flaps were rotated across the defect and closed. At the termination of the procedure, a 00 silk suture was placed through the tongue to be used by the nursing staff for airway maintenance during the first twenty-four hours. This procedure was performed independently, or in combination with the Dorrance "push-back" operation if only the soft palate was involved. In hard and soft palate clefts, it was combined with a modified V-Y Wardill procedure.

Subjects. A group of 28 males and 22 females, representing a random sample of cases treated with this procedure during the period from October, 1961, to March, 1973, were chosen for inclusion in this study. Of the 50 subjects, only 2 had a pure-tone better-ear-average exceeding 20 dB ISO.

TABLE 1. Speech tasks performed by each subject.

1. Repetition of 16 short sentences. Children whose memory span precluded repetition of the entire sentence were asked to repeat it in phrases.
2. Counting consecutively from 1–20.
3. Counting consecutively from 60–70.
4. Counting consecutively from 62–66 with the nares occluded by the examiner.
5. Counting consecutively from 90–99.
6. Sustained phonation of /a/, /i/, /s/, and /m/.
7. Sustained phonation of /a/, /i/, and /s/ with the nares occluded by the examiner.
8. 30–60 seconds of conversational speech. (In numerous cases, this sample was of several minutes duration.)
9. Responses to the Iowa Pressure Articulation Test.

Since re-analysis of the data with these two cases excluded did not significantly alter the findings, all 50 subjects were included in the analyses reported here. The group consisted of 2% Veau Class I clefts, 22% Class II, 60% Class III and 16% Class IV. Cases of congenital palatal insufficiency on whom this surgical procedure was performed were purposely excluded from analysis in this study. The mean age at which palatal surgery was done was 2.74 years (S.D. 1.44 years).[1] The mean age at which the child's speech was recorded for analysis was 6.82 years (S.D. 2.23 years). Thus, the mean time lag between surgery and speech sampling was 4 years (S.D. 2.29 years), the least time lag being less than one month, and the most being over 11½ years (11.67 years).

OBSERVATIONS. High fidelity tape recordings were made of the speech of each client, utilizing an Electro-Voice Lavalier microphone and an Ampex dual-channel tape recorder. Recordings were made with the child seated in an IAC sound-treated booth. The various speech tasks that each subject was required to perform are summarized in Table 1. The 16 sentences possessed a frequency of occurrence of the various consonant sounds that was approximately equal to their relative frequency of occurrence in English as reported by Wood (*49*), except that there was a greater preponderance of plosives and fricatives. Each subject was asked to repeat the sentences after the experimenter.

With the exception of the responses to the Iowa Pressure Articulation Test,[2] the speech samples from the 50 subjects were dubbed in random order onto master listening tapes. The recordings of 10 subjects, randomly selected from the group of 50, were re-recorded on the end of the last tape so as to enable an assessment of intra-judge reliability. Except for the spontaneous speech, the samples obtained from each subject were the same. For this reason, a copy of the test sentences and a description of the other speech tasks were given to each judge so as to minimize adaptation and practice effects.

[1] median age = 2.27 years

[2] Information concerning the articulation proficiency of each subject, as assessed from responses to the Iowa Pressure Articulation, are the subject of a paper in preparation.

TABLE 2. Speech rating profile. The scales employed are those of Subtelny, Van Hattum and Myers (*37*).

A. Hypernasality
   1. Normal resonance quality.
   2. Slight nasality; perceptible to the trained ear but probably not discernible by a layman.
   3. Moderate nasality; perceptible to the layman.
   4. Hypernasal; slight reduction in intraoral pressure; slight nasal airflow; a few consonants grossly distorted.
   5. Hypernasal—excessive; marked reduction in intraoral pressure; prominent nasal airflow; most consonants grossly distorted.

B. Hyponasality (Denasality)
   1. Normal resonance quality.
   2. Slight denasality; perceptible to the trained ear but probably not discernible by a layman.
   3. Moderate denasality; perceptible to the layman.
   4. Hyponasal; nasal resonance only very inconsistently present.
   5. Hyponasal—excessive; consistent absence of nasal resonance—"cold in the nose" quality prominent throughout speech.

C. Nasal Emission
   1. None.
   2. Slight—perceptible to the trained ear.
   3. Moderate—perceptible to layman on a few consonants.
   4. Marked—perceptible on most pressure sounds.
   5. Excessive—all pressure consonants grossly distorted.

D. "Speech Adequacy" (Understandability of speech)
   1. Superior for age.
   2. Normal for age.
   3. Mild difficulty in understanding—repetition not required.
   4. Moderate difficulty—repetition required infrequently.
   5. Marked difficulty—repetition required frequently.
   6. Unintelligible, with repetition.

Four speech pathologists, all of whom were experienced in the assessment of cleft palate speech, but only two of whom were affiliated with the Institute from which the subjects were selected, analyzed all 60 speech samples. Each of the judges made their assessments in three different listening sessions, each approximately 2½ hours in duration. The judges listened to the tapes privately in an IAC sound-treated booth through an Ampex tape recorder and loudspeaker/amplifier set to ensure a comfortable listening level (70 dB SPL).

The judges' initial task was to assign a numerical value reflecting their assessment of the overall degree of hypernasality for each subject's speech. To this end, they were instructed to use an adaptation of the scale reported by Subtelny, Van Hattum and Myers (*37*) which is presented in Table 2 Vocal quality obviously is not a static phenomenon, but can change from moment to moment as a function of numerous factors, including context. Therefore, each judge was also asked to define the range of hypernasality that a given subject manifested. For example, a person might have been rated as presenting, generally, a very mild degree of nasality (2), although

he may have sounded completely normal in some contexts (1) and moderately nasal in others (3). Each judge was instructed to record the numbers reflecting the least and the greatest degree of hypernasality manifested by each subject. The investigator subsequently subtracted the latter number from the former to obtain the range value.

The same type of overall rating and range specification was made for judgments concerning hyponasality. Weatherley-White (*41*) has shown that both hypernasality and hyponasality can and do occur in the speech of a single speaker, thus indicating that these phenomena are not mutually exclusive. Moreover, when one signifies hyponasality by a negative sign and hypernasality by a positive sign, it is quite possible that any report of group data might yield normal mean rating scale values for a population comprised of some denasal and some hypernasal speakers. It was for these reasons that two separate rating scores were employed to assess these resonance phenomena.

In addition to judgments of hypernasality and hyponasality, the judges assessed the amount of nasal emission manifested by each subject. They also judged each subject's overall "speech adequacy" (Table 2).

In an attempt to gain an appreciation of the effect that various factors might have upon the speech results reported here, several variables other than those pertaining to the perceptual judgments noted above were specified for study. (Table 3). The analysis of the population in terms of cleft type was performed in two ways. First, each subject was placed into one of the four traditional classes as described by Veau (*38*). Next, each child was re-classified in an attempt to more accurately describe the degree of palatal involvement. For this latter analysis, the extent of clefting in the soft palate, hard palate and alveolus was each marked in thirds. The codification of this information was made in such a way that a small cleft of

TABLE 3. Variables included in the correlation analyses.

1. Cleft
2. Sex
3. Age at surgery ("Surgage")
4. Age at taping ("Tapeage")
5. Time lag between surgery and taping ("Postop")
6. Duration of speech therapy after surgery ("Therdur")
7. T & A prior to surgery
8. Expiratory breath pressure ratio (EPR)
9. Inspiratory breath pressure ratio (IPR)
10. Manometer difference score (MDS)
11. Point of flap attachment
12. Hypernasality
13. Range of hypernasality
14. Hyponasality
15. Range of hyponasality
16. Nasal emission
17. "Speech adequacy"

the soft palate was recorded as a one (1) while a complete unilateral cleft was given a value of 9 (3/3 soft plus 3/3 hard plus 3/3 alveolus on one side) and a complete bilateral cleft was recorded as a twelve (12). While this latter system of classification necessarily is more exact than that proposed by Veau, it must be emphasized that the measurements were made from drawings appearing in the clinic records of each patient and, therefore, are subject to considerable error.

The expiratory breath pressure rations (EPR) were determined for 30 of the 50 subjects studied in the present investigation. This information was simply unavailable on the other 20 subjects. Readings of maximum, sustained positive (EPR) and negative (IPR) pressure with nares open and occluded were obtained from each of the 30 subjects utilizing a Hunter oral manometer. The bleed device was left in the open position at all times. The procedure employed in collecting this data corresponds to that described in the literature (*20*, *24*, *32*, *42*). Particular attention was paid to ensure that the inspiratory breath pressures were not generated by sucking since this is known to involve tongue valving (*19*) which necessarily precludes an accurate assessment of velopharyngeal adequacy.

When an individual obtained a higher pressure reading with the nostrils open than with the nostrils occluded, the ratio was still recorded as being 1.00. This was done under the assumption that "usually, the difference in the two readings is related to difficulty which the individual has in blowing with nostrils occluded, and the inference can be made that the 'true' ratio is 1.00" (*24*, 365). For purposes of analysis, the EPR and IPR scores were both grouped as follows: "high": 0.90 to 1.00; "medium": 0.51–0.89; and "low": 0.00 to 0.50 (*33*).

Weinberg and Shanks (*42*) have reported that the manometer difference score (MDS), computed by subtracting IPR from EPR, is useful in distinguishing children with mild degrees of hypernasality. For this reason, a similar computation was made on the data available on the present subjects.

The point of flap attachment was specified by determining the relationship between the flap and the palatal plane as seen on lateral head x-rays taken of each patient in the rest position. If more than 75 percent of the vertical extent of the flap attachment to the posterior pharyngeal wall lay above the palatal plane, the flap was considered to lie above that plane. If more than 75 % of the vertical extent of the flap attachment lay below the palatal plane, the flap was considered to be below that plane. All other flaps were considered to lie at the palatal plane. On the average, the lateral head x-rays were made approximately 2 months before the speech samples were recorded.

Results

Post-Operative Complications. Recovery from surgery was totally uneventful in 45 (90 %) of the cases included for study here. One child had

some slight, initial difficulty with the oral intake of food which was overcome "slowly but steadily." Another patient experienced obstruction of the right nasolacrimal duct which was corrected subsequently without incident. Of the remaining three patients, two were found to have evidence of infiltrates in the lungs which were treated with no subsequent complications. The last child developed a persistent, increased temperature which apparently was due to a partial breakdown of the attachment of the pharyngeal flap to the soft palate. No immediate correction of the flap was attempted, and a revision of the flap had not been performed prior to the collection of data on this patient.

JUDGMENT RELIABILITY. The Kendall coefficient of concordance corrected for ties, which measures the relation among several rankings of N individuals, was used to assess inter-judge reliability (*30*). The degree of agreement among the four judges was found to be significant at greater than the .001 level of confidence for every one of the ratings which these judges made. For this reason, the average ratings of these judges are presented in the results reported here.

Intra-judge reliability was assessed by having each listener evaluate 10 of the subjects twice. A Spearman rank correlation coefficient between the first and second ratings of each parameter was determined for each judge. Although the correlations ranged in value from .20 to 1.00, the average correlation was .80, indicating a reasonably high positive relationship between the scores obtained on the first and second ratings.

SPEECH ASSESSMENT. The results of the listener judgments made in this investigation are summarized in Table 4. Sixty-two percent of the subjects were considered to have no discernible degree of nasality in their speech, while an additional 32 % were judged to manifest a degree of nasality which was considered inaudible to all but a trained observer. Only three subjects (6 %) were found to have a degree of nasality that the judges felt might

TABLE 4. Listener judgment ratings. The numerical ratings are defined in Table 2.

udgment	*1*		*2*		*3*		*4*		*5*		*6*	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
Overall hypernasality	31	62	16	32	3	6	—	—	—	—	N/A*	
Least hypernasality	45	90	5	10	—	—	—	—	—	—	N/A	
Most hypernasality	16	32	24	48	8	16	2	4	—	—	N/A	
Range of hypernasality	36	72	14	38	—	—	—	—	—	—	N/A	
Overall hyponasality	23	46	8	16	19	38	—	—	—	—	N/A	
Least hyponasality	29	58	21	42	—	—	—	—	—	—	N/A	
Most hyponasality	13	26	14	28	16	32	7	14	—	—	N/A	
Range of hyponasality	27	54	23	46	—	—	—	—	—	—	N/A	
Nasal emission	37	74	8	16	4	8	1	2	—	—	N/A	
Speech adequacy	—	—	27	54	15	30	6	12	2	4	—	—

* Not applicable

be perceptible to a layperson. One of these three patients had experienced a partial breakdown of the flap during the immediate post-operative period, as reported above. It should be noted that 20 % of the subjects did demonstrate an obvious degree of nasality in at least certain contexts (Table 4). Nevertheless, it seems justifiable to conclude, on the basis of the rating scale employed here, that 94 % of the subjects were left with no appreciable degree of nasality in their overall speech.

Bzoch (*6*) has shown that when a broad-based pharyngeal flap is constructed in anticipation of gradual size diminution over time, the patient's speech is quite denasal at first. The present group of patients was no exception in this regard. Nineteen subjects (38 %) were judged moderately denasal in their overall speech (Table 4). Of the remaining 31 subjects who were considered to have no appreciable degree of denasality in their speech, 30 had been operated two or more years prior to the time at which their speech was recorded for analysis. Eleven of the 19 patients who were judged to have a moderate degree of denasality in their overall speech had received a flap more than 5 years before the time of assessment. However, no consideration will be given to surgically narrowing the flap for any of these patients until they have undergone the pubertal growth spurt.

Although vocal quality might be expected to fluctuate as a function of numerous factors, including context, the range of hypernasality and/or hyponasality manifested by each subject in the present investigation was noticeably small (Table 4). Thirty-six subjects (72 %) did not vary more than one scale point between the least and the greatest degree of hypernasality manifested during the tape-recorded samples of their speech. The remaining 14 subjects (38 %) did not vary more than two scale points. A similar lack of range is observable in the ratings of hyponasality (Table 4).

It is not to be anticipated that adequate correction of the cleft necessarily will result in adequate speech. Nevertheless, 54 % of the cases studied here were judged to have speech that was normal for their age (Table 4). Thirty percent spoke in a manner that was mildly difficult to understand, while 12 % were considered moderately difficult to understand, with repetition of utterances being required occasionally. Two subjects (4 %) spoke in a manner that was markedly difficult to understand. No children were judged to be unintelligible on the taped samples of their speech. It is not without significance that, while the correlational analyses summarized in Table 6 revealed no significant relationship between the age at which surgery was performed (Surgage) and the adequacy of a child's speech (Speech Ad.), the two subjects whose speech was considered to be markedly difficult to understand were the two on whom surgery had been performed at the latest ages (8.42 and 6.25 years). Both of these cases first came to the Northwestern University Cleft Lip and Palate Institute approximately three months before the surgery was performed.

In discussing the scale for rating "intelligibility," which is termed "speech adequacy" in the present investigation, Subtelny, Van Hattum and Myers suggest that the six-point scale could be reduced to five "since only 1 % of

the speech samples were rated better than normal" (*37*, *25*). The results of the present investigation obviously support such a modification since the speech of none of the children was judged to be above age level.

CORRELATIONAL ANALYSES. Contingency coefficients or Spearman correlation coefficients for every possible pair of the 18 variables included for analysis in the present investigation are reported in Tables 5 and 6. The analyses reported in these tables reveal that, regardless of the way in which clefts were classified, there were no significant relationships between cleft type and any other variable. This suggests that the success of the operative procedure described here did not depend upon the severity of the cleft. This is particularly true since cleft width was never a factor in selecting patients for this operation.

Sex was not found to be consistently correlated with any of the other variables specified for analysis here. Such a finding concurs with the reports of other authors (*15*, *44*).

The age at which surgery was performed ranged between 1.5 and 8.4 years (median = 2.27 years). Eighty-two percent of the patients were operated before the age of 3. There was no significant relationship between the age at which the surgery was done and the degree of success, as measured by the parameters specified in Tables 5 and 6. Insofar as speech adequacy, as defined in Table 2, is reflective of articulation proficiency, it is anticipated that when the IPAT responses of these children are fully analyzed, the age at surgery will not be found to be highly correlated with a child's articulation skills. However, articulation proficiency is a particularly important factor which should be assessed directly before making any statements concerning the effect that surgical timing might have upon the final speech result. No such statement is possible at this time since the articulation analysis is incomplete to date.

The authors do not mean to suggest that it is unimportant to close the

TABLE 5. Correlations of ten of the variables specified for analysis in the present investigation. Expiratory (EPR) and Inspiratory (IPR) breath pressure ratios and manometer difference scores (MDS) were available on only 30 of the 50 subjects. Contingency coefficient values are presented as an expression of the correlation between sex, a nominal variable, and the other variables specified here. All other values in this table are Spearman correlation coefficients.

	Cleft (Veau)	*Cleft (1/3's)*	*Sex*	*Surgage*	*Tapeage*	*Postop.*	*EPR*	*IPR*	*MDS*	*Therdur.*
Cleft (Veau)		.79	.18	.21	.01	−.00	−.05	.07	−.12	.27
Cleft (1/3's)			.01	.07	−.05	−.07	−.20	.24	−.46	.16
Sex				.31	.32	.32	.35	.13	.69	.36
Surgage					.22	−.26	.26	.22	−.09	.28
Tapeage						.68**	.14	−.21	.43	.60**
Postop.							.08	−.38	.58*	.35
EPR								.23	.55	−.06
IPR									−.81**	−.32
MDS										.33

* $p < .01$.
** $p < .001$.

TABLE 6. Correlations of eight of the variables specified for analysis in the present investigation. Expiratory (EPR) and Inspiratory (IPR) breath pressure ratios and manometer difference scores (MDS) were available on only 30 of the 50 subjects. Contingency coefficient values are presented as an expression of the correlation between sex and T & A, nominal variables and the other variables specified here. All other values in this table are Spearman correlation coefficients.

	Pt. flap	*T & A*	*hyper.*	*range hyper.*	*hypo.*	*range hypo.*	*emmission*	*speech ad*
Cleft (Veau)	.13	.21	−.03	.04	.10	.06	−.04	−.24
Cleft (1/3's)	−.00	.30	−.10	−.04	−.05	.11	−.27	−.28
Sex	.03	.09	.11	.38	.21	.41	.19	.18
Surgage	−.35	.46	−.07	.06	−.06	−.08	.03	−.01
Tapeage	−.16	.30	.16	.21	−.22	−.23	.17	−.23
Postop.	.04	.48	.03	.01	−.22	−.14	.14	−.37*
EPR	−.06	.29	−.17	−.09	.16	.15	.01	.30
IPR	.04	.08	−.30	−.27	.32	.37	−.34	−.22
MDS	.04	.66	.26	.32	−.18	−.28	.32	.43
Therdur.	−.16	.21	.18	.32	−.24	−.28	.21	−.04
Pt. flap		.24	.07	.05	−.03	.06	−.05	−.07
T & A			.28	.32	.30	.48	.21	.28
Hyper.				.72**	−.48**	−.46**	.55**	.26
Range hyper.					−.51**	−.56**	.62**	.23
Hypo.						.85**	−.41*	.02
Range hypo.							−.48**	−.06
Emission								.35

* $p < .01$.
** $p < .001$.

palate at a reasonably early age. What does appear in the analyses reported here, however, is that surgery may be deferred beyond 18 months without serious consequences to speech if the surgery provides a good velopharyngeal mechanism once it is performed.

It was not surprising to find that the age at which a child's speech was recorded for analysis (Tape age) was not significantly related to his speech adequacy (Table 6) since the rating scale for speech adequacy was worded in such a way that the judges were asked to assess each child's speech on the basis of his chronological age and not on some absolute scale. The significant relationship between tape age and the duration of therapy (Therdur) is due to the fact that the older the child at the time of taping, the greater the number of years during which that child could have been in therapy. The fact that this correlation is not higher than it is ($r_s = .60$) is undoubtedly due to the fact that 16 subjects (32%) never received speech therapy.

There was a significant, negative correlation between the adequacy rating of each child's speech and the time lag between surgery and the time at which his speech was recorded for analysis (Postop). Such a relationship suggests that a child's speech becomes more normal for his age

as the number of years since his operation increases. Since the correlation between Postop and Therdur also approached significance ($p < .012$), it might seem reasonable to assume that the relation between improved speech adequacy and the number of years since surgery was due to the therapy received by the child after the operation. However, this supposition is not borne out since the correlation between the duration of therapy and speech adequacy is notably low ($r_s = -.04$). This would seem to suggest that when a given investigation demonstrates a change in speech adequacy ("intelligibility"), as a function of the duration of therapy, at least part of that improvement probably would have occurred even if the child had not been given therapy.

Several authors (*20, 42, 48, 49*) have reported that manometric measures are significantly related to perceptual ratings of hypernasality, even though such measures do not directly assess the same kind of velopharyngeal closure competence that is required for speech. It would appear from the results of the present investigation (Table 6) that none of the three manometric measures employed here have utility in assessing velopharyngeal competence in persons who have been operated upon in the manner described in this report.

The lack of a high degree of correlation between expiratory breath pressures ratios (EPR) and perceived hypernasality might have been anticipated since this measure is believed to differentiate persons with normal resonance or mild degrees of hypernasality from those with moderate to severe degrees of hypernasality, and only 6% of the cases reported here were judged moderately hypernasal. Inspiratory breath pressure ratios (IPR) are presumed to differentiate normals from children with any perceptible degree of hypernasality and manometric difference scores (MDS) presumably distinguish persons with mild hypernasality from those with normal resonance or moderate to severe hypernasality (*42*). If this were true of the cases studied here, IPR and MDS should both be highly correlated with ratings of hypernasality, and this was clearly not the case (Table 6).

Morris (*25*) suggests that the best measure of surgical success is the way in which the child responds to speech therapy. Insofar as speech adequacy is reflective of responsiveness to therapy, it could be said that the surgical procedure reported here was a failure since there was essentially no correlation between these two variables ($r_s = -.04$). However, this lack of relationship undoubtedly is due in large part to the fact that 32% of the subjects in this study never received speech therapy, presumably because they did not need it. Of the remaining 68%, 38% had received therapy which was terminated after a mean duration of 20 months (S.D. = 25.42 months). Since the speech of these 35 children (70%) was presumably normal or near-normal after therapy was terminated, if indeed they had ever received it at all, it is understandable that the number of months in therapy would not be highly correlated with judged speech adequacy.

Curtin *et al.* (*9*) have indicated their belief that careful closure of the donor site eliminates the tendency toward downward contracture of a pharyngeal flap. Despite the fact that the flaps raised during the procedure reported here were high-based superior flaps and considerable care was taken in closing the donor site, 22 subjects had flaps which were found to be attached to the posterior pharyngeal wall at a point below the palatal plane. It is possible that this discrepancy is due to the fact that the observations of Curtin *et al.* were made on cephalometric films taken eight months after surgery, while 18 of the 22 subjects discussed here were two or more years post-operative at the time lateral head plates were taken to assess flap position. Regardless of the reason for this discrepancy, no significant relationship was found to exist between the point of flap attachment and the perceived degree of hypernasality in the speech of the children investigated ($r_s = .07$). A similar lack of relationship has also been reported by Graham (*14*) and Subtelny (*36*).

Thirty-eight percent of the subjects in the present investigation had their tonsils and adenoids removed prior to primary nasopalatal pharyngoplasty while 62% did not. On the basis of the analyses reported in Tables 5 and 6, it seems justifiable to conclude that there is nothing to contraindicate the removal of this tissue before the palate is closed with the surgical procedure described here.

As might be expected, there is a significant tendency for hypernasality and hyponasality to be mutually exclusive within the speech of a single individual ($r_s = -.48$). However, the fact that the negative correlation between these two variables was not higher is *prime facie* evidence that, as has been suggested by Weatherly-White (*41*), these two vocal qualities can and do exist within the speech of a single speaker.

Discussion

The number of cleft palate patients achieving adequate velopharyngeal closure after initial palatal closure varies anywhere from "less than 50%" (*12*) to 95.8% (*3*, *23*) although "most plastic surgeons concede that about one-third of their patients . . . require secondary procedures to correct residual palatopharyngeal incompetence" (*47*, 451). Undoubtedly, this wide range is due in large part to differences of opinion concerning what constitutes "adequate" velopharyngeal functioning. It is obvious that there is a great need for standardization of the criteria used to define success. While the current authors do not presume to undertake such a task, a concerted effort has been made to clearly define the parameters employed to assess the speech of the children investigated here and to be specific about what is considered "success." To circumvent some of the other problems evident in previous reports of this kind in the literature, four, rather than 1 or 2, trained speech pathologists experienced in the assessment of cleft palate speech, were employed to evaluate each child's speech. Moreover, only two of these persons were affiliated with the Institute from

which the subjects were selected. This was done in an attempt to minimize any biases that might have arisen from employing judges who ostensibly had a vested interest in each patient's success. The high degree of inter-judge reliability suggests that such biases did not seriously affect the judgments made in the present study.

From an analysis of a summary of 24 reports provided by Yules and Chase (*47*, 458), it appears that approximately 5% of all cleft palate patients will never achieve successful surgical correction of velo-pharyngeal incompetence, regardless of the manner in which success is defined. These data refer to subjects on whom a primary closure of the palate was followed by a secondary pharyngeal flap. This failure rate is almost exactly the same as that reported in the present investigation, where 6% of the subjects were found to manifest a moderate degree of hypernasality after having received a single palatal operation.

Employing primary nasopalatal pharyngoplasty, as described here, reduces to one the number of palatal operations that a child will have to undergo to achieve a maximum degree of velopharyngeal adequacy. In addition, a primary procedure of the sort described here enables well over 90% of the patients to begin the process of speech sound learning at a relatively early age, unimpeded by residual velopharyngeal incompetency.

One recurrent criticism that has been raised concerning primary pharyngeal flap procedures is that approximately two-thirds of all patients would be operated upon unnecessarily. This presumes that the attending surgeon performs such operations without attempting to determine which patients would achieve adequate velopharyngeal closure with primary palatal closure alone. Such indiscriminate use is neither necessary nor desirable.

Among the patients in the present study, it appears that the only disadvantage to employing primary nasopalatal pharyngoplasty was that 22% were still moderately denasal 5 years after surgery. While this is not ideal, the authors believe that it is more acceptable than a situation in which 33% are hypernasal. This is particularly true since it is anticipated that most, if not all of these denasal patients will experience a normalization of their resonance during the pubertal growth spurt. However, it should be noted that this assumption is based on clinical impressions and has yet to be substantiated by systematic analysis.

Study Limitations. The patients on whom primary nasopalatal pharyngoplasty was performed do not represent a random sample of all cleft palate children seen at the Northwestern University Cleft Lip and Palate Institute during the period from October, 1961 and March, 1973. Rather, they constitute a population selected by the surgeon on the basis of his clinical impressions concerning the need for such an operation, once the team and the family agreed upon surgery as the treatment method of choice. Unfortunately, it is not possible at this time to report an objective specification of the manner in which the surgeon made this decision. It should be emphasized, however, that the subjects employed in the present

investigation do represent a random sample of those patients on whom this operation was performed.

Counihan and Cullinan (*8*) have reported that during the production of isolated vowels, an increase in production intensity results in an increase in the degree of perceived nasality when the playback intensity of the tape-recorded samples is not held constant. No specific procedures were employed during the taping of each child's speech in an attempt to control for production intensity nor was playback intensity held constant. However, it should be pointed out that the judgments of hypernasality made in the present investigation were not based solely upon isolated vowel productions, but were made after listening to a considerable number of varied speech tasks (Table 1).

Another possible limitation that should be noted is that no attempt was made to assess whether any of the children manifested obstructions within the nasal cavity. This omission might have had an effect upon the results reported here since such obstructions can reduce the degree of perceived nasality in a patient whose velopharyngeal closure is inadequate (*40*). With respect to this point, however, it is not without significance that there was no appreciable relationship found in the present study between the perceived degree of hypernasality or hyponasality of children who had their adenoids removed before palatal surgery and those who did not (Table 6).

Summary

The purpose of the present investigation was to assess the efficacy of a unique form of primary pharyngeal flap surgery performed by a single surgeon at the Northwestern University Cleft Lip and Palate Institute. The results of this study suggest that an exceptionally high percentage of velopharyngeal competency is obtained utilizing this procedure.

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