Pharyngeal Flap Surgery and Voice Quality-Factors Related to Success and Failure

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Introduction

Almost 100 years ago the pharyngeal flap procedure for surgical correction of palatal deficiencies appeared in the European literature. In 1865 Passavant (*5*) sutured the uvula to the posterior pharyngeal wall, initiating the use of the pharyngeal flap operation. Late in the 19th century, the pharyngeal flap operation fell into disrepute because of numerous failures. In 1924 it was revived by Rosenthal of Germany and was introduced in the United States in 1930 by Padgett (*2*). Since that date the pharyngeal flap has been used extensively as a secondary technique for the correction of palatopharyngeal incompetence.

Many investigators have studied the relationship between pharyngeal flap surgery and post operative reduction in hypernasality. Generally they report a speech success rate ranging from 100 percent to 66 percent (*2*). More recently, Owsley (*4*) reported that of 56 patients with a high, attached pharyngeal flap, 27 had satisfactory quality and 21 evidenced improvement with minimal nasality. Subtelny's (*8*) data on 60 subjects showed that approximately 80 percent of the patients had nearly normal voice quality.

The purpose of this paper was to investigate the effect of pharyngeal flap surgery on hypernasal voice quality. The following factors were investigated: 1. Pre and postoperative voice quality changes; 2. The relationship of postoperative reduction in hypernasality and (a) etiology of

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velopharyngeal insufficiency, (b) postoperative adequacies of the velopharyngeal sphincter mechanism as measured by the panendoscope, (c) operative age and (d) variations in surgical techniques.

Procedures

SUBJECTS. The participants in this study were 62 subjects who had undergone pharyngeal flap surgery at Montefiore Hospital and Medical Center, Bronx, N.Y. The population included 28 males and 34 females ranging in age from 3 to 37 years. The time lapse from surgery to this investigation ranged from 6 months to 10 years.

The subjects were divided into two groups. One group consisted of 38 patients who had pharyngeal flap surgery as a secondary procedure to correct residual velopharyngeal insufficiency after repair of a cleft palate. The second group consisted of 24 patients, who had pharyngeal flap surgery as a primary procedure to correct velopharyngeal insufficiency in the absence of an overt cleft palate.

SURGERY. Approximately 50 percent of the patients who had pharyngeal flap surgery responded to our request for re-examination. This may have resulted from the transient nature of the population and the fact that some came from long distances. Also, there were several patients who responded that they were satisfied with the results and saw no need for further examination or treatment.

All pharyngeal flaps were superiorly based and consisted of the entire width of the posterior pharyngeal wall. However, there were some important variations in the surgical techniques. In more than half of the pharyngeal flaps, the donor area on the posterior surface of the pharynx was closed by approximation. In the remaining cases, this area was allowed to heal spontaneously. In our opinion, this technical variation might have an effect on the postoperative course but not on the ultimate speech result. The main technical variables in the manner of attachment of the pharyngeal flap to the palate were arbitarily coded (A, B, C, D) as follows:

1. Procedure A. A small denuded area was created on the nasal surface along the posterior border of the soft palate, by forming a triangular mucosal flap based on the posterior border of the palate, with the apex of the flap pointed anteriorly. The flap was then reflected posteriorly and attached to the undersurface of the pharyngeal flap.

2. Procedure B. The posterior edge of the palate above the uvula was split from one anterior tonsillar pillar to the other. By deepening the incision between the oral and nasal mucosa, a cavity was created into which the pharyngeal flap was introduced like a "sandwich." The oral "lip" of the split incision was then sutured to the undersurface of the pharyngeal flap at its insertion on the pharyngeal wall.

3. Procedure C. The soft palate was split in the midline, thus permitting the flap to be based high in the nasal pharynx above the level of the palate. The pharyngeal flap was then inserted along the midline of the palate on the nasal side with its mucosal surface towards the nose. The

oral mucosa was approximated underneath it. In recent years this approach was modified by combining it with severance of the nasal mucosa and palatal aponeurosis along the posterior border of the hard palate and displacement of the palatal musculature posteriorly. The tip of the pharyngeal flap was spread fan-like to resurface the resulting raw area at the junction of the hard and soft palate.

4. Procedure D. The pharyngeal flap was combined with the standard pushback procedure, as recommended by Dorrance, without splitting the soft palate. The tip of the pharyngeal flap was then inserted, as in procedure C, covering the raw surface on the nasal side but the body of the pharyngeal flap was not incorporated into the palatal musculature.

PANENDESCOPY. Each subject was given a Taub oral panendescopic examination observing the velopharyngeal sphincter mechanism at rest and during phonation of "pɑ" (Pah). Each patient was examined to evaluate the appearance of the hard and soft palate, mobility of the soft palate and posterior pharyngeal walls, width of the pharyngeal flap, estimates in millimeters of the size of the lateral flap gutters, presence or absence of tonsils and adenoids, and the adequacy of the velopharyngeal closure. Inspection of the panendescopic data seen in Figure 1 suggested 7 cate-

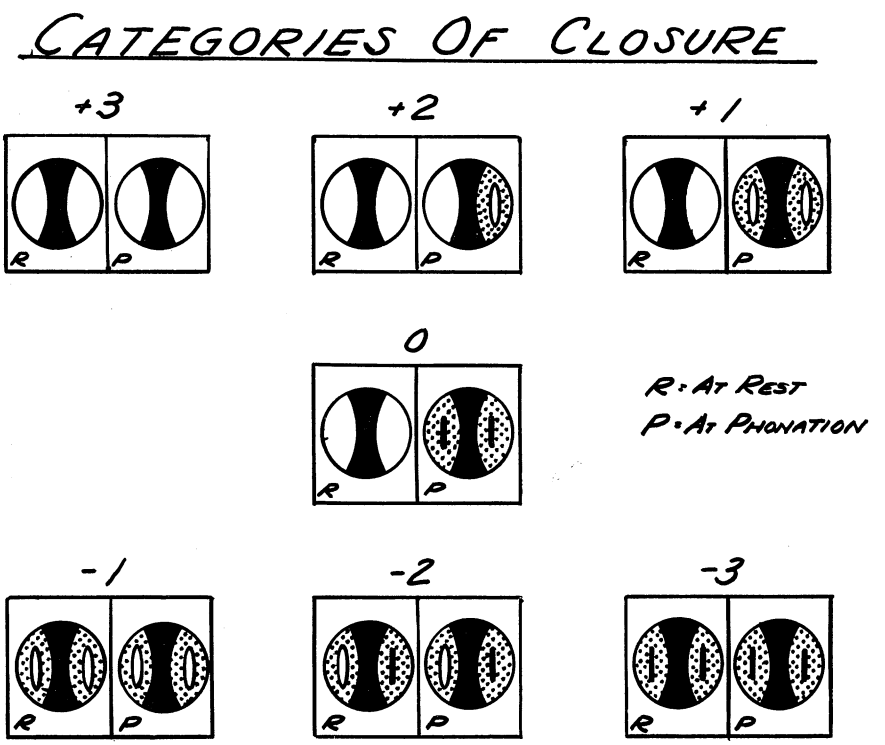

FIGURE 1. Categories of velopharyngeal closure of the lateral gutters in pharyngeal flap patients as viewed through the oral panendoscope.

gories of velopharyngeal closure as follows:

+3 Lateral apertures open at rest and during phonation.
+2 Lateral apertures open at rest, one remaining open at phonation and one achieving borderline closure at phonation.
+1 Lateral apertures open at rest, both achieving borderline closure at phonation.
0 Lateral apertures open at rest, both achieving firm closure at phonation.
−1 Both apertures achieving borderline closure at rest and during phonation.
−2 One aperture closed at rest, one achieving borderline closure, and during phonation remaining the same.
−3 Both apertures closed at rest and during phonation.

SPEECH. The speech examinations consisted of phonetic analyses of articulation errors using pictures, loaded sentences, and spontaneous speech, evaluations of intelligibility and nasal quality. Only the latter is discussed in this paper. Judgements of nasality were based primarily on samples of spontaneous speech.

Pre and postoperative tape recordings for each patient were randomized and assigned identifying numbers. Each voice sample was rated by 3 judges on a 7 point nasal resonance scale where plus 3 represented severe hypernasality; plus 2, moderate hypernasality; plus 1, mild hypernasality; 0 represented a normal voice quality; minus 1, represented mild hyponasality; minus 2, represented moderate hyponasality and minus 3 represented severe hyponasality. Interjudge reliability was .94. A rating of plus 1 or less for the postoperative tapes was regarded as a voice success.

Results

The distribution of preoperative and postoperative voice quality ratings are summarized in Table 1. It can be noted that all patients had a preoperative rating of +3 or +2, with the exception of one who was rated as +1. Postoperatively only 11 patients continued to have unacceptable voice quality ratings.

Table 2 shows the direction of the changes from pre to postoperative voice quality rating. Of the 47 subjects who were rated as having severe preoperative hypernasality only 3 showed no change in voice quality. The largest postoperative number fell into the normal or mild postoperative nasality group. Of the remaining 15 patients all but one showed substan-

TABLE 1. Distribution of pre and postoperative voice quality ratings.

	voice quality ratings							
	+3	*+2*	*+1*	*0*	*−1*	*−2*	*−3*	*total*
preoperative.....	47	14	1	0	0	0	0	N-62
postoperative.....	3	8	25	19	4	3	0	N-62

TABLE 2. Changes from pre to postoperative voice quality ratings.

Preoperative voice quality ratings	*postoperative voice quality ratings*						
	+3	*+2*	*+1*	*0*	*−1*	*−2*	*total*
+3	3	7	22	12	1	2	N-47
+2	0	1	4	5	3	1	N-14
+1	0	0	0	1	0	0	N-1

tial change. Seven subjects became hyponasal following surgery. Postoperative hyponasality has also been reported by Bzoch (*1*) and Subtelny, et al. (*8*).

Subjects were classified according to improvement or no improvement and success or failure in voice quality. Table 3 shows a comparison of these findings. Ninety-five percent of the population showed improvement in voice quality. Using normal or near normal voice quality as the criterion of success, 83 percent of the patients achieved this goal.

Table 4 summarizes the findings related to etiology of the velopharyn-

TABLE 3. A comparison of postoperative improvement and lack of improvement and postoperative success and failure in voice quality changes.

	N	*percent*
improvement	59	95
no improvement	3	5
success*	51	83
failure†	11	17

* Voice quality rating of +1 or less.
† Voice quality rating greater than +1.

TABLE 4. Etiology of velopharyngeal insufficiency and postoperative voice quality ratings.

subject group	*N*	*postoperative voice quality ratings*			
		*success**		*failures†*	
		N	*percent*	*N*	*percent*
cleft palate	38	28	72	10	28
non-cleft palate	24	23	96	1	04

* Voice quality rating of +1 or less.
† Voice quality rating greater than +1.

TABLE 5. Distribution of postoperative panendescopic ratings.

	panendescopic ratings						
	+3	*+2*	*+1*	*0*	*−1*	*−2*	*−3*
N	5	6	13	35	1	2	0

geal insufficiency and postoperative successful reduction in hypernasality. Of the 38 cleft palate patients, 28 achieved success and the remaining 10 were failures. Of the 24 non-cleft palate patients 23 achieved success and one was a failure.

Table 5 shows the distribution of postoperative panendescopic rating categories. Forty-nine patients or 79 percent of the population achieved either borderline or firm closure of both lateral apertures during phonation. Five patients showed no evidence of velopharyngeal closure during phonation and two patients showed evidence of over-obturation. The relationship between postoperative adequacy of the velopharyngeal sphincter mechanism and postoperative voice quality was investigated. Each subject's voice quality rating was correlated with his closure category as obtained by the oral panendescope. The correlation between voice quality and closure category was .87. A "T" test revealed that the correlation was significant at the .05 level, indicating that there was a positive relationship between the postoperative adequacy of the velopharyngeal sphincter mechanism and the postoperative voice quality.

The relationship between operative age and postoperative successful reduction in hypernasality is summarized in Table 6. Excellent results were obtained with all groups of patients under the age of 18. The success rate for these groups ranged from 83 percent to 100 percent. All five patients in the older age group, however, were rated as postoperative speech failures.

TABLE 6. Distribution of postoperative voice quality ratings according to operative age.

subject age group (yr)	*postoperative voice quality ratings*				
	N	*success**		*failures†*	
		N	*percent*	*N*	*percent*
2–4	3	3	100	0	0
5–8	29	24	83	5	17
9–12	18	17	94	1	6
15–17	7	7	100	0	0
18–37	5	0	0	5	100

* Voice quality rating of +1 or less.

† Voice quality rating greater than +1.

TABLE 7. Distribution of postoperative voice quality ratings according to type of surgical procedure.

type of surgical procedure	*N*	*success*		*failures*	
		N	*percent*	*N*	*percent*
A	5	5	100	0	0
B	23	19	79	4	21
C	29	23	74	6	26
D	4	3	75	1	25

The relationship between the variations in surgical techniques (the methods of attachment of the flap), and postoperative successful reduction in hypernasality is summarized in Table 7. With the B procedure (sandwich method) in a population of 23, 19 were rated as successes and 4 as failures; with the C procedure (high based with splitting of the palate) in a population of 29, 23 were rated as successes and 6 as failures. Reliable conclusions cannot be drawn for procedures A and D because of the small number of patients. Although the literature cites theoretical preferences for certain operative procedures, our data indicate that for the procedures B and C, the percentage of success was essentially the same.

Discussion

In reviewing the literature on pharyngeal flap surgery it is evident that there is a divergence of claims regarding the success of this operative procedure. The reported ratings of improvement of normalcy in speech vary from 66 percent to 100 percent. The inconsistencies in these findings may be attributed to several factors. There have been differences in the standards and methods of speech evaluations. The expertise of listeners have ranged from surgeons to speech pathologists to laymen and the criterion of success has ranged from improvement to normalcy. Subjective listener ratings in some cases have not been correlated with objective measures of anatomical function *i.e.* cineradiography, panendoscopy, airflow studies or electromyography.

Velopharyngeal insufficiency resulting from various etiologic factors have also accounted for differences in findings. Pharyngeal flaps were used: (a) as a primary procedure in the repair of cleft palate, (b) as a secondary procedure to correct the residual velopharyngeal insufficiency after repair of the cleft palate, and (c) for correction of velopharyngeal insufficiency in the absence of an overt cleft palate. In addition, the indications for pharyngeal flap surgery vary from surgeon to surgeon and clinic to clinic. In some centers, it is reserved for severe insufficiencies, relying on other procedures such as postpharyngeal implants and pushbacks for milder forms of insufficiencies. Some surgeons use the pharyngeal flap for practically all forms of secondary insufficiencies. With the increased number of reported successes of the pharyngeal flap operation,

the indications for this procedure have been extended and the standards for anticipated speech improvement increased. In recent years, the pharyngeal flap has been used for patients with minimal nasality or mild velopharyngeal insufficiency. At the same time, because of its popularity, some surgeons have utilized this procedure to reduce nasality in children with mental and/or physical handicaps.

Our study substantiates the reports of previous investigators that pharyngeal flap surgery is an effective procedure in the reduction of hypernasality. A survey of clinical results of investigations of the past 10 years, *(2)* using improvement in voice quality as the criterion of success, shows improvement in approximately 87 percent of the cases. If we compare our findings with those of previous investigators, who used improvement in voice quality as the criterion, our findings would show 95 percent success in our population. However, as the goal of pharyngeal flap surgery, in our opinion, is normalcy or near normalcy in voice quality, we defined success as a rating of not greater than one. Using this higher standard of success, 51 of 62 patients or 83 percent of our population achieved this goal.

Prior to this investigation it was anticipated that there would be a higher degree of success with the non-cleft palate group, involving patients with unoperated palates. A large number of the patients in this group had normal speech and developed hypernasality following a tonsilectomy and an adenoidectomy. Our findings of 96 percent success in the non-cleft palate group and 72 percent success in the cleft palate group substantiates our original hypothesis.

In reviewing the 10 speech failures from the cleft palate group it was noted that: 5 patients had excessively scarred and short palates; one had cerebral palsy; one had minimal brain dysfunction; one had severe cardiac anomolies, having spent the first 10 years of life with minimal cardiac reserve and presently functioning at a retarded level, and one had a severe emotional disturbance and delayed language development. In the non-cleft palate group the one failure had cerebral palsy.

Previous investigators have indicated that the best results have been achieved with younger age groups (3, 7). Although the findings of this study generally concur, it appears that there may be contributing factors other than age. Investigation of the data indicated that the failures fell into 2 age groups (5–8 and 18–37). Closer investigation of the patients in the younger age group revealed that each had a multiplicity of additional handicaps. The older age group had 100 percent failure and these findings confirmed the general concept that speech results after pharyngeal flap operation in older patients are unsatisfactory. However, these results cannot be attributed to age alone. All 5 cases over 18 years of age had original palatal repair 16 to 35 years ago with residual velopharyngeal insufficiency. All showed unusual amounts of palatal mutilation rarely seen in the more recently repaired palates. It is therefore apparent that operative age alone is not a determinant of success.

The Taub Oral Panendoscope is an effective clinical tool in the assessment of velopharyngeal function. The panendoscopic data showed a high degree of correlation with the voice quality ratings. Additional research utilizing the nasal optic fiberscope and base view cineflurograms (*6*) will be helpful to corroborate the findings of this study regarding the correlation of velopharyngeal function and voice quality.

Changing concepts in pharyngeal flap surgery have resulted in multiple surgical modifications of this procedure. These modifications have been largely based on theoretical consideration and subjective preference of the surgeon and have rarely been based on hard data which would objectively establish the superiority of one method over the other. For example, Skoog (*7*) reported that the results from the superiorally based and inferiorally based pharyngeal flaps are comparable, whereas Owsley (*4*) claimed, on the basis of his own material, that a highly based superior flap offers better results than a lower pedicled superiorally based flap. The findings in this study indicate that essentially the same speech results were obtained with each of the four different surgical procedures.

It can, therefore, be concluded that the pharyngeal flap is a highly effective procedure in reducing hypernasality. In a cooperative patient, without extreme mutilation and scarring of the palate and in the absence of severe emotional or neurological deficit, a normal voice quality may be expected. This applies both to cases of velopharyngeal insufficiency after previous palatal repair and to primary insufficiency without overt cleft palate, such as submucous cleft and velopharyngeal disproportion. Substantial improvement in voice quality may be obtained in cases of velopharyngeal insufficiency associated with emotional, intellectual or neurological handicaps but normal voice quality frequently cannot be reached. If the pharyngeal flap is used on patients with such additional handicaps a higher risk factor must be expected.

Summary

This study involved voice quality and panendoscopic evaluations of 62 cleft palate and non-cleft palate patients aged 3 to 37 years. The study was designed to take into account several variables which may have direct bearing on the interpretation of the data obtained.

The following findings and conclusions are drawn from the data:

1. Pharyngeal flap surgery, when indicated, is an effective surgical procedure in the reduction of hypernasality. Normal voice quality was achieved by 83 percent of the patients.

2. There was a relationship between etiology of velopharyngeal insufficiency and postoperative reduction in hypernasality. Of the 38 cleft palate patients, 28 achieved success and the remaining 10 were failures. Of the 24 non-cleft palate patients 23 achieved success and one was a failure.

3. There was a positive relationship between the postoperative ade-

quacy of the velopharyngeal sphincter mechanism, as revealed by the Taub Oral Panendoscope, and the postoperative voice quality.

4. There was a relationship between operative age and postoperative reduction in hypernasality but it was concluded that operative age alone was not a determinant of success.

5. In superiorly based pharyngeal flaps, using 4 different surgical techniques of attachment, the percentage of success in the reduction of hypernasality was essentially the same for each operative technique.

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References

1. Bzoch, K., The effects of a specific pharyngeal flap operation upon the speech of forty cleft palate persons. *J.S.H.D., 29,* 111–121, 1964.
2. Grabb, W., S. Rosenstein, and K. Bzoch, *Cleft Lip and Palate.* Boston: Little, Brown and Co., 1971, 451–489.
3. Moll, K., W. Kuffman, D. Lierle, and J. Smith, Factors related to the success of pharyngeal flap procedures. *Plast. Reconstr. Surg., 32,* 581–588, 1963.
4. Owsley, J. et al, Speech results from high attached pharyngeal flap operation, *C.P.J., 7,* 306-317, 1970.
5. Passavant, G., Ueber die verbesserung der schprache nach der uranoplastik. *Deutsch, Gessellschaft Chir., 7,* 128–187.
6. Skolnick, M. Videofluorascopic examination of the velopharyngeal portal during phonation in lateral and base projections—a new technique for studying the mechanics of closure. *C.P.J., 7,* 803–816, 1970.
7. Skoog, T., The pharyngeal flap operation in cleft palate: A clinical study of eighty-two cases. *Brit. J. Plast. Surg., 18,* 265–282, 1965.
8. Subtelny, Joanne et al, Speech, intraoral air pressure, nasal air-flow before and after pharyngeal flap surgery. *C.P.J., 7,* 68–90, 1970.
9. Taub, S., The Taub oral panendoscope: A new technique. *C.P.J., 3,* 328–346, 1966.