The Evaluation and Management of Velopharyngeal Insufficiency

HARRY J. BUNCKE, Jr., M.D.
PATRICIA PAGE, L. C.St.
BARBARA PRICE, M.A.
CAROL BLAZINE, M.A.
FREDA FRASER, B.A.
San Mateo, California

During the past six years, a longitudinal study has been performed on 18 patients with velopharyngeal insufficiency referred for speech therapy to the Rehabilitation and Research Center of the San Mateo Society for Crippled Children and Adults. Of these, 10 were repaired cleft palate cases and eight had cleft palate speech in the absence of overt clefts. The study was begun in order to determine the best procedure to be used to assist these patients in obtaining as normal speech as possible.

Early in the project, a questionnaire concerning information about clinical management was sent to 40 cleft palate centers throughout the United States and Europe. Twenty responses were received and the information in them was used in formulating a rather detailed cleft palate evaluation form and to organize a standardized routine.

Techniques

Velopharyngeal insufficiency was assessed by the following methods: intraoral examination, speech evaluation, manometric studies, and lateral x-rays of the skull (*2, 3, 4, 10, 18, 19, 21, 22, 25*).

INTRAORAL EXAMINATION. The following features were noted: hard palate—width, degree of arching, fistulae and scarring, and bony defect; soft palate—length, mobility, fistulae, scarring, degree of velopharyngeal closure on the production of *AH*, and levator dimple; and pharynx—width, depth, mobility of walls, tonsil status, and scarring.

SPEECH EVALUATION. Each speech evaluation included a case history, oral examination, hearing test, and evaluation of language and articulation ability. The Templin-Darley articulation test (*24*) was administered and, where possible, reading and conversational samples were ob-

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Dr. Buncke is Clinical Instructor of Surgery at Stanford University Medical School, and Mrs. Page, Mrs. Price, Miss Blazine, and Miss Fraser are the speech therapy staff, Rehabilitation Research Center of the San Mateo Society for Crippled Children and Adults, Burlingame, California.

This paper was presented at the 1964 Convention of the American Cleft Palate Association, Los Angeles, California.

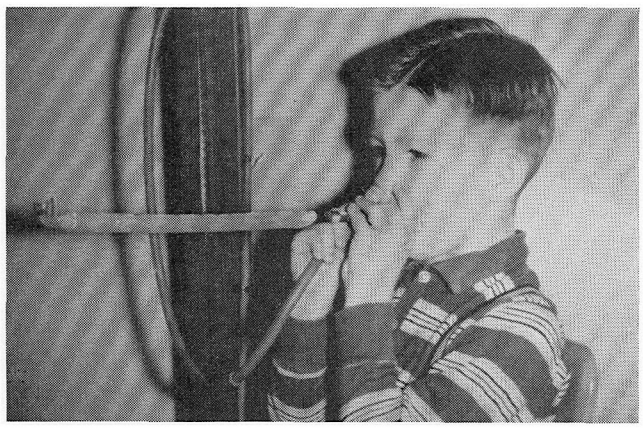

FIGURE 1. Technique for measuring nasal escape on maximum effort. The carnival blower and needle vent in the manometer tubing prevent the patient from building up oral pressures between the tongue and cheeks.

tained. Tape recordings were made frequently during evaluation and treatment. The Ammons (*1*) test and the Peabody (*9*) tests were aids in assessment of language ability. In some cases, results from psychometric evaluations were used.

Articulation errors were carefully analyzed and special attention was paid to the use of glottal stops and pharyngeal fricatives. Evidence of nasal escape on individual sounds was supported by manometric readings. A consensus of judgment on the severity of nasal tone in the overall speech pattern was obtained from at least three speech therapists. For purposes of comparison, each case was graded as follows: a judgment of Type I indicated normal speech, no nasality or overt articulation defects; Type II indicated stigmatized speech; and Type III indicated unintelligible speech. On re-evaluation, the same tests were repeated. Comparisons to assess progress were made with the earlier tests and tape recordings.

MANOMETRIC STUDIES. Intraoral and intranasal pressure studies were performed, using a glass tube water manometer with an 85 cm scale. Nasal escape was measured by placing a wax-covered plug attached by a rubber tube to the manometer in one nostril and occluding the other nostril while the patient blew out a carnival blower. The rubber tubing was vented with an 18 gauge hypodermic needle (Figure 1).

A reading for nasal escape of over 3 cm of pressure was considered to indicate velopharyngeal insufficiency. Maximum intraoral pressure was then measured with the patient blowing directly into the tubing, first with nostrils open, then with both nostrils occluded. A higher reading with nostrils closed was also presumed to indicate velopharyngeal insufficiency. It is well known that one can produce elevated intraoral pressure by blocking off the pharynx with the tongue, building up pressure

between the cheeks. This is one of the objections to closed-system manometry (*10*). However, venting the system with the hypodermic needle prevents the patient from building up and sustaining a pressure in this manner.

Intranasal pressure studies were then recorded for a series of test sounds and phrases (for example, *Coca Cola* and *Sister Susie's sewing shirts for soldiers*). The *S, SH, CH, P,* and *K* sounds were found to give the highest readings in the presence of velopharyngeal insufficiency.

Subjects were instructed to articulate the speech sounds, particularly the *S, T, SH, CH,* and *K*, with correct teeth and tongue placement and to make every effort to produce frontal oral breath pressure during the articulation testing. If any of these sounds were replaced by glottal stops or pharyngeal fricatives, which do not have forward breath direction, then, typically, they do not show nasal escape on manometric studies. Similarly, many of the subjects articulate the alveolar consonants with the teeth apart, thus disseminating an already weak oral breath pressure and producing a concomitantly lower nasal pressure. After receiving speech therapy, the patient may have learned the correct placement and oral breath pressure for these sounds, which would show more nasality on subsequent manometric studies than had been evident at the first evaluation.

Lateral Head X-Ray Films. Three lateral head x-ray films of the skull were taken, one film with the patient breathing through his nose, one film with him saying a prolonged *S* sound, and a third one during forced oral expiration. Failure to obliterate the nasopharyngeal shadow was considered evidence of velopharyngeal insufficiency (*6, 15*).

Procedures

An initial evaluation was made on each patient using the preceding techniques. This was followed by at least six months of speech therapy consisting of twice-weekly individual sessions and complemented by a home program. During therapy, standard procedures were followed to increase oral breath pressure and to decrease nasality on blowing and on individual sounds. The patients were taught to recognize oral breath pressure by tactile methods. Mirror work was used to establish correct phonetic placement of sounds. Tape recordings were also used to help the patient monitor his own speech as the corrected sounds were introduced into words and into connected speech.

Therapy was followed by a second evaluation duplicating the methods used in the first evaluation. If this indicated that the patients had failed to make progress, then the referring physician was advised that further surgery or additional consultation should be considered. Eight patients were referred by their physicians to the Cleft Palate Panels at Stanford University or the University of California for further consultation. There,

they were assessed by the full panel following cinefluorographic studies and in six of the eight cases further surgery was advised.

Results

The cases were grouped for the study in the following way: *Group A.* Eleven patients underwent secondary velopharyngeal surgical procedures during the course of this study. Before surgery, all patients manometrically showed velopharyngeal insufficiency on blowing and test sounds. Two patients gained closure on blowing after a year of speech therapy. All eleven individuals were able to achieve closure on blowing and test sounds following secondary surgery and speech therapy. For three patients the pre-operative x-ray studies revealed velopharyngeal closure, while the manometric studies showed evidence of nasal escape, once again pointing out that these film studies represent a sagittal plane analysis of three dimensional contact (*5, 15*). Seven cases were converted to Type I speech. Of the remaining cases in Group A, three have improved from Type III to Type II. *Group B.* Four patients were seen for the first time after secondary velopharyngeal surgery had been performed. One was discharged after a year of speech therapy, having achieved Type I speech. The second and third patients had velopharyngeal closure on blowing. One of them had closure on test sounds also. Both are making satisfactory progress. The fourth case had received years of speech therapy after a pushback procedure and although his x-rays revealed closure on blowing, manometry still shows nasal escape. *Group C.* Three patients have received speech therapy alone. The first is making continued progress and will probably gain Type I speech with time. The second case is a complex problem of nasal obstruction, maxillary hypoplasia, poor muscular coordination, and shows velopharyngeal insufficiency on manometry but closure on x-ray films. It is interesting to note that in this instance, velopharyngeal contact is made against a well-defined Passavant's ridge (Figure 2). Cinefluorographic studies reveal inconsistent contact during speech, and bear out Calnan's premise that Passavant's ridge does not function during continuous speech (*7*). The third subject in that group is also something of an enigma, since he is responding slowly to speech therapy. Velopharyngeal closure is evidenced on blowing by manometry and x-ray films but is incomplete on test sounds (Figure 3). Again, cinefluorographic studies reveal inconsistent velopharyngeal closure with speech.

Eight of the subjects in this series had submucous clefts, or cleft palate speech in the absence of visible anatomical defects (*1, 20*). Five had undergone adenotonsillectomies. The speech problem developed after the operation in two instances, and was made worse by the operation in another instance (*14, 23*). Five of the eight patients underwent a pushback and pharyngeal flap operation. Four gained Type I speech with postoperative therapy and the remaining one is making good progress.

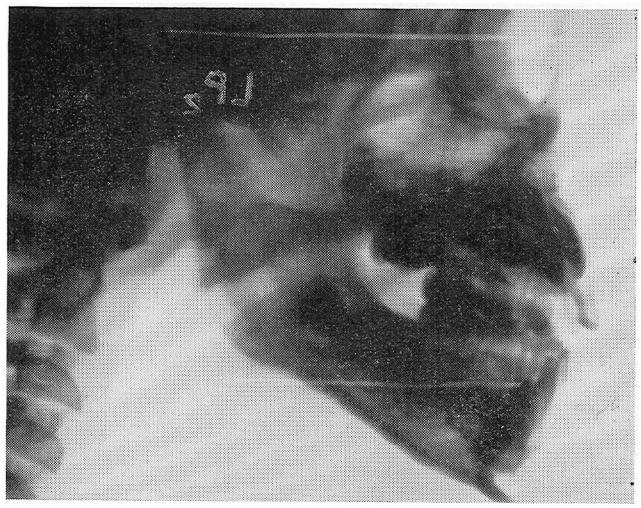

FIGURE 2. Velopharyngeal closure against Passavant's ridge on blowing and isolated sounds. This disappeared during continuous speech.

Discussion

The evaluation techniques described were used to decide which cases could be rehabilitated with speech therapy only, and which would need surgery to supplement speech therapy. It seems reasonable to state that patients who have failed to respond to a concerted program of speech therapy and have manometric and x-ray film evidence of inadequate velopharyngeal closure on blowing and phonation should be considered for secondary surgical procedures at an early age, perhaps at age five or six (*13, 14*). After an intensive course of speech therapy, it is not unusual for a patient to acquire velopharyngeal closure on blowing or effort but still be incompetent on the test sounds. In spite of this apparent improvement, a plateau may have been reached and surgery must be considered. That situation may still prevail after secondary surgical procedures. However, improvements in operative technique and design may salvage some of these failures. Two patients in this series have had more than one velopharyngeal procedure, and four others may yet fall in this category.

Three patients in this series failed to respond to the pushback procedure used alone (*14*). The first was converted to normal speech by subsequent combined pushback and pharyngeal flap, the second was greatly improved by the pharyngeal flap in isolation, and the third still has grossly stigmatized speech.

Four out of five pharyngeal flaps studied had normal or near normal speech (*12, 26*). One patient still has velopharyngeal incompetence on test sounds. The pharynx is wide and deep and the flap is unusually tight.

Mild degrees of velopharyngeal insufficiency may respond to posterior pharyngeal wall implants (*16*). More severe cases merit maximum

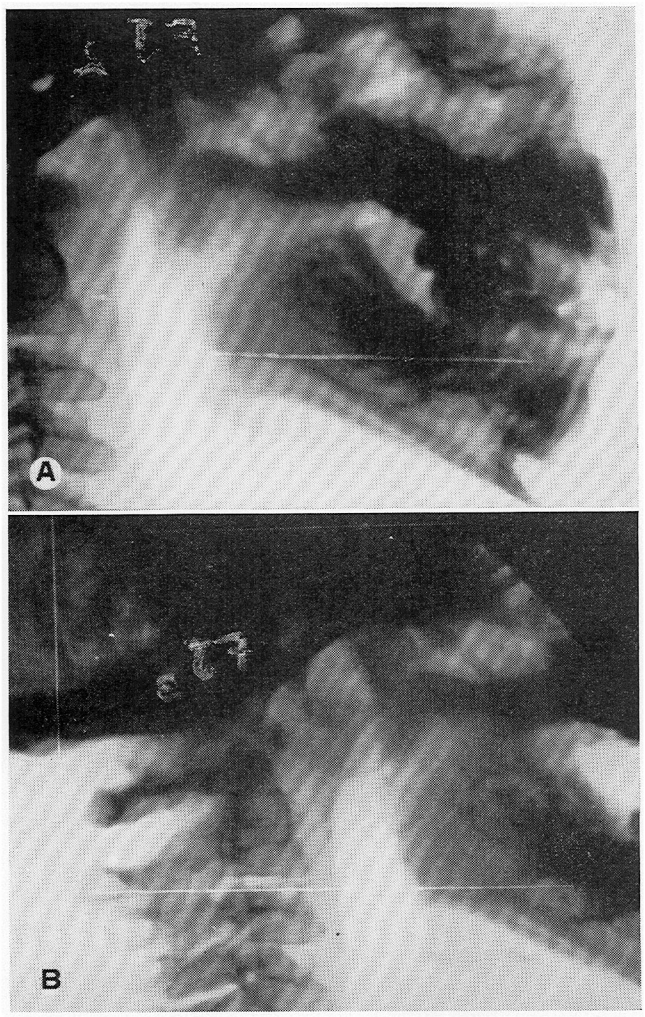

FIGURE 3. Left, mild degree of velopharyngeal insufficiency on test sounds. Right, same case demonstrating velopharyngeal closure on effort.

surgical effort in the form of the combined pushback and pharyngeal flap (*11*). The use of a superiorly based posterior pharyngeal flap to line the raw areas on the nasal surface of the retro-displaced palate seems most logical (*17*). If the point of attachment of the flap is placed in the dynamic middle third of the palate, the normal physiological relationships for velopharyngeal contact so carefully described by Calnan (*7, 8*) can be recreated. Figure 4 illustrates how this can be accomplished by creating a long flap of nasal mucosa extending from the posterior border of the hard palate. The end of the superiorly based pharyngeal flap is sutured to this nasal mucosal flap and to the defect in the central third of

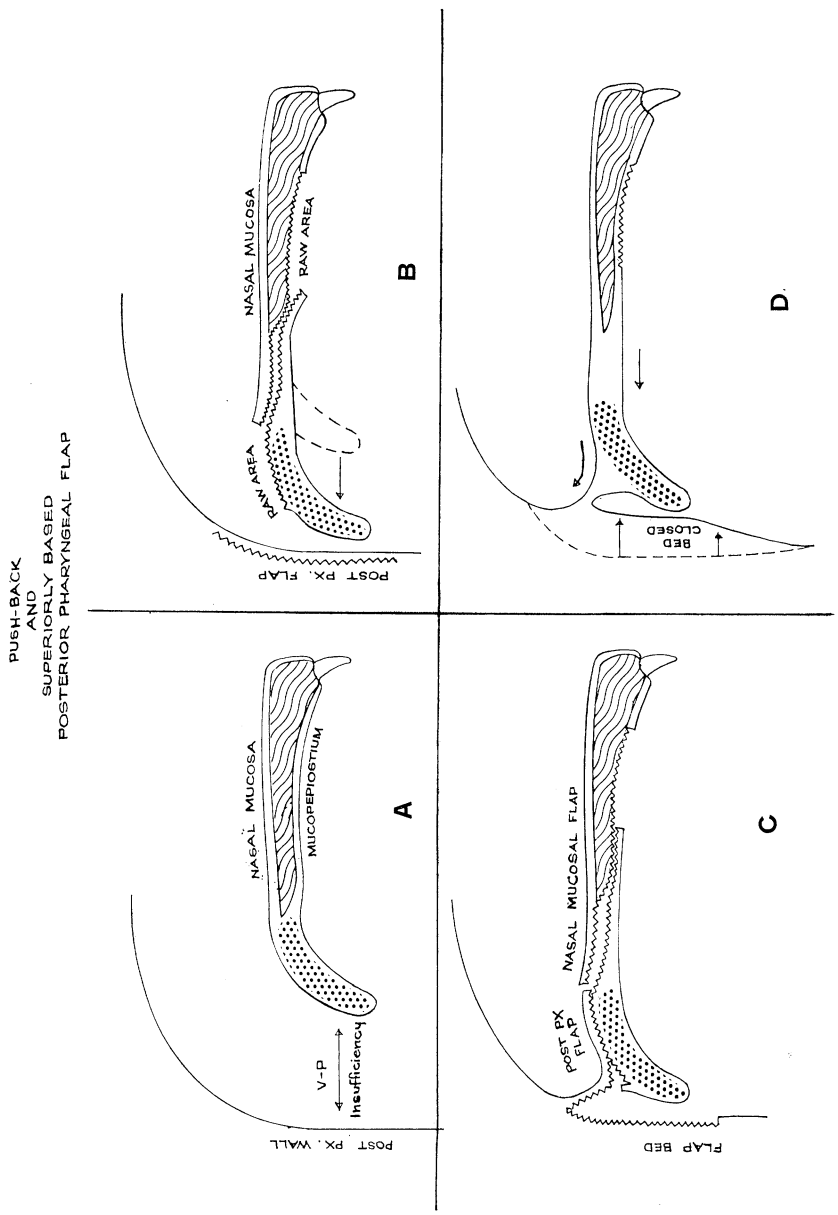

FIGURE 4. A. Sagittal section through the midline of the oronasopharynx. B. Wardill palatal flaps have been elevated and the dissection carried submucosally on the nasal surface of the soft palate to the region of the middle third where a transverse incision releases the soft palate for retrodisplacement. C. A superiorly based posterior pharyngeal flap has been raised and inset into the raw area on the nasal surface of the middle third of the soft palate. D. Healed result. The dynamic middle third of the soft palate is pulled posteriorly and superiorly.

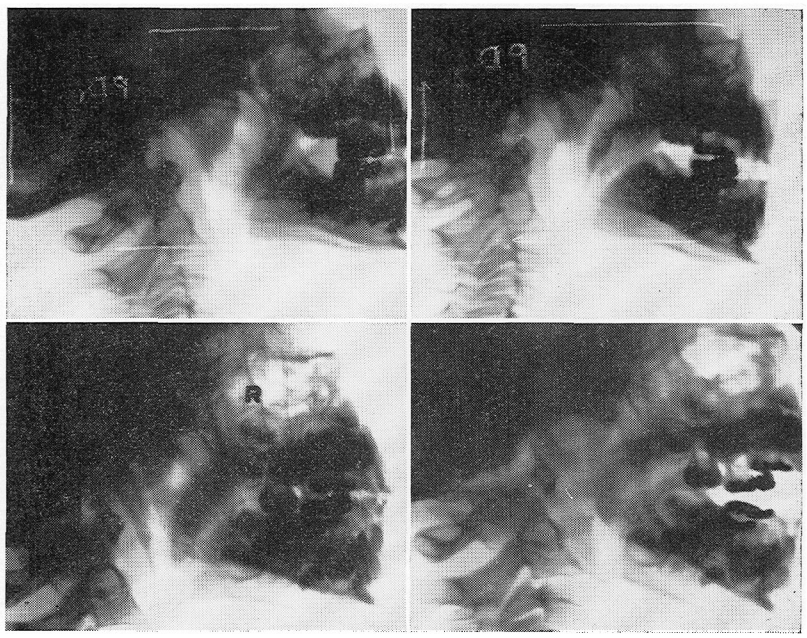

FIGURE 5. Each photograph is the same patient. Upper left, pre-operative palate at rest. Upper right, post-operative palate at rest. (Note decrease in velopharyngeal space.) Lower left, pre-operative velopharyngeal incompetence during prolonged *S* sound. Lower right, post-operative wide, high velopharyngeal contact on prolonged *S* sound.

the soft palate. The base of the flap is kept high, above the level of the hard palate between the Eustachian tube openings, and the donor defect is closed. Raw areas are thus kept to a minimum. Any contraction in the pharyngeal flap tends to pull the soft palate superiorly and posteriorly toward the point of normal velopharyngeal contact. The pre- and post-operative lateral skull x-ray films in Figure 5 depict the improvement in velopharyngeal contact produced by such a combined procedure. Similar results have been achieved in six patients to date.

Summary

A longitudinal study of 18 cases of velopharyngeal insufficiency is presented. The coordinated effort of speech therapy and secondary surgery is evaluated by a standardized diagnostic routine consisting of examination of the palate, speech evaluation, manometric studies, and lateral x-ray films of the skull.

39 North San Mateo Drive
San Mateo, California

Acknowledgment: The authors wish to express their appreciation to Charles M. Stern, Administrator of the Rehabilitation Center of the San

Mateo Society for Crippled Children and Adults for his encouragement, continued support, and direction throughout the entire study.

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