Velopharyngeal Physiology After Pharyngeal Flap Surgery as Assessed by Oral Endoscopy

DANIEL H. ZWITMAN, Ph.D. Los Angeles, California 90024

The velopharyngeal structures involved in port closure subsequent to pharyngeal flap surgery were examined endoscopically. Observations revealed that lateral wall, posterolateral wall and velar movement closed the pharyngeal ports, although the degree of involvement of each of the structures varied among patients.

KEY WORDS: Velopharyngeal physiology, pharyngeal flap

Pharyngeal flap surgery is the most frequently utilized secondary procedure to correct velopharyngeal incompetence. Although many individuals are successfully treated with this surgery, a considerable number remain hypernasal post-operatively. Yules et al. (1971) reviewed the literature on pharyngeal flap failure and found the reported rate to range between 3 and 29 percent. Pharyngeal flap surgery provides for apertures on each side of the flap for breathing, speech and postnasal drainage. The function of lateral wall movement in occluding these pharyngeal ports during speech has been discussed thoroughly by Skolnick and McCall (1972). However, as important as lateral wall motion is to the closure of the pharyngeal port, posterolateral wall motion as well as velar elevation should also be considered as part of the closure pattern.

VELOPHARYNGEAL DYNAMICS PRIOR TO PHARYNGEAL FLAP SURGERY

Our study of the unoperated velopharynx revealed that posterolateral wall and lateral wall motion were two separate movements clearly differentiated during speech by a hairline fissure which appeared between the most anterior lateral aspect of the posterolateral wall and posterior aspect of the lateral pharyngeal wall (salpingopharyngeal fold) (Figure 1). Posterolateral wall, as referred to here, is commonly referred to elsewhere as Passavant's ridge. It has two aspects. Most of the ridge is formed along the posterior pharyngeal wall, and this forward bulging, seen by lateral radiography, is usually described when referring to this structure. However, the posterolateral wall is a semi-circular formation that has lateral aspects along the sides of the pharynx just behind the salpingopharyngeal folds.

Our investigative results of separate posterolateral wall and lateral wall motion are contrary to previous findings using fluoroscopy that consolidated pharyngeal wall movement (Skolnick *et al.* 1973; Glaser *et al.* 1979). Nevertheless, observations of a demarcation between the pharyngeal walls were made consistently, and we suspect this fine distinction was not delineated in the "shadows" of fluoroscopy. The finding of separate structures is important to our understanding of velopharyngeal dynamics and it was anticipated that it would provide additional insight into function of the velopharyngeal sphincter after pharyngeal flap surgery.

The purpose of this study was to observe endoscopically the interaction of posterolateral and lateral wall motion and velar elevation after pharyngeal flap surgery to delineate the action of each in port closure.

Method

The pharyngeal ports of eighteen patients with normal nasal resonance were examined at least six months after pharyngeal flap sur-

Dr. Zwitman is affiliated with the University of California at Los Angeles. Address correspondence to: Daniel H. Zwitman, Ph.D., UCLA School of Medicine, 62-202 CHS, 10833 LeConte Avenue, Los Angeles, California 90024.



FIGURE 1. Velopharyngeal closure in progress with significant lateral and posterolateral wall motion (a posterolateral wall (Passavant's Ridge), b—lateral wall, c—velum, d—posterior pharyngeal wall).

gery using an inverted oral endoscope. Patients were selected whose pre-surgical examination or case history revealed lateral wall motion at least up to and frequently past the lateral recesses of the pharynx, and posterolateral wall displacement at the level of the velum. This selection process was necessary to insure that posterolateral wall motion was present in all of our subjects so that its movement could be studied in depth.

Most patients had one of two operations. The flap was raised similarly but in five cases the flap was sutured to the nasal surface of the velum and a nasal velar flap was used to line the flap. In five patients, the flap was brought through the velum after making a coronal incision through the soft palate about 1½ cm. from the free margin. The flap, always superiorly based, was then sutured to the oral surface of the palate. In four patients the flap was sutured to the nasal surface of the velum without flap lining. No surgical report was available on another four patients.

The oral endoscope used in this study has a small diameter ranging from 6 mm. to 9 mm. depending on which scope model is utilized-model 8700D or 8702D, Storz, Co., Los Angeles. A 1:1 ratio exists between the actual object and the visualized image for focal distances up to 30 mm. During examination, the scope is approximately 30 mm. from velopharyngeal closure and structures can be studied near their actual size. The tube of the scope is 21 cm. long and was passed into the mouth behind the uvula. A three-dimensional indepth view into the nasopharyngeal ports was obtained while subjects said the phrase "a papa pup". This phrase was used because /p/ cannot usually be produced normally without velopharyngeal competence and the vowels require the tongue to be positioned low in the mouth. During the endoscopic exam, each subject's production of the phrase was monitored by the examiner to insure that voice quality was similar to that in his conversational speech.

Films of the velopharynx were obtained at 16 fps. by attaching the scope to a Beaulieu R16 motion picture camera by means of a Storz Robot clamp. A viewing projector with a stop frame feature was subsequently utilized to examine the films (LW Photo Optical Data Analyzer Model 22 4K MK II).

Results

Oral endoscopic observations of the velopharynx after pharyngeal flap surgery revealed that the mobile structures surrounding each port consisted of the posterolateral pharynx, the lateral pharyngeal walls, and the posterior aspect of the velum. During phona-



FIGURE 2. Velopharyngeal port after pharyngeal flap surgery (v-velum; p-posterolateral wall; L-lateral pharyngeal wall).

tion the following velopharyngeal dynamics were identified:

- 1. As might be expected, both the apparent size of the ports and the amount of tissue displacement varied during phonation among patients.
- 2. Port closure was accomplished by one or more of three physiological processes (Figure 2):
 - a. The *velum*, in an already attached and elevated position, frequently moved somewhat further posteriorly during phonation. The most lateral aspect of the velum narrowed the pharyngeal port; however, posterior movement was limited to 2–3 millimeters and was observed to be most prominent when lateral wall motion was absent.
 - b. The *posterolateral pharynx* moved slightly anteriorly and met the velum or combined with the lateral walls to complete closure of the port. It seemed likely that the middle posterior section of the posterolateral wall now composed part of the pharyngeal flap, and that it was only the lateral aspect of the posterolateral wall that continued to move anteriorly and medially closing the pharyngeal port to various degrees.
 - c. The *lateral pharyngeal walls* moved medially, filling all or part of the port.

Subjects demonstrating similar velopharyangeal movements were grouped together. All three muscular structures were active together in five individuals; posterolateral and lateral wall motion was observed in three; and lateral motion only was seen in three. Velar and posterolateral wall motion closed the ports in four subjects. One person occluded the velopharyngeal ports by posterolateral wall motion only. Two had posterolateral and lateral wall motion in one port but had lateral wall motion in the other.

Discussion

The crescent constriction of the posterolateral walls and medial movement of the lateral walls have been visualized by this author as two independent sphincteric actions in the unoperated velopharynx, and each movement may be present in the absence of the other.

After pharyngeal flap surgery, the importance of posterolateral wall motion should not

be underestimated, for it appears to contribute significantly to port closure in some patients, and may be a primary adductor when mesial lateral pharyngeal wall movement is minimal or absent. Its importance increases with the degree of elevation and movement of the soft palate after flap surgery. If the pharyngeal flap lifts the soft palate so that it is in close proximity to the posterior pharyngeal wall, anterior movement of the wall may contribute significantly to port closure. Similarly, the slight but often discernible upward and backward velar movement gains significance depending upon the final proximity of the soft palate to the posterior pharyngeal wall. In cases where lateral wall motion is absent, port closure may be accomplished solely by approximation of the posterolateral pharyngeal wall and remaining velar movement.

As previously mentioned in this paper, the posterolateral wall is a semi-circular formation that has posterior and lateral aspects. The lateral aspects of the ridge can continue to contract even after the posterior section of the ridge has been excised as part of the flap. In one patient, only the lateral aspect of what might be considered Passavant's ridge was visible. After surgery, this movement was evident although limited.

Since either or both posterolateral and lateral wall movement were observed to occlude the pharyngeal ports, it is evident that their separate function observed pre-surgically remained distinct movements postsurgically. Anatomical evidence appears to support observations of separate structures although data is limited and controversy exists. Browne (1932) was among the first to credit the palatopharyngeus muscle with the formation of Passavant's ridge. Last (1978) also described the horizontal palatopharyngeus muscle fibers at the level of the hard palate and concluded that these fibers were responsible for Passavant's ridge. However, there is also support for a relationship between superior pharyngeal constrictor contraction and Passavant's ridge formation (Iglesias et al., 1980).

In contrast, lateral wall motion observed endoscopically to comprise the anterior section of the lateral pharynx in front of the "cupped" Passavant's ridge appears related to salpingopharyngeal fold displacement. The salpingopharyngeal folds are inert structures and their medial displacement has been attributed to different muscular movements. Hollinshead (1968) related displacement to levator contraction; Iglesias *et al.* (1980) related it to superior pharyngeal constrictor contraction; and Last (1978) associated it with contraction of the palatopharyngeus muscle. Pharyngeal contraction appeared to us to be responsible for fold movement.

Based upon endoscopic observation and anatomical information, it appears that in patients with post-surgical posterolateral wall and velar motion, the pharyngeal ports can be occluded by the contraction of these separate and independent structures, and this arrangement provides an extra margin of safety against hypernasality post-surgically.

> Reprints: Daniel H. Zwitman, Ph.D. UCLA School of Medicine, 62-202 CHS, 10833 Le Conte Avenue Los Angeles, CA. 90024

References

- Browne, D., The operation for cleft palate. Brit. J. Surg., 20: 7-25, 1932.
- Glaser, E. R., Skolnick, M. L., McWilliams, B. J., and Shprintzen, R. J., The dynamics of Passavant's ridge in subjects with and without velopharyngeal insufficiency—a multiview video fluoroscopic study. *Cleft Palate J.*, 16: 24-33, 1979.
- Hollinshead, W. H., Anatomy for Surgeons, Volume 1: The Head and Neck. Hagerstown, Maryland: Harper and Row, 1968.
- Iglesias, A., Kuehn, D. P., and Morris, H. L., Simultaneous assessment of pharyngcal wall and velar displacement for selected speech sounds. J. Speech Hear. Res., 23: 429-466, 1980.
- Last, R. J., Anatomy, Regional and Applied. London: Churchill Livingstone, 1978.
- Skolnick, M. L., and McCall, G. N., Velopharyngeal competence and incompetence following pharyngeal flap surgery: videofluoroscopic study in multiple projections. *Cleft Palate J.*, 9: 1–12, 1972.
- Skolnick, M. L., McCall, G. N., and Barnes, M., The sphincteric mechanism of velopharyngeal closure. *Cleft Palate J.*, 10: 286–305, 1973.
- Yules, R. B., et al., Secondary techniques for correction of palatopharyngeal incompetence. In *Cleft Lip and Palate*, edited by W. C. Grabb, W. W. Rosenstein, and K. R. Bzoch, pp. 451–489. Boston: Little, Brown and Co., 1971.