The Use of Videonasopharyngoscopy for Biofeedback Therapy in Adults After Pharyngeal Flap Surgery

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Nasopharyngoscopy with videorecording was used as a visual feedback therapy tool to establish and promote consistent closure of the velopharyngeal ports during connected speech after pharyngeal flap surgery. Of the three adults in this report, two achieved consistent closure during connected discourse and have been discharged from therapy; the third demonstrated improved velopharyngeal closure but elected not to continue therapy. These outcomes demonstrate that nasopharyngoscopy biofeedback therapy is useful in helping the motivated adult to achieve better velopharyngeal closure during connected speech after pharyngeal flap surgery or revision. This type of therapy may also prove beneficial with children.

KEY WORDS: video nasopharyngoscopy, biofeedback therapy, pharyngeal flap surgery

Velopharyngeal insufficiency (VPI) is usually surgically or prosthetically treated. Speech therapy using various biofeedback techniques to improve the function of the velopharyngeal mechanism has been studied, but most of these techniques do not permit direct visualization of the velopharyngeal valve during unimpeded connected speech (Shelton et al, 1970a, 1970b; Tudor and Selley, 1974; Shelton, 1975; Shelton et al, 1978). Flexible fiberoptic nasopharyngoscopy does provide such visualization. In combination with video imaging and playback, its use in patients with and without cleft palate suggests that it may be an effective biofeedback tool for altering velopharyngeal movements during speech (Miyazaki et al, 1975; Siegel-Sadewitz and Shprintzen, 1982; Yamaoka et al, 1983; Hoch et al, 1986; Witzel et al, 1988).

VPI sometimes persists after pharyngeal flap surgery. Closure of the lateral ports following pharyngeal flap surgery is dependent on the medial movement of the lateral pharyngeal walls to the lateral edges of the flap (Morris and Spriestersbach, 1967; Skolnick and McCall, 1972; Shprintzen et al, 1979). Persistent VPI may be related to compensatory articulation patterns such as glottal stops, pharyngeal stops, pharyngeal fricatives, or affricates. Compensatory articulation may prevent or restrict velopharyngeal movements because the airstream is stopped or constricted below the velopharyngeal valve (Golding-Kushner, 1981; Shprintzen, 1989; Henningsson and Isberg, 1986; Hoch et al, 1986). Alternatively, the flap may not be wide or high enough or the patient may not have habitually adjusted his muscle movements to achieve closure of the valve.

Based on an experiment in changing valving patterns in a normal subject, Siegel-Sadewitz and Shprintzen (1982) hypothesized that videonasopharyngoscopic biofeedback could be beneficial in enhancing lateral wall movement before pharyngeal flap surgery or in patients with a failed pharyngeal flap. The purpose of this report is to describe three adults who received videonasopharyngoscopy as a visual feedback tool in combination with articulation training after pharyngeal flap surgery or revision. The treatments and observed changes in velopharyngeal function are described.

METHOD

Subjects

Three patients aged 34 to 50 years who had persistent hypernasality, nasal air emission, and VPI after undergoing pharyngeal flap surgery or revision for VPI in adulthood were investigated. Two had a repaired bilateral cleft lip and palate, and the third had an isolated cleft palate.

Procedure

An end-viewing flexible fiberoptic nasopharyngoscope (Olympus ENF P) with a diameter of 3.7 mm and a bending
radius of 180 degrees was used. An Olympus ILK III 150-watt halogen light source provided the illumination. The sessions were recorded on a three-fourth-inch videocassette machine (Sony U-matic Recorder) by a high-resolution video-camera (Sony DCC 1850). The patient and a therapist were able to view the velopharyngeal mechanism on a television monitor simultaneously throughout the sessions.

All sessions were carried out with the patient sitting upright in a chair. The examiner passed the nasopharyngoscope through the patient’s nostril, which had been anesthetized with a combination of 2-percent tetracaine hydrochloride and 0.5 percent phenylephrine (Shprintzen et al, 1985) until the velopharyngeal area was visualized. Initially, each patient was asked to repeat the sentences “Put the baby in the buggy,” “Give Gary the chocolate cake,” and “Susie sees the sun in the sky”; to count from one to 10 and from 60 to 70; and to sustain /s/. This procedure identified the most appropriate starting point for biofeedback therapy with the patient, based on the sounds that produced the most extensive lateral wall motion or closure of the lateral velopharyngeal ports.

Each patient was then asked to close both ports without producing speech (i.e., by blowing, whistling, or, in one case, swallowing), and to observe the television monitor to note what lateral pharyngeal wall movements or a closed port looked like. The patient was also instructed to attempt to identify the sensation of closing the ports or of movement in the velopharynx during these activities. Then the patient was asked to repeat this process and attempt to move the lateral pharyngeal walls medially at will while observing the results on the television monitor. When the patient was able to move the velopharyngeal mechanism voluntarily without speech, using whatever type of cuing was necessary (e.g., “squeeze the muscles in your throat,” “concentrate”), the patient was instructed to articulate the consonant sounds that produced the best lateral wall movement or closure and to observe the movement of the velopharyngeal mechanism. Consonant and then consonant-vowel combinations were identified in order of ease of production and completeness of velopharyngeal closure.

Therapy continued, moving from the sounds that could be produced with the best closure of the lateral ports to those that resulted in the least amount of closure. A traditional speech therapy approach was used, progressing from consonant and consonant-vowel combinations to monosyllabic words, polysyllabic words, varied positioning of the sound in the word, phrases, sentences, and conversational speech. Two subjects also received traditional articulation therapy between biofeedback sessions, directed specifically at correct manner, placement of articulation, or both.

CASE REPORTS

Subject 1 was a 50-year-old man with a repaired bilateral cleft lip and palate who had significant hypernasality, nasal air emission, and definitive velopharyngeal insufficiency. Visualization of the velopharyngeal valve indicated a circumferential pattern of valving with a Passavant’s ridge (Fig. 1A). The patient had a weak production of sounds that required oral pressure and evidence of glottal stop substitution for the velar stop sound /k/ used in combination with the sibilant-fricative sound /s/. The velar stop sounds /g/ and /k/ were produced normally in other contexts. The patient had undergone pharyngeal flap surgery 9 weeks before biofeedback therapy was initiated. The first postoperative nasopharyngoscopy revealed that he was able to close the right port during speech (Figs. 1B and 1C), but the left remained open for sibilant-fricative and affricate sounds (s, z, sh, ch) and the combination of /ks/ (Figs. 1D and 1E). Overall, hypernasality and nasal air emission had improved to the normal range, except during production of words containing these sounds. He was instructed on correct tongue placement and encouraged to concentrate and think about producing the stop sound /t/, which is produced in the same general area of the mouth and for which he achieved complete closure. He was then able to close the left port entirely during production of sibilant-fricative and affricate sounds (Fig. 1F) while observing his efforts on the television monitor. With careful articulation, using gentle contact of the tongue against the palate for /k/ and keeping his tongue forward in the ready position for sibilant-fricative sounds, he was able to eliminate the glottal stop. He was seen for four 30-minute biofeedback sessions at monthly intervals and received traditional speech therapy weekly. Follow-up nasopharyngoscopy 2.5 months and 1 year after the final session revealed that the patient completely closed both ports appropriately and consistently during connected speech; hypernasality and excessive nasal air emission had been eliminated; and articulation for sibilant-fricative and affricate sounds and the velar stop sound /k/ had improved.

Subject 2 was a 37-year-old woman with a repaired bilateral cleft lip and palate. She had persistent hypernasality, nasal air emission, and consistent velopharyngeal insufficiency caused by an inadequate pharyngeal flap (Fig. 2A). The flap was narrow and taut. During speech the right port remained open, leaving a large gap. Increased muscle movement was observed on the left, but a small slit-like opening remained in the port during speech. The closure pattern was classified as coronal (Siegel-Sadewitz and Shprintzen, 1982), although slight mesial movements of the lateral pharyngeal walls were noted. The patient’s articulation was also affected by poor pressure for oral sounds, and there was evidence of glottal stop substitution for a /k/ used in combination with /s/. Pharyngeal flap revision to widen the flap 7 months before initiation of biofeedback therapy had improved nasal resonance and nasal air emission somewhat, but had not changed articulation. Nasopharyngoscopic examination after surgery revealed a small right port (Fig. 2B), a larger left port (Fig. 2C), and inadequate closure with a coronal valving pattern, particularly of the left port (Fig. 2D) when articulating the plosive (p, b, t, d), sibilant-fricative sounds, and the glottal stop. When these sounds were articulated with correct tongue position, however, the patient was able to achieve complete velopharyngeal closure as the lateral walls moved medially (Fig. 2E). Two 30-minute sessions of biofeedback therapy were spent showing her how improved tongue and lip placement for articulation enhanced velopharyngeal closure. At discharge, the patient’s articulation was normal; hypernasality and excessive nasal air emission had been eliminated; and she was achieving complete closure of both velopharyngeal ports consistently during connected speech.

Subject 3 was a 34-year-old woman with a repaired cleft palate. She had persistent hypernasality, nasal air emission,
and VPI even though she had had a pharyngeal flap (Fig. 3A and 3B). During speech there was evidence of inconsistent use of pharyngeal fricatives for sibilant-fricative sounds and glottal stop substitution for /k/ when it occurred in combination with the /s/ sound. On the preoperative nasopharyngoscopic study, only flickers of movement of the palate or lateral pharyngeal walls were observed during correctly articulated speech. She had undergone pharyngeal flap revision to widen the flap 2 months before initiation of biofeedback therapy. Postoperative nasopharyngoscopy revealed a small opening of the right velopharyngeal port (Fig. 3C) and a slightly larger left port (Fig. 3D). There was little observed movement of the velopharyngeal valve during speech, and the patient continued to exhibit hypernasality and nasal air emission. Articulation was unchanged. With biofeedback therapy, the patient began to control medial movement of the lateral pharyngeal walls to close the ports during the initial session (Figs. 3E and 3F). In four additional sessions at 1- to 2-month intervals, she achieved good lateral wall movement by swallowing or squeezing the muscles in the velopharynx before speech production. She was also instructed in correct tongue position for sibilant-
fricative and velar stop sounds. The patient received traditional speech therapy sessions between the biofeedback sessions. Despite the improved coordination and control of lateral pharyngeal wall movement and improved articulation, the patient was frustrated and impatient with her progress. Also, she reported that personal problems were adding to her frustration. After the fifth session, she did not return for biofeedback or her traditional speech therapy sessions.

**DISCUSSION**

The results of pharyngeal flap surgery in correcting hypernasal resonance and nasal air emission during speech are believed to be better in young patients than in adults. Riski (1979) reported that pharyngeal flap surgery was more successful in children less than 6 years old than in those who were older. He cited several hypotheses from Fletcher (1978) to explain these results. First, early surgery allows a family to establish confidence and direct its energies to helping the child develop speech skills. Second, it results in less permanent maladaptations in speech physiology. Finally, articulation movements and posture are more malleable at earlier ages.

Several investigators have studied the success of pharyngeal flap surgery in correcting hypernasality in adults. Although some authors (Moll et al, 1963; Skoog, 1965; Hamlen, 1970) report a greater incidence of failure in adults than in others, all state that the operation is less successful.
in adults than in children (Moll et al, 1963; Skoog, 1965; Hamlen, 1970; Albery et al, 1982; Bronsted et al, 1984). Hamlen (1970) suggested that the poorer results in adults may be associated with their greater self-consciousness when using new speech habits, and with family resentment about the change in the patient's speech and his or her new independence.

Our study suggests that visual biofeedback using video-nasopharyngoscopy may help adults with persisting VPI after pharyngeal flap surgery to achieve the physical potential provided by the surgery. In these patients the therapy was not an alternative but an adjunct to surgery and traditional speech therapy methods. Two patients were discharged with good results. The third patient experienced increasing control and coordination of the velopharyngeal mechanism but has not returned for biofeedback therapy because of frustration with her progress. The improvements in extent and consistency of velopharyngeal movements during speech may not have been a direct result of the patient's observations of his velopharyngeal mechanism;

however, we believe that the visual feedback of velopharyngeal movements to the patient and therapist is a useful adjunct to traditional speech therapy techniques, which emphasize auditory feedback. The patients in this report all felt that the visual feedback helped them to control velopharyngeal movements, to find the best tongue positions for articulation and velopharyngeal closure during speech, and to understand the mechanism of velopharyngeal closure.

The use of videofiberopticnasopharyngoscopy as a visual biofeedback tool in speech therapy for patients with inadequate movement of the velopharyngeal valve during speech warrants further study. Studies involving experimental controls and specific therapies are needed to investigate the causal relationship between biofeedback and observed changes in velopharyngeal movements and articulation. These types of investigations would provide information about which components of treatment are essential to change.

Each patient is different, and no one therapy technique will benefit all patients. Selection of an appropriate technique or combination of techniques requires study of the patient’s speech under different stimulus conditions and during the formation of different combinations of speech sounds.

Some of our patients seemed to use the images of velopharyngeal movements to guide their attempts at closure, whereas others used the visual display to observe changes in movement when they attempted different tongue positions for articulation. These two responses to the visual image constitute conceptually different types of use of this visual biofeedback technique. With the first, the patient is taught to move the velopharyngeal structures and to incorporate these movements into articulation of conversational speech. In the second, the patient is helped to improve articulation of nonnasal or oral sounds. Both processes probably involve some alteration of the patient’s motor control pattern for speech.

The flexible fiberoptic nasopharyngoscope is an efficient and effective instrument for observing velopharyngeal movements during connected speech. The procedure is easily tolerated and may be repeated as necessary. In addition, there is no exposure to radiation and no obstruction of the normal flow of speech. However, this technique is expensive and requires the patient’s motivation and compliance. Furthermore, a speech pathologist and a physician must be present during its use. Nevertheless, its advantage of allowing visual input to therapy rather than relying primarily on auditory feedback, which is believed to be less effective in adults, should outweigh its drawbacks, particularly in the older patient whose speech patterns are long-standing and ingrained.

We recommend that a more formal study using a standardized therapy regimen be designed. We have already found that nasopharyngoscopic biofeedback therapy may be helpful in children with sound-specific velopharyngeal insufficiency (Trost, 1981; Witzel et al., 1988), but more work is needed in this direction as well.

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Commentary

This paper is still another convincing piece of evidence that the velopharyngeal valve can be controlled in at least some cases by direct visual feedback. To date, the reports that have appeared in the literature, including my own, have lacked standardization of approach and the reporting of results, as is pointed out by the authors. In looking to the future, those of us who are continuing to explore the use of the fiberoptic endoscope as an instrument for biofeedback should attempt to take into account the following factors:

1. The age of the subjects and the duration of their velopharyngeal insufficiency
2. The size, position, and shape of the insufficiency
3. The types of muscle activity in the velopharyngeal valve
4. If the subject has had a surgically repaired cleft, the type and extent of previous surgery
5. If the subject has had a pharyngeal flap, the surgical placement of the flap, especially the vertical level of the flap
6. The specific procedures used in traditional speech therapy, either before or at the same time as nasopharyngoscopic biofeedback therapy
7. Other associated problems, such as hearing loss, intellect, and other anomalies

Once these factors, and perhaps others, have been standardized, we may begin to understand the mechanisms by which visual biofeedback works. That it does work has been amply demonstrated by Witzel et al and by other investigators.

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