Speech Status following Uvulopalatopharyngoplasty*

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The purpose of this study was to evaluate the adequacy of speech following uvulopalatopharyngoplasty surgery. Twenty UPPP subjects, all of whom exhibited obstructive sleep apnea syndrome, and 15 non-UPPP control subjects participated in the study. Evaluation included measures of nasal airflow, speech recordings with listener judgments, and a questionnaire survey. Nasal resonance in the UPPP subjects was found not to be deviant by a panel of four experienced judges. The UPPP subjects were differentiated from their non-UPPP pairs on the basis of significant phonation (voice) problems, and to a lesser extent, their articulation problems. It is suggested that dryness problems that remained in many subjects postoperatively may be related to the observed voice problems.

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UPPP = uvulopalatopharyngoplasty; EAI = equally appearing interval

Sleep apnea, a cessation of breathing for at least 10 s during sleep, has been known to occur over 300 times in one evening, thereby severely affecting daytime functioning. The sleep apnea syndrome results in behavioral manifestations such as excessive daytime sleepiness, memory impairments, depression, and complaints of early morning headaches.1-3 Due to these disruptions in daily functioning, intensive study has been given to the elimination of these apneic episodes during sleep.

Several methods for eliminating sleep apnea have been attempted. These involve medical procedures including the administration of drugs,4,5 therapeutic procedures such as CPAP (continuous positive airway pressure)6 and surgical techniques such as tracheostomy7,8 and UPPP.9

Although UPPP surgery has been in use since the early 1980s, it does not appear to be successful in all patients. In fact, it may only provide resolution of the sleep apnea symptoms for as few as 50 percent of the patients who undergo the surgery.11,12 This may be due to the fact that the site of obstruction may have been diagnosed incorrectly or the patient may have multiple sites of obstruction. It appears that this surgery may be performed unnecessarily in some cases, as the sleep apnea symptoms remain unresolved.

The UPPP surgical procedure involves removal of 1.0 to 3.0 cm of soft palate tissue with removal of redundant oropharyngeal mucosa and lateral tissue from the anterior and sometimes posterior faucial pillars.10 This procedure results in a shortened soft palate. In cleft palate children or adults who also have a shortened soft palate due to structural abnormalities, speech problems are known to occur as a result of this palatal inadequacy.13 It follows that if palatal tissue in this area is purposely removed, as in UPPP, palatal inadequacy leading to defective speech also may occur in the UPPP population.

Because the UPPP surgery is not an absolute cure for sleep apnea and its symptoms, it is important that the individual patient and the sleep disorders team weigh the potential risks and benefits of the surgery. A possible risk following this surgery may be velopharyngeal malfunctioning due to the shortened palate. Few researchers have systematically studied the effects of this surgery as it relates to speech production.

Preoperative and postoperative speech recordings of 34 patients following UPPP were completed by Gislarson et al.14 Their findings indicated that signs of nasality were not identified in these patients. They did report some changes in the voice quality of their patients which appeared to be resolved by six months. Of 64 patients evaluated with speech recordings by Poole et al.,15 none was reported to experience speech problems following UPPP. Similarly, Dickson and Blokmanis8 failed to find speech problems postoperatively in their patients. In an unpublished study by Coleman and Sly,16 acoustic analysis and listener judgments did not identify a nasal correlate during the speech of their UPPP patients.

It is of importance to note that little information is given regarding the methodologic approach of the studies cited above. Although speech results are reported in these studies, control measures generally are not discussed. Thus, the rigor with which speech

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parameters were measured is questionable.

In carefully controlled studies by Monoson and associates, speech problems were identified in apnea patients who had not been treated surgically. These results appear to be in conflict with the more subjective studies cited above in that the latter studies reported no speech problems either before or after surgery. Monoson et al reported that patients with sleep apnea do exhibit speech disorders involving resonance (nasality), articulation, and phonation. More prevalent were the voice disorders (phonation) and the articulation disorders. Twenty of the 27 apnea patients studied were identified as having a speech disorder.

In view of the conflicting reports discussed, there remains some uncertainty about the speech status in patients following the UPPP surgery. The twofold purpose of this study was: 1) to determine if speech quality is altered following the UPPP procedure, and 2) if speech quality is modified, what major factors are related to the change? The study was conducted in three phases: 1) nasal airflow assessment, 2) speech recordings with listener judgments, and 3) questionnaire survey.

**METHODS**

**Subjects**

Eight men and seven women completed the airflow assessment and questionnaire portion of the study. The same subjects with sex and age-matched control subjects were used for the speech recordings. Five additional UPPP subjects returned the questionnaire but did not participate in the airflow or speech recording aspects of the study. The 20 UPPP subjects had undergone UPPP surgery between 1986 and 1988 in a medium-sized midwestern hospital. Five UPPP subjects had septoplasty and two subjects had nasal turbinectomy. An additional two UPPP subjects had both septoplasty and turbinectomy. They were between the ages of 28 and 68 years with a mean age of 48.8 years. The control subjects were drawn from the same community as the UPPP subjects and were matched within one year of age.

**Airflow Assessment**

Airflow assessment included screening measures of nasal air emission. The first screening measure was a mirror fogging test. Each subject was asked to produce nonnasal consonants in isolation, single syllable words and multisyllable words. While holding one nostril closed and placing the mirror below the other, condensation on the mirror was rated as mild, moderate or severe.

Secondly, a device called the See-Scape was used. With one nostril occluded, a nasal olive was placed in the other nostril. The nasal olive was connected to flexible plastic tubing that led to a rigid plexiglass tube. The plexiglass tube contained a styrofoam ball that rose if nasal airflow entered the tube. As the patient counted, a reading between 0 and 8 was taken on the degree of styrofoam ball elevation within the tube (0 = no nasal emission, 8 = maximum nasal emission).

Aerodynamic measurements of velopharyngeal adequacy were obtained by a modified version of an airflow technique described by Warren and DuBois. The adequacy of the velopharyngeal port was assessed by measuring the airflow through it. Nasal airflow was recorded by means of a heated pneumotachograph connected to plastic tubing that fit snugly in the subject's nostril. The other nostril was occluded by a cork stopper. Airflow data were collected while the subject produced ten repetitions of [p], [s], , and [m].

Airflow was recorded on a Dynograph ink pen recorder. The airflow measurement equipment was calibrated with a flowmeter (Fischer Porter model 10A). Flow measurements were calibrated to provide full-scale deflection of 80 ml/s for flow (17 mm = 20 ml/s).

**Speech Recordings**

A stereo cassette recorder (Sony, model TC-FX600) was used to record the speech samples using a pressure zoned microphone (Realistic, model PZ-M). The first paragraph of the Rainbow Passage was used for listener evaluations.

Four experienced speech pathologists were selected to serve as listeners. In the first set of 30 speech samples, the recordings of 15 UPPP subjects and their age and sex-matched controls were played in pairs. The listeners were asked to discriminate between the UPPP and the matched non-UPPP subjects.

In the remaining three sets of 30 samples, the degree of abnormal nasal resonance, articulation, and phonation was judged separately. Nasal resonance logically might be expected to be affected by the UPPP surgery because of the substantial amount of tissue removed. Articulation involves positioning of the tongue, lips and other structures. Phonation is most closely related to laryngeal activity (i.e., the approximation of the vocal folds). The latter two parameters, articulation and phonation, conceivably could be affected by the UPPP surgery in an indirect fashion. Moreover, the data of Monoson et al warranted inclusion of these two parameters.

A 1-to-7 equally appearing interval scale was used to evaluate nasal resonance, articulation, and phonation. A judgment of 1 indicated normal speech and 7 was the most severely disordered speech. Prior to the EAI evaluation, a tape was played to the judges demonstrating the range of severity.

**Reliability**

The listening session was repeated three months following the initial session to determine intra- and interjudge reliability. The 15 paired comparisons for identifying UPPP versus non-UPPP subjects resulted in an interjudge reliability of 82 percent.

Intrajudge reliability measures for the speech descriptors (phonation, articulation, and nasal resonance) were determined by a mean difference score. Across all four judges, the average difference in speech descriptor ratings for session 2 versus session 1 was 0.5 for phonation, 0.3 for articulation, and 0.2 for nasal resonance.

**Questionnaire**

The questionnaire generated for this study (available from authors) contained questions which provided information relating to several factors before and after surgery. The subjects were asked to rate the severity of five recovery conditions at one week, one month, and three months following surgery on a scale of 1 to 4 (1 = no problem, 4 = severe problem).

**RESULTS**

**Airflow**

The mirror test for assessing nasal air emission indicated that slight fogging in certain speech contexts was observed in 6 of 15 subjects. There appeared to be nasal blockage in many of these patients, as 9 of 15 did not have nasal air emission from at least one nostril as would be expected for nasal consonants. See-Scape results indicated that UPPP subjects exhibited some degree of inadequate nasal emission as evidenced by
high scores during the counting series of 60-69. Some lower scores were found for the UPPP subjects for counting in the 70s suggesting that they exhibited some degree of nasal resistance compared to the control subjects. The UPPP subjects received ratings from an average of 0.5 to 7.5 during the 90s series. Although some nasal air flow would be expected (controls' ratings 0.5-1.0) 14 of 15 UPPP subjects received scores higher than the controls. During the pneumotachograph airflow measurement, 5 of 15 subjects showed slight air emission during the production of /p/.

Questionnaire

Questionnaire data revealed that the UPPP subjects had severe problems with swallowing, as would be expected, during the week following surgery, but the severity decreased significantly over the following three months (p<.01). The most severe variable at one week was swallowing/choking followed by dryness, speech, nasal regurgitation and gagging. As noted in Figure 1, all recovery variables decreased significantly (p<.01) over time. Further analysis of variance revealed that most of the change over time occurred during the first month following surgery (p<.01). Nevertheless, even at three months following surgery, the UPPP subjects continued to experience some degree of difficulty with at least one of the recovery variables, swallowing/choking, dryness, nasal regurgitation, gagging, or speech.

As revealed in Figure 1, the severity of dryness and gagging did not change appreciably from one month to three months postoperatively. In fact, at the time of the study, six months to three years postoperation, many subjects continued to complain about problems with dryness. Dryness problems were not limited to those who had undergone the most recent surgery, but affected some who were three years postoperative.

Four subjects reportedly had mild to moderate problems with speech three months postoperation. Subjects complained of difficulty with "tone" of their voice and pitch problems while singing. Others felt their voice was "nasal" and sounded like they had a cold. Seven subjects had mild to moderate nasal regurgitation after three months. They expressed having difficulty drinking from a water fountain and drinking orange juice or water from a glass. Some felt they had to "chew their food better" and "swallow harder" to avoid having food pass through the nose.

The most frequent complaint overall involved oropharyngeal dryness. Although dryness had decreased significantly from the first week following surgery, as stated earlier, at three months 15 of 20 subjects continued to have mild to moderate problems with dryness.

Speech Judgments

The judges were asked to discriminate between each UPPP subject and his or her non-UPPP matched pair. The judges as a group were able to identify 11 of 15 UPPP subjects correctly. A chi-square analysis revealed this to be significant at the .01 level.

Figures 2, 3, and 4 show phonation, articulation, and resonance mean scores. Analysis of variance procedures revealed significant differences between the UPPP and non-UPPP groups for phonation and articulation (p<.01). The UPPP group was rated as having poorer speech for phonation and articulation but nasal resonance was not found to discriminate the UPPP from the non-UPPP group. The UPPP group received consistently poorer scores for phonation as shown by the significant value obtained on the median

![Recovery Variables Graph](image)

**Figure 1.** The mean severity score for 20 UPPP subjects for all recovery variables at one week, one month, and three months postoperation.
**FIGURE 2.** Mean rating by four judges on phonation. The higher the rating number, the poorer the judged phonation.

**FIGURE 3.** Mean rating by four judges on articulation. The higher the rating number, the poorer the judged articulation.

**FIGURE 4.** Mean rating by four judges on nasal resonance. The higher the rating number, the poorer the judged nasal resonance.
chi square test (p<.01). A discriminant function analysis also showed that phonation was the most influential factor in discriminating between the UPPP and the non-UPPP groups. A negative value was found for resonance in the discriminant function analysis indicating that more non-UPPP subjects than UPPP subjects were found to have resonance problems.

**DISCUSSION**

Listener judgments did not identify a nasal resonance problem in this group of UPPP subjects as might be expected on the basis of the velopharyngeal tissue removed. It appears that velopharyngeal functioning was adequate for the production of speech following UPPP. This finding does not conclusively rule out that velopharyngeal functioning was normal for all activities in that nasal regurgitation did occur in these subjects at least up to three months postoperation.

Speech performance depends on a number of physiologic variables that interact and not just the ability of an individual to achieve complete velopharyngeal closure during the production of single words. It may be that the inability to completely close the velopharyngeal port did occur in these subjects following UPPP, as suggested by the nasal regurgitation of liquids and some solids and also by the measured nasal air emission, but these subjects may perform well with regard to nasal-oral resonance balance for speech due to their adequate anatomic configuration of the oral and nasal cavities and the ability of the speech structures to adapt to the modified anatomic environment. Such adaptation has been referred to as "plasticity."20

This study revealed that phonation (voice or laryngeal) disorders, and to a lesser extent articulation disorders, were present in these subjects following UPPP. The presence of speech disorders in this population may not necessarily be a result of the UPPP surgery, as speech problems also were identified in sleep apnea subjects who had not undergone UPPP surgery.17,18

Related to the identification of phonation disorders in these subjects may be the presence of persistent oropharyngeal dryness that could result in surface irritation of the vocal folds. Several factors may account for this dryness: 1) increased airflow into the oropharyngeal and laryngeal area from reconstructed nasal passages; 2) removal of turbinates, as is done in many UPPP patients, depriving the air entering the pharyngeal and laryngeal area of its natural filtering, temperature control, and humidifying system; 3) removal of the uvula, thus eliminating some mucus-secreting glands; 4) the entrance of foreign particles into the laryngeal airway during nocturnal obligate mouth breathing which occurs as the patient is gasping for air while attempting to terminate the apneic episode; and 5) any agent or condition resulting in generalized dryness (medication, alcohol).

In addition to dryness, snoring might be related to voice disorders in this population. Loud and intense snoring is common in the apneic population. In the patient with long standing sleep apnea the pharyngeal tissue has undergone years of continuous vibration during snoring. Swelling of the soft tissues might occur. If this swelling is generalized to the laryngeal area, vocal fold mass might increase and pathology might result.

Minor articulation problems were found in this group of apnea subjects. Although Monoson et al19 identified significant articulation problems in their apnea subjects, they indicated that phonation was the most influential factor in identifying the apnea group. Our findings are in agreement with those of Monoson and colleagues. The subjects in the present study also exhibited a more severe phonation disorder, whereas articulation problems were relatively mild.

Nonspeech oropharyngeal aspects also were of interest in this study. Severe difficulty with swallowing was common for almost all the subjects immediately following UPPP surgery. This is not an unexpected finding due to the surgical procedure performed. The subjects also complained of problems with gagging and choking extending beyond the three-month postoperative period.

In relation to the continued problems of swallowing difficulty, nasal regurgitation, choking and gagging after three months, a sensory impairment may be implicated following UPPP. Cutaneous sensory receptors in the oropharyngeal area may have been completely removed or significantly reduced as a result of the UPPP surgery. This may be particularly important when one considers the swallowing and gagging problems.

The pharyngeal stage of swallowing presumably begins with the triggering of the swallow reflex at the base of the anterior faucial pillars which appears to be the most sensitive place for the elicitation of this reflex.31 Resection of the anterior faucial pillars is included in the UPPP surgery in almost all patients. The swallow reflex may not be triggered if there is a lack of proprioceptive or cutaneous receptors in this area.

If the swallow reflex is absent or modified, several important physiologic activities may not occur. These include: 1) elevation and retraction of the velum and complete closure of the velopharyngeal port to prevent material from entering the nasal cavity, 2) initiation of pharyngeal peristalsis to transport the bolus as it passes the anterior faucial pillars, and 3) elevation and closure of the larynx to prevent material from entering the airway.31 The choking and nasal regurgitation
reported by the UPPP patients would suggest reduced oral sensation or an absent or delayed swallow reflex.

In contrast, a hyperactive gag reflex, as found in some subjects, may not be involved in swallowing problems. The hyperactive gag reflex found in these subjects might be explained by a preponderance of sensory receptors in one area. This might be a function of the surgical manipulation or repositioning of tissue. Other reasons for continued gagging might be the presence of foreign material or an alteration of tissue in the oropharyngeal area such as stitches from the surgery or subsequent scar tissue as was found in some UPPP subjects.

CONCLUSION

Although there remains no definitive way to predict the outcome of the UPPP surgery, it continues to be performed. Fortunately, the results of this study indicate that adequate velopharyngeal functioning for speech is possible after UPPP surgery. Although some patients do continue to have a mild velopharyngeal malfunctioning problem, ie, nasal regurgitation, the subjects in this study report that the benefit from the surgery was sufficient to override the complication.

It is important for practitioners to alert their patients to the problematic recovery variables identified in this study. Because of the significant finding of dryness, it is recommended that some form of humidification be used especially immediately postoperatively. On the other hand, because no problem was found regarding nasal resonance, the results of this study allow the physician to be more confident in recommending the UPPP surgery without expectation of serious velopharyngeal malfunctioning.

Research that will provide more information regarding phonation problems in the sleep apnea population should continue. Another area that would be pertinent to the speech-language pathologist includes study of the apnea patients who have received UPPP combined with the more radical maxillary, mandibular, and hyoid advancement.22 Perhaps in this population nasal resonance problems might be identified. Because the majority of these patients previously have undergone UPPP and are possibly at greater risk for velopharyngeal malfunctioning, further expansion of the posterior airway space could result in nasal resonance problems.

The uvula is involved in uvular trill and uvular /r/ productions in several world languages. Phonetic changes, in the Hebrew language, involving /r/ and /λr/, have been reported in 7 of 57 patients following UPPP surgery.23 It would be of interest to evaluate the results of the UPPP surgery in other populations as well. A more detailed analysis of articulation problems identified in apnea subjects with and without surgery also is suggested.

Although central or arrhythmic apneas were not addressed in this study, obstructive and central apnea can coexist. Study of their common physiologic basis and their implications for speech, such as potentially modified respiratory activity, would be important in future research.

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Beth Israel Medical Center and The Page and William Black Post-Graduate School of Medicine of the Mount Sinai School of Medicine, City University of New York, will present this program at Beth Israel Medical Center, First Avenue at 16th Street, New York 10003, on March 2. For information, contact Nora Pisano, Medical Education, Beth Israel Medical Center (212) 420-2849.