A Comparison of Transverse and Vertical Pharyngeal Flaps Using Electromyography and Judgments of Nasality

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Previous studies have reported less than adequate speech results for vertical types of pharyngeal flaps with some patients. However, no controlled judgments of nasality have been reported for transverse pharyngeal flaps, and no comparative studies have been done.

In this investigation, 21 listeners evaluated nasality in two groups of seven cleft palate patients. One group had had vertical pharyngeal flaps, while the other group had had transverse pharyngeal flaps. The possible relationship of observable electromyographic activity to nasality was also studied.

The results indicated that perceptual ratings of postoperative speech in the two groups did not differ significantly. Also, because similar muscle action potentials were observed in both types of pharyngeal flaps, it was concluded that this activity was not a contributing factor in the judgments of nasality.

A primary goal for any pharyngeal flap procedure is the reduction of hypernasality. Although vertical pharyngeal flap procedures are successful in the correction of velopharyngeal incompetence with the majority of cleft palate patients, a significant number of patients have hypernasal speech postoperatively (Yules, 1970; Fára and Véle, 1972; Owsey et al., 1972). Accordingly, transverse pharyngeal flap procedures were developed (Owsey et al., 1972; Kapetansky, 1973, 1975) in an attempt to improve speech. However, there have been no objective studies with listener judgments of nasality to compare patients managed with transverse pharyngeal flaps with those who have had vertical pharyngeal flaps.

Owsey et al. (1972) have suggested that the poor postoperative velopharyngeal function for speech in vertical flaps is the result of poor muscle ability in the flap produced by denervation and atrophy in the central pedicle. Owsey et al. (1972) demonstrated with adult mongrel dogs that parallel vertical incisions to the level of the prevertebral fascia result in the absence of electromyographic activity along the edge of the incision. Thus, Owsey et al. (1972) assumed that a vertical pharyngeal flap would function as a passive obturator and that progressive atrophy might cause shrinkage of the central pedicle resulting in poor speech performance. To avoid this possibility, Kapetansky (1973, 1975) has reported on a transverse double pedicle procedure that attempts to avoid injuring motor innervation to the pharyngeal flap.

After recording EMG activity from patients with both inferiorly and superiorly based vertical pharyngeal flaps, Fára and Véle (1972) reported that only 18 out of 154 patients demonstrated an absence of muscle activity in the flap. Furthermore, Fára and Véle (1972) found that inferior flaps tended to show greater EMG activity than superior flaps, but superior flaps had a far superior closure for speech. This suggests that it is questionable whether muscle activity observed in EMG recordings is related to the perception of hypernasality in cleft palate speakers.

In an attempt to learn which surgical pro-
procedure yields better speech results in terms of reduced of hypernasality, this investigation compared judgments of nasality for a group of patients who had had transverse pharyngeal flaps (Kapetansky, 1975) with a similar group who had had vertical pharyngeal flaps (McEvitt, 1971). A secondary objective of this study was to search for EMG activity in the pharyngeal flaps.

Methods

Subjects. Fourteen subjects were selected for the study on a voluntary basis. Seven of the subjects had vertical pharyngeal flaps, and the remaining seven had transverse pharyngeal flaps. Characteristics of the participating subjects are summarized in Table 1. Participants in the study had to be at least eight years of age and had to have been operated on by the same surgeon. Only patients who had had a single pharyngeal flap operation were included in the study thereby eliminating the effects of pre-existing scars in the platopharyngeal area. None of the subjects was neurologically impaired, mentally retarded, or had histories of blood dyscrasia.

Equipment. Bipolar hooked-wire electrodes were produced by threading two wires through a 26 gauge ½ inch hypodermic needle. All wires were stainless steel, .003 inch in diameter, coated with .0014 inch teflon insulation. EMG was recorded differentially with a Honeywell Accudata 135 with EMG preamplifiers. The first processing was high-pass filtered to eliminate movement artefact and the amplified output was displayed on a Honeywell 1508 A visicorder (optical oscillograph). A two mV calibrated marker was placed on the oscillographic records. Tape recordings of the subject’s speech were made on a high-quality tape recorder.

Procedure. All subjects were seen individually during the investigation in the dental operators of Children’s Hospital of Michigan. First, a tape recording was made while each subject read part of the Rainbow Passage (Fairbanks, 1960). Next, a 5% lidocaine jell was liberally swabbed on the flap insertion point. Then, a single bipolar electrode was inserted via the oral surface of the pharyngeal flap at approximately 1 cm from its velar attachment. This placement was suggested by Basmajian (1979). EMG recordings were made for swallowing and tussive reflexes and the prolonged phonation of /a/. EMG amplitude for individual subjects during phonation was measured by averaging the maximum positive or negative peak amplitude for several repetitions.

Judgments of the severity of nasality were obtained by perceptual rating methods similar to those described by Morris (1960). A 15-point, equal-interval-scale was used for listener judgments, where “minus seven” represented severely hyponasal speech, “zero” represented normal speech and “plus seven” represented severely hypernasal speech. A 15- or 20-second portion of the recorded Rainbow Passage for each subject was played in two randomized sessions for a total of 21 listeners, who were either clinicians, or graduate students in speech-language pathology. At no time did any listener have knowledge of which group a particular subject belonged to. Before making judgments, the listeners heard a training tape, which presented the speech of three cleft-palate speakers, one with severe hyponasality, one with severe hypernasality, and one with normal speech.

Analysis of the severity of nasality listener judgment scores consisted of calculating (1) mean scores for each subject in each of the pharyngeal flap groups (2) the range of these subject means for each group (3) the group mean and standard deviation of the subject mean scores.

<table>
<thead>
<tr>
<th>Type of Procedure</th>
<th>Number</th>
<th>Type of Clefts</th>
<th>Age at Surgery Mean</th>
<th>Range</th>
<th>Years Post-Flap Surgery Mean</th>
<th>Range</th>
<th>Sex</th>
<th>Male</th>
<th>Female</th>
<th>Age at Taping Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical</td>
<td>7</td>
<td>5 Submucous</td>
<td>5.2 5.11-8.7</td>
<td></td>
<td>5.8 3.8-6.5</td>
<td></td>
<td>4</td>
<td>3</td>
<td></td>
<td>11.0 8.5-16.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 Short Palate</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>1 Soft Palate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transverse</td>
<td>7</td>
<td>4 Submucous</td>
<td>9.0 4.5-12.1</td>
<td></td>
<td>2.6 0.7-4.0</td>
<td></td>
<td>2</td>
<td>5</td>
<td></td>
<td>11.6 9.5-13.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Soft Palate</td>
<td></td>
<td></td>
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</table>
Results

Results of the judgments of nasality are presented in Table 2. While the mean nasality rating appears to be slightly better for the group who had had transverse pharyngeal flaps, there was no statistically significant difference ($t = .18, p > .05$) between groups in mean nasality ratings.

The EMG recordings demonstrated muscle potentials with all subjects in both groups for all speech and non-speech tasks. A typical example of this activity is presented in Figure 1. The mean EMG amplitude (see discussion) during phonation was 21.1 mV ($SD = 4.4$) for the group having vertical flaps and 19.3 mV ($SD = 5.1$) for the transverse flap group.

Discussion

Results of this study indicate that skilled listeners could not detect any significant difference in nasality between speakers who had had transverse pharyngeal flaps and those who had had vertical pharyngeal flaps. Also, the ranges of nasality perceived in the two groups were nearly equal, and the mean nasality ratings for both groups were similar to the listeners' concepts of normal speakers.

In designing this study, the author considered the value of obtaining presurgical data on the severity of nasality as a source for measuring speech improvement. However, there was an insufficient number of candidates for these pharyngeal procedures who

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**TABLE 2. Analysis of Listeners’ Judgments for the Severity of Nasality**

<table>
<thead>
<tr>
<th>Type of Pharyngeal Flap</th>
<th>Number</th>
<th>Group Mean</th>
<th>Standard Deviation of Group Mean</th>
<th>Range of Subject Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical</td>
<td>7</td>
<td>+.53</td>
<td>1.30</td>
<td>−1.0 to +2.33</td>
</tr>
<tr>
<td>Transverse</td>
<td>7</td>
<td>+.36</td>
<td>1.07</td>
<td>−1.28 to +1.71</td>
</tr>
</tbody>
</table>

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![FIGURE 1. Electromyographic recording for a typical subject during speech and non-speech tasks.](image-url)
also were able to meet the criteria for inclusion in the study. Thus, postsurgical subjects were used. Nevertheless, the collection of presurgical data should be considered for future investigations.

The EMG data showed activity in all subjects, and there were no quantitative differences between groups. Typically, when using bipolar hooked-wire electrodes, a comparison of absolute EMG potential values is unreliable for more than one insertion. However, considering the assumption of Owsley et al. (1972) to the effect that there is injured motor innervation when there is a vertical incision, it seems significant to note that the mean EMG amplitude for the transverse group is nearly identical to that of the vertical group.

This is in marked contrast with the results reported by Owsley et al. (1972). They showed no EMG potentials for subjects with parallel vertical incisions to the prevertebral level. The fact that potentials were observed in vertical flaps in the present study might be explained by (1) maintenance of innervation in some undetermined way, (2) the occurrence of unexplained reinnervation, or (3) by the inclusion of musculature deep to the fascia (such as muscle longus colli) in the central pedicle. This latter assumption would require a deeper incision than that reported by Owsley (1972). Likewise, incised tissue in the vertical flap may or may not receive deep vascularization. If this occurred, it would help to preserve contractile capabilities of muscle tissue in the pedicle by avoidance of progressive atrophy, which could result in nasal speech as some later time.

Summary

The primary criterion for success following a pharyngeal flap is the speech result, specifically the degree to which the hypernasality is perceived. Results of this study indicated no significant difference in mean nasality ratings between subjects who had had transverse and those who had had vertical pharyngeal flaps. Factors thought to contribute to the speech result include location (height) and size (width and thickness) of the flap and the usefulness of muscle tissue in the flap as determined from EMG potentials. This study demonstrated similar EMG potentials in both groups, thereby suggesting that EMG activity was not a contributing factor to the judgments of nasality.

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