PALATOGLOSSUS ACTIVITY DURING VCV UTTERANCES CONTAINING ORAL AND NASAL CONSONANTS OF HINDI

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ABSTRACT

This study presents some EMG data from the palatoglossus (PG) and levator palatini (LP) muscles and examines the "gate-pull" model of active velar lowering for the nasal sound production.

1. INTRODUCTION

In January, 1972, Lubker et al [8, p.235] proposed the "gate-pull" model of nasal sound production, which says that '...the levator may relax its activity in an almost gate-like fashion, thus allowing a temporal space during which palate is easily lowered. At some point in time during the "open" phase of the gate - or during the very early opening phase of it, a slight "pull" is provided by the palatoglossus to facilitate the ease and rapidity of palatal lowering. During this "gating" and "pulling" process the articulators function for the actual production of the nasal phoneme.' However, various EMG studies of the PG muscle have produced conflicting results. The EMG data from PG reported by Lubker et al [7,8] on Swedish nasal consonants, by Fritzell [5] on English nasal consonants, by Benguerel et al [3] on French nasal vowels, and by Dixit et al [4] on Hindi front nasal vowels provided unequivocal support for the "gate-pull" model of nasal sound production. The PG data reported by Dixit et al [4] on back nasal vowels of Hindi were, however, primarily related to the tongue-body movement and positioning. On the other hand, the PG data on English nasal consonants reported by Bell-Berti [1], Bell-Berti and Hirose [2], and on French nasal consonants reported by Benguerel et al [3] did not provide any support for the above model of nasal sounds production. Thus, the purpose of the present study was to explore whether the PG muscle is actively involved in lowering the velum for the production of nasal consonants of Hindi.

2. METHOD

Bipolar hooked-wire electrodes were used for EMG recordings. They were inserted perorally into the PG and LP muscles. (LP muscle data are a must for appropriate interpretation of PG muscle data.) EMG signals from these muscles were recorded simultaneously with audio signal while a native speaker of Hindi produced five repetitions of each VCV nonsense utterances containing a nasal or an oral consonant. In these utterances, C represented /t d n/, and V represented /i a u/. The first and second vowels in each utterance were the same, and the second vowel was stressed. EMG and audio signals were rectified, integrated and digitized. The offset of the first vowel was selected as the line-up point for ensemble averaging of the EMG and audio signals. Graphic illustrations of the ensemble-averaged EMG and audio signals were generated under computer control. They are presented in Fig 1.

3. RESULTS AND DISCUSSION

Figure 1 shows a high level of activity in the LP muscle for the utterances /iti/, /ata/, /utu/, /idi/, /ada/ and /udu/ containing an oral consonant. Whereas its activity is suppressed for the utterances /ini/, /ana/ and /unu/ which contain a nasal consonant, suggesting that the vowels surrounding the nasal consonant in these utterances are fully nasalized. It is of interest to note that suppressed LP continues to maintain a certain level (though a low level) of activity even in entirely nasal utterances, at least in this subject. Further, the consonant/vowel, and vowel height related differences (e.g., higher levels for consonants than vowels, and for high vowels than low vowels) generally observed in LP activity during oral utterances show up in nasal utterances also. We will refer to these EMG patterns of the LP muscle in the description and discussion of PG muscle data below.

The PG muscle generally shows three peaks of EMG activity. The only exception is the utterance /ini/ where it shows only one peak. This lone peak in /ini/ and the last peak in all other utterances seem to be associated with velar lowering to open the nasal passage way at the end of the utterances, hence are of no concern to the topic of this study. Therefore, in this study, we will be concerned primarily with the presence or absence of the first two PG peaks. Incidentally, the PG muscle shows considerably higher peaks of EMG activity for the stressed (second) vowels as compared to those for the unstressed (first) vowels in Figure 1.

In this figure, the PG muscle shows suppression of its activity throughout the utterance /ini/ which contains a nasal consonant surrounded by fully nasalized high front vowels. This suggests that PG is not involved in lowering the velum for the nasal consonant or the nasalized vowels in /ini/ and that the velum is lowered passively - simply by the suppression of LP activity for these nasal sounds. This finding for the Hindi nasal consonant is consistent with those reported by Bell-Berti [1], Bell-Berti and Hirose [2] on English nasals, and by Benguerel et al [3] on French nasals, but inconsistent with those reported by Fritzell [5] on English nasals, and by Lubker et al [7,8] on Swedish nasals. The finding on the front nasalized vowels of Hindi is rather unexpected, since in a previous study Dixit et al [4] observed a high level of EMG activity in PG for the production of the front nasal vowels of Hindi. Similarly, in French a front nasal vowel was produced with a high level of activity in PG [3]. In these previous studies, however, the nasal vowels were contrastive, whereas in the present study they are contextually nasalized. Perhaps the PG muscle functions differently for contrastively nasal vis-a-vis contextually nasalized vowels.

On the other hand, in the utterances /iti/ and /idi/ which contain an oral consonant in the front oral vowel context, PG shows two peaks of EMG activity. These peaks seem to represent its antagonistic or reflexive activity related to the tongue-body fronting by the genioglossus muscle for these high front vowels. Notice that LP in Figure 1 is highly active for the oral utterances /iti/ and /idi/ and suppressed for the nasal utterance /ini/. Thus the velum is in an elevated position for the former two utterances and depressed for the latter utterance. When the velum is depressed, the tongue- body fronting would not result in stretching the PG muscle, but when it is elevated, the tongue-body fronting would stretch the PG muscle, which may cause stretch reflex in this muscle. Lubker and May [9] have hypothesized such a stretch reflex in PG under similar physiological conditions.

In Figure 1, two peaks of PG activity are also observed for the utterances /ata/, /utu/, /ada/ and /udu/ containing an oral consonant surrounded by the back oral vowels. Both these peaks appear to be

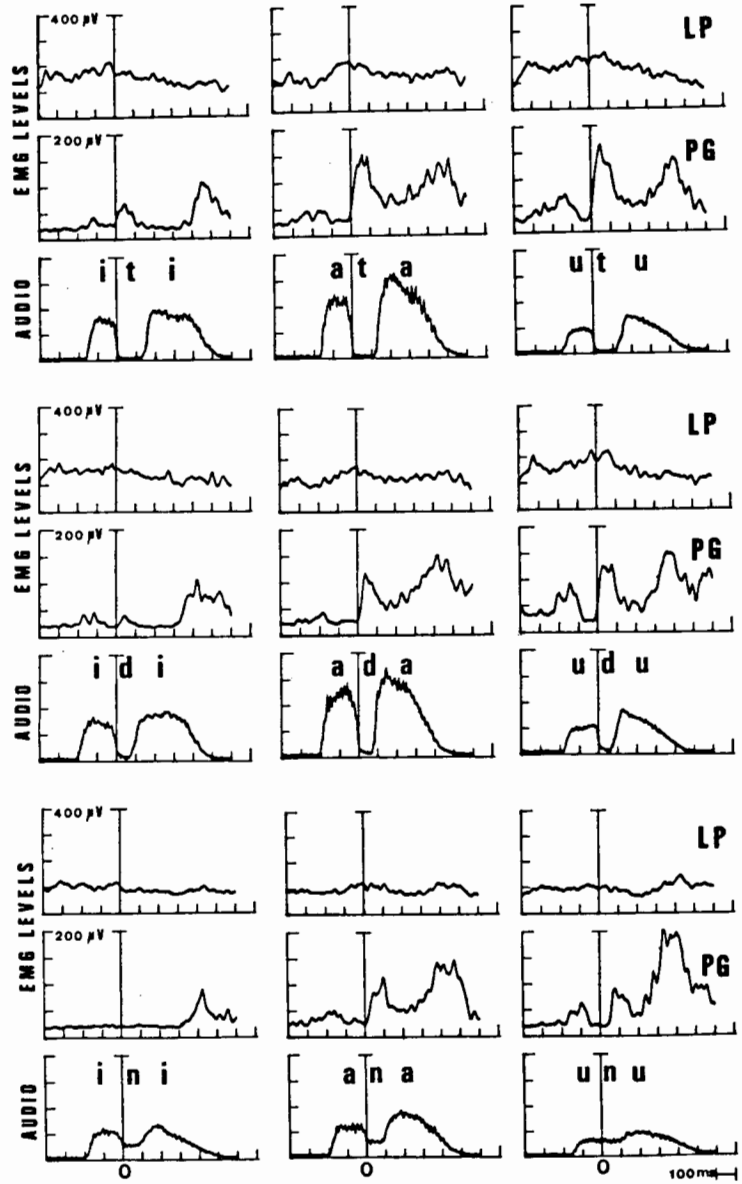

Fig. 1 Superimposed curves of ensemble averages of LP and PG EMG signals and audio signals for the experimental utterances. Audio and EMG signal amplitudes in arbitrary units and microvolts, respectively, are represented along the ordinate. The units along the absicssa represent 100 ms intervals. Zero (0) on the abscissa marks the line-up point used for ensemble averaging.

associated with the tongue-body movement and positioning for these back vowels. This is an expected result since LP shows a high level of activity throughout these utterances to stabilize the velum so that PG activity could contribute to the tongue-body movement and positioning (See condition or mode 1 in Lubker and May [9]). This result is in agreement with those reported in the other cited studies (particularly in [1,2,3,4]). In addition, two peaks of PG activity are also observed for the utterances /ana/ and /unu/ which contain a nasal consonant in the context of back vowels. Notice that LP activity is suppressed throughout these utterances as the back vowels surrounding /n/ are fully nasalized. However, EMG levels in the LP muscle for the utterances /ana/ and /unu/ never reach the zero level, that is the activity of LP is suppressed but not completely inhibited. As indicated earlier, LP maintains a certain level (though a low level, about 100 uV) of activity throughout nasal utterances. Because of this level of EMG activity in LP, it does not seem presumptuous to believe that the two peaks of EMG activity observed in PG for /ana/ and /unu/ are also relat
ed to the tongue-body movement and positioning for the back vowels surrounding the nasal consonant in these utterances. However, there is no PG peak that could be related to the nasal consonant in /ana/ and /unu/.

The above findings suggest that the activity of the PG muscle is primarily associated with the movement and positioning of the tongue-body for the production of oral and contextually nasalized back vowels, and antagonistically or reflexively related to the fronting of the tongue-body by the genioglossus muscle in the production of front oral vowels. The PG muscle does not appear to be involved in velar lowering either for the nasal or for the contextually nasalized vowels. Thus, the "gate- pull" model of nasal sound production fails to account for the results of the present study.

4. REFERENCES

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