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Tongue posture during speech

Ebtisam A. Kadhim[1] and Adnan R. Alassal[2]

[1]*Lecturer in Ibn-Hayyan University College Karbala*
[2]*Orthodontics ,Department of Dentistry, Ibn Hyyan Medical University , Karbala*

Abstract

An interesting finding of tongue posture is that the position of tongue constriction is influenced by the character of the phonation, and the articulatory pattern of the tongue movement with velar movement need certain parametric measurement. In this study, we consider all letters, /A/,/B/,/C/...., and so on, to know the movement and position of the tongue, constriction during phonation, and release at the end of the phonation, to use it as a guide to correct any pathological problem in the movement and position of the tongue during speech production. A sample of 10 each of normal and native speaking males and females, with no history of cleft lip and palate served as subjects for this investigation. Cephalometric x-ray analysis has been used in this study. Also, tongue movement tracking and its time points for start and end of consonant phonetics were performed. By using the method of synchronization and time measurement in lateral Cephalometric x-ray, this study shows that the coordinated function of tongue movement was evaluated on the speech production of vowels /Ka/, /Ko/, /Ku/, /ke/, /ki/, and /a/o/u/e/i /s/ sounds in normal subjects; these subjects were studied as the articulatory patterns were observed, and the time relationship between the articulatory movement and phonation was analyzed. The results show that the character of the vowels influenced the position of the tongue by a combination of the articulatory position between the velum and the tongue, which is considered a significant physiological factor; and the coordinated function of the tongue and palate shows a strong relationship and high correlation among all the oral units throughout the articulatory process.

Key words: tongue posture, speech, tongue constriction, phonation

INTRODUCTION

Articulation consists of quick and subtly coordinated activities among oral structures, such as soft palate, tongue, cheeks, lips, and teeth. The articulatory mechanism is mainly composed of velopharyngeal function and tongue activity. Tongue constriction was observed to be formed during phonation in a certain position of the oral cavity according to each phonation. Tongue comes in contact with the palate in the tongue–palate closure. The degree of closure is increased until the intraoral pressure can be obtained. An interesting finding is that the position of the tongue constriction was influenced by the character of the phonation (1, 2, 3). The articulatory pattern of the tongue movement with velar movement need certain parametric measurement. There are many attempts to measure the structure, position, and movement of the tongue. To analyze the tongue movement during speech, it is necessary to use the time element as the parameter for matching phenomena. Moll and Power used their own synchronization system in the cinefluorographic study of articulatory movement and demonstrated that useful and reliable data for normal and cleft palate subject can be obtained (8,10). Fujiki and Wada in 1967 also devised a synchronization system between cinefluorosocopy and phonetic sound, which uses the method of correct time for synchronization of articulatory movement (4, 5 ,6 ,7). Tokuro wada in 1970 found in normal subjects that the velopharyngeal closure was complete and the tongue constriction was observed in a certain position of the vocal tract according to each vowel sound (17). This tongue constriction was being formed during phonating and released at the end of phonation. The tongue contact with the palate in the tongue–palate closure was observed almost at the same position, the degree of closure then increases until the consonant /K/ sound was produced as a result of explosion of this air pressure by the quick opening of this tongue–palate valving. In 2005, several studies have been carried out regarding the tongue posture and its association with various malocclusion (20). Class II malocclusion is a consequence of backward position of the tongue that impedes the respiratory function, whereas class III condition is due to the forward position of the tongue. In this study, we consider all the letters /A/, /B/, /C/, …and so on to know the movement and position of the tongue constriction, and whether it is being constricted during and released at the end of its phonation, and whether it could be used as a guide to correct any pathological problem in the movement and position of the tongue during speech production.

MATERIALS AND METHOD

Twenty normal subjects randomly selected from Ibn Hayyan University College, 10 male and 10 females, severed as subjects for this investigation. All were normal speakers between ages 23 and 30 years, criteria for subject acceptance were that they be native speakers of the general Arabic dialect, have normal articulation, resonance, and balance, and have no history of cleft palate or palatal insufficiency. These subjects were subjected to parametric evaluation, which can be easily performed in our country. Cephalometric analysis was used for each subject by seating him/her and using cephalostat to visualize the structure more clearly. Two kinds of contrast media were used prior to the procedure. The midline of the tongue, the palate, and the posterior pharyngeal wall were coated with a barium sulfate solution, and iodoform powder was sprayed on the epipharyngeal and nasal sides of the soft palate. Lateral cephalometric x-ray photographs were taken using a general electric x-ray unit. Prior to the experiment, subjects were instructed to produce vowel /a/,/o/,/u/,/e/,/i/ and consonant sounds /ka/,/ko/,/ku/,/ke/,/ki/ and the /k/,/g/,/p/,/ng/,/f/,/v/,/n/,/t/,/d/,/th/, and /s/ *. These subjects performed two successive and five second trials for each task. The first trial was evaluated for the accuracy of production, and x-ray was taken midway through the second production. The distance from the source of the x-ray to the mid-sagittal plane of the subject was 58 inches, setting of the x-ray was 15 milliamperes, 90 kilovolts, and 21 pulses per second. The distance from the mid-sagittal plane to the cassette was 20 cm. The radiation dosage was 0.02 roentgen for each exposure, a total of 0.1 roentgen for five exposures, each was projected to life size. Five lateral cephalometric x-ray photographs were taken for each subject in a randomized sequence of the /a/,/o/,/u/,/e/,/i/ and /k/,/g/,/m//,/p/,/d/,/ng/,/f/, /v/,/t/,/th/, and /s/ and consonant /ka/,/ko/,/ku/,/ke/,/ki/. The measurement procedure involved tracing from all the head palates on to acetate transparencies and all tongue postures for each task were taken. All the measurements that were carried out for all 10 male and 10 female subjects following the trackings as given in Figure 1. Similar measurements for all 10 conditions of /ka/,/ko/,/ku/,/ke/,/ki/ and the tracking for the vowels /a/,/o/,/u/,/e/,/i/ were performed as shown in the Figure 2, and the tracing were also performed for the consonants /k/,/g/, /m/,/p/,/d/,/ng/,/f/,/v/,/n/,/t/,/d/,/th/ as shown in Figure 3 . The tracking was performed for vowels for the tongue movement at the following varying time points: (1) beginning of the tongue movement at rest position), (2) tongue constriction, (3) release of tongue constriction, and (4) end of the movement (rest position). These steps of tracking the tongue movements have been shown in the Figure 4. Tracking was also done for the following tongue movements and its time points from the beginning of a consonant:

1. Tongue–palate closure,
2. Maximum tongue–palate closure,
3. Tongue–palate opening,
4. Constriction of the vowel subsequent to the consonant /k/, and
5. Release of the tongue constriction and end of the movement (rest position)

RESULTS

General patterns of tongue articulatory movements, patterns of tongue movement in vowel phonation in a normal subject is shown in Figure 1. The Velopharyngeal closure was complete and the tongue constriction was observed in a certain position of vocal tract accordingly formed during the phonation and releasing at the end of phonation. The position of this constriction in /a/, /o/, /u/,/e/, and /i/ vowels are shown in the Figure 2, which are frames tracked at the onset of the phonation. For /k/ consonant, the pattern of the tongue movement was peculiar, as shown in Figures 3 and 4. The tongue contact with the palate in tongue–palate closure is almost at the same position. The degree of closure then increases until the intraoral pressure can be obtained. Thus, it was observed that the consonant /k/ sound was produced as a result of explosion of this air pressure by quick opening of the tongue–palate valving. The interesting finding was the position of the tongue constriction at the onset of the phonation (as shown in Figure 2). These positions were influenced by the character of vowels that were subsequent to the /k/ sound. Regarding the tongue movements in the vowels phonation, various time points to be considered are the start of the movement (rest position), the point of tongue constriction, the release of tongue "constriction," and the end of the movement (rest position). In the phonation of consonant /k/, the various time points considered are the start of the movement, the point of tongue–palate closure, the maximum tongue–palate closure, the point of tongue–palate opening, the point of tongue "constriction" of the vowel subsequent to (/k/ phonation) the release of the tongue constriction, and the final movement (rest position). These time points were considered to be significant both physiologically and acoustically, and were measured in relation to the onset of phonation. In the process of articulatory movement, these time points of velum and tongue were "combined" as they corresponded with each other. These combined elements might be considered as the "articulatory unit" between the velum and the tongue; both the velar and tongue movements occur exactly at the same time. Figure 3 illustrates the pattern of the tongue movement in a sequence /k-g/,/m/,/p.b/,/ng/,/f.v/,/n/,/t.d/,/th/, and /s/, which are traced at the onset of the phonation. The tongue constriction was observed in certain positions of the vocal tract according to each constant sound. This type of tongue constriction was formed during consonant production for the letters mentioned hereinbefore and released at the end of each consonant production.

DISCUSSION

The speech samples in this study are the vowels and the consonant /k/. The production of this consonant requires not only the velopharyngeal closure, but also tongue–palate closure, both of which create high intraoral pressure. The /k/ sound is produced as a result of an explosion of the air steam caused by a quick opening of the tongue palate valving. Most cleft patients have a distortion in the articulatory function in this consonant. In addition, they show many difficulties in obtaining the normal articulatory pattern, even if clefts have been repaired successfully (11, 12, 13, 17). Thus, this consonant is one of the appropriate speech samples for the analysis of the articulatory pattern of the tongue movements, and analysis of the movement of the tongue is difficult because of its amorphous contour clearing the movement demonstrate tongue position with satisfactory measurements, but the measures have the serve limitation that they are made only before or during the phonation. Moll and Power reported tongue-pharyngeal wall distance and the tongue –aveolus distance with significant results (9, 15).

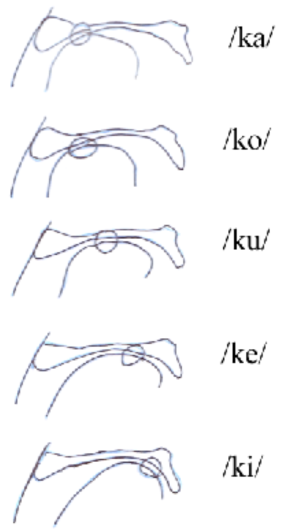

Figure 1. The position of tongue constriction in /k/, mark (0). The constriction area of the vocal tract caused by the tongue was located during the sequence of /ka/,/ko/,/ku/,/ke/,/ki/ from the back to front. The preceding consonant /k/ was effected by the characteristics of the subsequent vowels. These were traced from the frames at the onset of phonation.

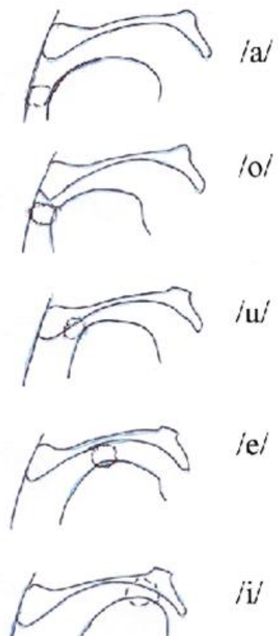

Figure 2.The position of tongue constriction in the vowels, mark(0) the constriction area of the vocal tract caused by the tongue was located during the sequence of /a/,/o/,/u/,/e/,/i/ from the back to front.

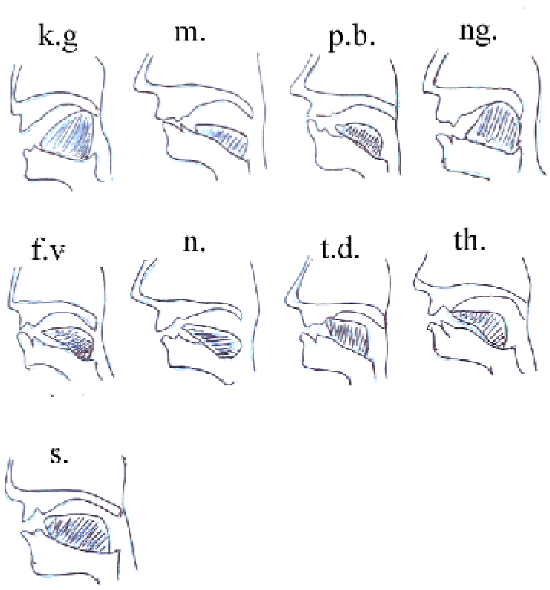

Figure 3. The position of the oral structures during the production of certain consonants.

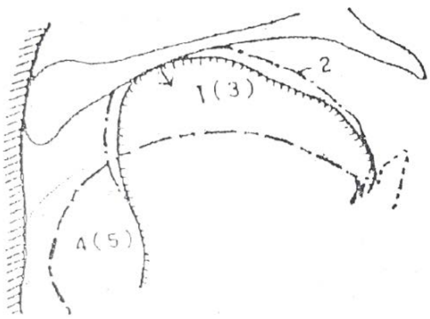

Figure 4. Tongue movement and its time points (consonant /k/), start of the movement (rest position), (1) tongue–palate closure, (2) maximum tongue–palate closure, (3) tongue–palate opening, (4) tongue constriction of vowel/k/, (5) release of its tongue constriction, and end of the movement (rest position).

The tongue position demonstrate satisfactory measurements, but a limitation is that the measurements can be done only before or during the phonation. Other studies reported the tongue–pharyngeal wall and the tongue–aveolus distances with significant results. Steven and House defined the parameter of the vocal tract analog in vowel production: position of the tongue constriction, size of the constriction formed by the tongue, and demonstration in the vicinity of the mouth opening (18, 19). In this study this notion was applied, the time point was selected when the vocal tract was made the narrowest by the physiological tongue constriction. The /ka/,/ko/,/ku/,/ke/,/ki/ constant generally consists of a combination of preceding constant + subsequent vowel (CV). The tongue–palate closure in various /k/ ,/s/ phonations when observed closely were found to take a different position that were affected by the characters of the subsequence of /k/ ,/s/ as displayed by the observations of Irwin (15). In addition, this phenomenon is observed at the very onset of phonation, as shown in Figure 3. It suggests the feature of articulation of the CV combination in a primitive form. The time relationship between the articulatory movement and sound varies among subjects. Consequently, the articulatory unit was defined in this study as the combination of the articulatory position(14, 16).

CONCLUSION

By the method of synchronization and time measurement in lateral cephalometric x-ray, the coordinated function of tongue movement was evaluated on the basis of speech production of vowels /ka/,/ko/,/ku/,/ke/,/ki/ and /a/,/o/,/u/,/e/,/i/ and /s/ ……. Sound in normal subjects were studied, the articulatory patterns were observed, and the time relationship between the articulatory movement and phonation was analyzed. From the results of this study, the following conclusions were drawn:

A. The position of tongue constriction in /k/ sound was located in a sequence of /ka/ ,/ko/,/ku/,/ke/,/ki/ from the back to front, and this sequence corresponded to that in the vowels demonstrating that the character of the subsequent vowels influenced their position.

B. We defined the combination of the articulatory position between the velum and the tongue, which are considered to have physiological significance.

C. Through the analysis of the articulatory units the coordination function of the tongue and palate was evaluated. Normal subjects showed a strong relationship demonstrating a small dispersion and a high correlation among all units throughout the articulatory process.

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