COMPLEX NATURE OF THE SEEMINGLY SIMPLE VOCAL FOLD CYCLE

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ABSTRACT

Vocal fold vibration by phonation is currently viewed as a passive, myoelastic-aerodynamic process [1] of simple opening and closing of the glottal chink at fundamental frequency.However, vibration recorded directly from the thyroid cartilage could prove this seemingly simple vocal fold cycle to be more complex and associated with a probably reflex event.

1.INTRODUCTION

Laryngeal anatomy does seem to be simple at first sight, see Fig.1. As such it could

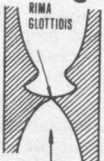


Fig.1 Simplified laryngeal section

Fig.2 Ewald's pipe

in the past do with the substitute model of a kind of Ewald's pipe, see Fig.2.

2.LARYNX BY PHONATION

Phonation is measured by methods focusing on the behaviour of the proper glottal chink opened by the exhaled air stream as seen in Fig.3, large arrow. The lateral opening along the axis y , see arrows, is well evident in the electroglotto -

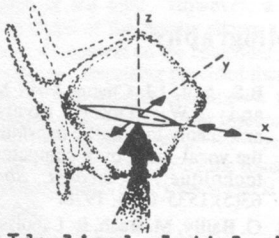


Fig.3 Idealized glottal chink

graphic recording (EGG) of Fig.4 below. This is matched by actualized frame sectors in the upper part of Fig.4

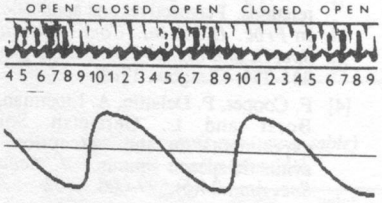
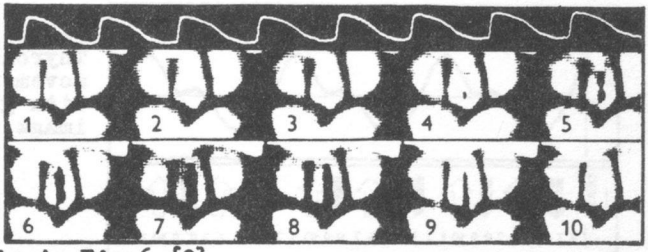


Fig.4 Simultaneous recordings of EGG signal and glottal chink image

according to Hirose (Fig.5) [2]. Recordings belonging to one vocal fold cycle are numbered 1 to 10. The course of EGG impedance changes informs about the way the chink is opened or closed. Other information can be obtained from a simultaneous recording of thyroid cartilage vibration. An acceleration recorder can be placed on the thyroid cartilage,

Fig.5 Glottal chink image according to Hirose



with an example in Fig.6.[3]

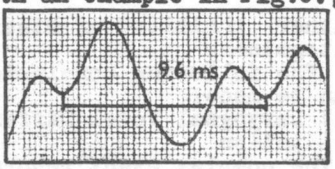


Fig.6 Course of thyroid cartilage amplitude

The current conception would expect an uncomplicated process corresponding to simple opening or closing of the chink. The measured course, however, describes a complex event with two oscillations within one cycle.

3.ACCOUNT OF THE COMPLEX EVENT

Let us inspect the larynx more closely, noticing the two ligaments joining the arytenoid with the thyroid cartilage. The upper one, ligamentum ventriculare, proba - bly has a centring role, the ligamentum vocale playing the part on an oscillator for the thyroid cartilage as a resonator[4] , [5]. A simplified description of laryngeal activity in the course of the four basic phases of the vocal fold cycle can be derived from Fig.7. The first phase is preceded by the mentioned setting up of phonatory position. The symbolic section through the thyroid cartilage passes from the respiratory to the centred position. Now the thyroid cartilage can vibrate arround this new centred position. During the first phase, the expired air stream

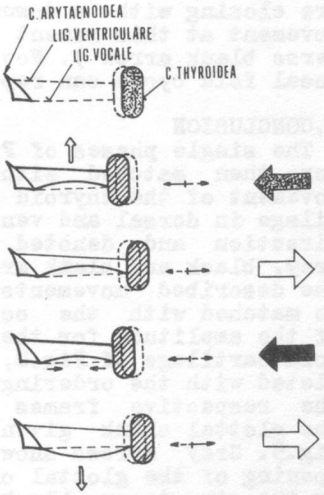


Fig.7 Four phases of the vocal fold cycle

stretches the vocal ligament pulling the thyroid cartilage inwards. Blank arrow indicates upward movement of the vocal folds. During the second phase, due to its own elasticity, the thyroid cartilage returns back to its equilibrium at once to overshoot outwards. During the third phase, the musculus vocalis probably contracts to attract the thyroid cartilage. During the last,fourth phase, the thyroid cartilage, again due to its own elasticity,will first return back at once to overshoot, taking away with it the vocal ligament and giving it an im - pulse to a downward movement.

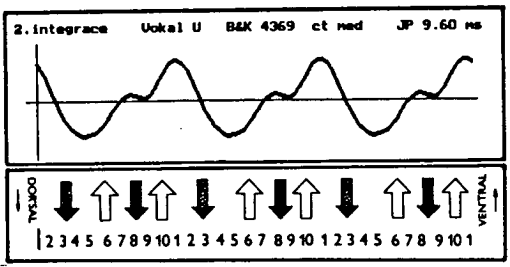


Fig.8
Thyroid cartilage movement matched with glottal chink image

In this way the vocal folds are closing with a downward movement at this moment (inverse blank arrow). Now the vocal fold cycle can repeat.

4.CONCLUSION

The single phases of Fig.7 were then matched with the movement of the thyroid cartilage in dorsal and ventral direction and denoted by grey, black and blank arrows. The described movements can be matched with the course of the amplitude for the thyroid cartilage of Fig.8, completed with the ordering of the respective frames for the glottal chink given in Fig.5. Grey arrows show the opening of the glottal chink by the air stream, blank arrows the elastic backward movement of the thyroid cartilage, and black arrows the presupposed presence of a neuroreflex event , whose role it probably is to close the glottal chink before its subsequent opening. Compared with the situation in Fig.4, we thus obtain new information.What we now have is not only information on the progress of the opening and closing,but also on the way the glottal chink is being closed. So far, this process is accounted for by reference to Bernoulli's effect. The presence of neuromuscular junction is supported by the results obtained in subjects suffering from some organic lesions of the nervous system, in whom this event was either inhibited or missing altogether.

The following conclusions can be made:

4.1 Laryngeal Vowel Differentation

The complex event recorded straight on the thyroid cartilage is of vowel differentiated nature [2] .

4.2 Laryngeal Diagnostic

Investigation of laryngeal vibrations offers diagnostic utilization in some organic lesions of the nervous system.

4.3 Study of Voice

The described complex event, that can be observed during speech and two octaves of a modal voice, can be used in the study of voice production.

5. REFERENCES

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