Evaluation of vocal cord vibration using high-speed imaging in cases of vocal cord nodules

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Introduction

Vocal cord nodules usually affect both vocal cords, and are associated with glottal closure insufficiency anterior or posterior to the nodule during phonation. This can be confirmed on laryngeal stroboscopy; in addition, decreased mucosal waves are often observed. We herein investigated the feasibility of numerically evaluating these types of abnormal vocal cord vibration using high-speed imaging.

Subjects

Subjects were 6 women with vocal cord nodules and 16 healthy female volunteers. Age range was 21 to 30 years (mean, 24.5 years) for the nodule group and 19 to 31 years (mean, 25 years) for the control group. There was no statistical difference in age between the groups. A doctor with extensive experience at voice clinics confirmed the diagnosis of vocal cord nodules, which were defined as laterally spreading swellings in the medial area of both vocal cord membranes.

Method

Observations of the vocal cord were conducted using a high-speed video system (Kay equipped with a FASTCAM-PCI camera (Photron). Subjects were instructed to vocalize the vowel sound /a/ at a comfortable pitch and intensity for analysis. Images taken at a speed of 2000 frames/s were analyzed using Kay Image Processing Software (KIPS) with regard to the following: 1) maximum or minimum area, maximum or minimum opening at the midpoint of the glottis, and speed quotient (SQ) from montage with glottal area waveform (GAW) analysis, 2) vibration amplitude in the anterior, medial, and posterior areas of both vocal cord membranes using point FFT analysis, and 3) determination of glottal closure rate using kymograph edge analysis (KEA).

Results

No clear inter-group differences were observed for GAW analysis. Vibration amplitude measurement using point FFT analysis revealed greater vibration at multiple sites in the normal group, with a statistically significant difference on the Mann-Whitney U test. Glottal closure rate was higher in the nodule group for the medial area of the membrane, where the nodules were located, and higher in the normal group for the anterior and posterior areas of the membrane. The Mann-Whitney U test showed a significant difference (p=0.0150) for the anterior area of the membrane.

Discussion

Considerable variation in data was observed for certain parameters in both the nodule and normal groups. In addition, although the number of cases investigated was small, significant inter-group differences were observed for anterior glottal closure insufficiency and vibration amplitude of the vocal cord. Therefore, glottal closure insufficiency and decreased mucosal waves, which are characteristics of vocal cord nodules, were successfully evaluated.

Conclusion

Objective assessments of vocal cord vibrations can be performed by analyzing images obtained by high-speed imaging.