JITTER AND SHIMMER IN VOCAL FOLD NODULES, POLYPS AND EDEMAS BEFORE AND AFTER PHONOSURGERY

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ABSTRACT

Perturbation analysis in patients suffering from nodules, polyps and Reinke's edemas are studied by means of acoustic (MC), electroglottographic (EGG, Lx) and flow glottographic (FGG) waves before and after microlaryngoscopic phonosurgery.

INTRODUCTION

According to the myoelastic theory, pressure below the vocal cords increases till the glottis opens setting the vocal folds in vibration. In the light of the source-filter theory of speech production, larynx is the source with the vocal folds chopping the column of exhaled air. In this way the "buzz" generated in the glottis, becomes audible as a vocal sound, outside the lips, by the action of the vocal tract, that behaves as a filter.

Vibratory pattern of the vocal folds is not always regular. Perturbation is the term applied to these deviations from regularity. Multiple indices for measuring perturbation have been developed. Most of them represent some sort of average of the difference between the periods (jitter) or amplitudes (shimmer) of successive vocal cycles [1].

Since the first attempts to create objective measures for perturbation analysis by Von Leden, research on this matter has generated numerous papers, a comprehensive overview of them can be found in Laver et al [2].

Several factors have been suggested as possible contributors to irregularity in vocal fold vibration [3]: 1) unsteadiness in muscle contraction in the laryngeal and respiratory system; 2) turbulence in glottal air stream; 3) instability in the jet emerging from the glottis; 4) asymmetry in the mechanical or geometrical properties of the two vocal folds; 5) nonlinearity in the mechanical properties of the vocal fold tissues; 6) changes in coupling between the vocal fold and vocal tract and 7) mucus riding on the surface of the vocal folds.

If perturbations are present in normal phonation, it stands to reason that jitter and shimmer should be increased in the presence of vocal fold pathology. So perturbation could be employed to detect vocal fold pathology and to evaluate the resulting disordered voice.

Nodules, polyps and Reinke's edemas are common findings of ENT practice. Management of this vocal abuse pathology (VAP) includes voice therapy and surgery.

Phonosurgery (PS) refers to surgical techniques, designed to improve or restore the voice, based in the three layer structure of the vocal folds.

The first purpose of the study was to establish the clinical usefulness of perturbation measures to follow patients that underwent phonosurgery. The second is to investigate the influence of the type of voice signal employed for perturbation analysis: microphonics (MC), laryngographic (Lx), inverse filtered (FGG). We studied RAP (relative average perturbation factor) [4] for frequency perturbation and shimmer in dB for amplitude perturbation [5].

METHODS

1. Signal acquisition hardware. Signals from a microphone (MC) (Shure Prologue), a Fourcin's Laryngograph (Lx) (Kay Elemetrics) and an inverse filtering system (FGG) provided with a Rothenberg mask (Glottal Enterprises) and a filtering system designed by the Tech. Dep. of Malmö General Hospital, were digitized two by two (MC, Lx) in dB, with a sampling rate 51200 Hz, using a 486, 8 Mb RAM PC.

2. Test procedures. All tests were carried out in three different moments: before surgery, 2 weeks and 1 month after surgery. a) Subjects. 52 patients (32 polyps, 11 Reinke's edemas and 9 nodules) were examined using laryngostroboscopy. Age ranged from 65 to 15, mean 40. Sex was 22 (M): 30 (F).

b) Recording. Recordings made in a sound treated booth were stored in a rewritable optical disk 1.3 GB.

c) Voice tasks. The first task was to produce 2s of a sustained /a/ with Rothenberg mask and laryngographic electrodes in position, at a comfortable pitch and loudness. Both signals (FGG, Lx) were simultaneously recorded. The second task was to produce 2s of a sustained /a/ at 5 cm mouth-to-microphone distance with laryngographic electrodes in position, at a comfortable pitch and loudness. A simultaneous recording of both signals (MC, Lx) was made. This second task was performed twice (acoustic analysis II and III).

d) Analysis. analysis was based on sustained /a/ because formant configuration in this vowel was more suitable for inverse filtering procedures. Relative average perturbation (RAP) was used for jitter measures, and shimmer in dB for calculus of amplitude perturbation.

RESULTS AND DISCUSSION

Increased perturbation in voice may result from unsuitable patterns of vocal fold vibration, induced by the presence of pathology. Attempts of objective evaluation of voice in patients were restricted to medical research voice labs. Recent computer development has made this attempt in the clinic reasonable.

We evaluated the effect of nodules, polyps and edemas in the capacity for regular vibrations of the vocal folds. A nonparametric ANOVA test (W-Wilcoxon) for paired data was used to establish the influence of choosing a determined production of the vowel /a/ of the different possible trials. There were no significant differences in jitter and shimmer values, supposed the same type of voice signal was employed (MC, Lx or FGG).

The same test showed significant differences (p<0.05) for jitter and shimmer depending on the type of wave.
used for perturbation calculus. Our results are opposite to those found in other articles [6] where these differences proved erratic. According to our results FGG-jitter values were always higher than Lx-Jitter (p<0.05). Differences could be owed to the manual process for filtering the flow glottographic signal, particularly before PS when the register was more irregular and a correct filtration specially difficult to achieve. Despite this we think differences are basically due to the distinct nature of the phenomena represented by both waves.

Patients with polyps showed before PS superior values of shimmer computed on FGG basis than Lx basis. But two weeks and one month after PS Lx-shimmer was superior to FGG-shimmer. A possible explanation for this is that once the lesion is excised, the small volumes of air liberated with each vocal cycle, represented by the peaks of the FGG, should be more uniform, as the glottal closure improves and mechanical balance of vocal folds is restored. In the case of Lx wave peaks could be contaminated with artefacts. These artefacts, even present before PS, are probably masked by the superior grade of variation due to the lesion presence.

Patients with Reinke's edema showed before PS higher values for shimmer than in the case of inflammatory signs were more evident in the free margens of the vocal folds were more irregular, glottic closure was more superior to the values obtained in our study, provide more evidence for definite voice quality improvement in our patients.

For a correct interpretation of our results it should be noticed certain differences of our study with refered works. For analysis we employed a sustained /a/ while others used the vowel /i/ [6,15] and with older subjects than our patients (mean age 40).

CONCLUSIONS

1.-Jitter and shimmer are increased in nodules, polyps and edemas no matter the type of wave used for the analysis (MC, Lx or FGG).
2.-Perturbation analysis does not make differential diagnosis among different pathologies.
3.-Perturbation values do not depend on the trial chosen for analysis (supposed the same evolution moment of the study is compared), but depends on the type of wave used.
4.-Perturbation analysis is a useful method to evaluate results in phonosurgery.

REFERENCES