STUDIA PHONOLOGICA XI (1977)

Vocal Shimmer of the Laryngeal Polyp

Kazutomo KITAJIMA

Abstract

1 Pre-operative vocal shimmer were determined in patients scheduled for micro-laryngeal surgery. These parameters were retested post-operatively and the comparison of pre-and post-operative results was found to afford an objective means by which to gauze the extent of recovery of the patient's vocal function.

Advances in the techniques of phonosurgery have facilitated the approach to the etiology of lesions. The objective assessment of the voice before and after operation is thought to be indispensable to a proper evaluation of the operation.

For a number of years we have been applying several tests for the pre- and post-operative evaluation of patients receiving phonosurgery. These include (1) aerodynamic analysis with a pneumotachograph or a spirometer, (2) acoustic analysis with a sonagraph or more recently with a digital computer, (3) stroboscopic examination of the vibrating vocal cords[1].

In auther's previous article[2] vocal shimmer was compared in normal and pathologic larynges. In this study vocal shimmer was analyzed pre- and post-operatively, in order to learn the usefulness of this parameter in evaluation of phonosurgery.

Subjects

The subjects were 14 males and 6 females with vocal cord polyps, aged from 27 to 68. The diagnosis of polyp was made through indirect laryngoscopy. The size and location of the polyp varied among the patients.

Methods

(1) Essentially, the approach was to record the voice of each subject, and to digitize the vocal signal so that the amplitude could be measured with the aid of a digital computer. The voice signal of 360 msec. in duration was then measured and from this measurement the amount of shimmer was calculated. The individual steps involved are omitted here, since details have been described elsewhere[2]. Vocal shimmer was expressed as the mean amplitude difference between consecutive cycles in dB, using the following:

$$\text{vocal shimmer} = \frac{\sum_{i=1}^{N} 20 \times \left| \log \frac{A_{i+1}}{A_i} \right|}{N}$$

Kazutomo KITAJIMA (北嶋和智): Department of Otolaryngology, School of Medicine, Kyoto University Kyoto, 606, Japan.

Where N=the number of pitch periods measured

A_i=the amplitude of period i

A_{i+1}=the amplitude for the period following A_i

(2) Listener judgement of the voice

The change in the value of vocal shimmer resulted from the surgery should be affected by the proximity of the polyps to the margin of the vocal cord and also by the size of them. In order to minimize the effects of these parameters, the measured shimmers were compared with the scores of the listener judgement as was described below.

A pair of pre- and post-operative voice of the magnetic tape was edited for each subject. The order of pre- and post-operative ones within the pair was arranged randomly in order to avoid the biased judgement of the listeners.

Four persons who had experiences in voice study were asked to judge the followings for each subject.

(1) Which voice within the pair has lower degree of hoarseness compared with the mate? (2) How much change in magnitude was noticed between these two voices? The magnitude of change was divided into four degrees: 0, unchanged; 1, slight change; 2, moderate change; and 3, marked change. The score of four listeners was averaged for each subject.

RESULTS AND DISCUSSION

Pre- and post-operative values of vocal shimmer are listed in table 1. The asterisks in this table indicate that the values exceed the normal limit of 0.19 dB, determined in authers' previous article[2]. Five of the 14 subjects who had abnormal values before operation fell within the normal limit after operation; the other nine subjects still had values exceeding the normal limit after operation. Six subjects showed the change of vocal shimmer within the normal region. In general, the post-operative values were lower than pre-operative ones at the 5% significance level.

The difference between pre- and post-operative values, obtained by subtracting the latter from the former, for each subject is listed in table 2. The magnitude of change varied with the subject from −0.02 dB to 1.25 dB.

In table 3, the mean scores of listener judgement for each subject are listed. All showed improvement except one, which is indicated by an asterisk. These scores were compared with the changes in vocal shimmer, as shown in figure 1, where score of listener judgement is plotted on the abscissa, and the value of vocal shimmer on the ordinate. The dark dot and the open circle indicated pre- and post-operative values respectively, and these are linked by a vertical arrow for each subject. It can be noticed in this figure that subjects showing larger changes in vocal shimmer also showed generally larger scores in listener judgement. In order to demonstrated this finding more clearly, the values listed in table 2 (that

Table 1. Vocal shimmer in dB.

Subject number	Pre-operative	Post-operative
1	0.14	0.08
2	1.42*	0.17
3	0.19	0.14
4	0.57*	0.24*
5	0.39*	0.38*
6	0.53*	0.32*
7	0.28*	0.30*
8	0.32*	0.32*
9	0.24*	0.16
10	0.55*	0.33*
11	0.35*	0.28*
12	0.30*	0.32*
13	0.14	0.13
14	0.25*	0.24*
15	0.30*	0.13
16	0.09	0.06
17	0.24*	0.09
18	0.18	0.06
19	0.08	0.07
20	0.21*	0.18

Table 2. Difference between pre- and post-operative values of vocal shimmer.

Subject number	dB.
1	0.06
2	1.25
3	0.05
4	0.33
5	0.01
6	0.21
7	−0.02
8	0
9	0.08
10	0.22
11	0.07
12	−0.02
13	0.01
14	0.01
15	0.17
16	0.03
17	0.15
18	0.12
19	0.01
20	0.03

Table 3. Mean score of listener judgement.

Subject number	Score
1	0.6
2	2.0
3	0.6
4	1.8
5	0
6	1.2
7	0.2
8	0.4
9	0.8
10	1.0
11	0.4
12	0.2
13	0.4
14	0.2
15	1.0
16	0.6
17	0.2
18	0.8
19	−0.4*
20	1.8

0, unchanged; 1, slightly improved; 2, moderatly improved; 3, markedly improved.
* more hoarse after operation.

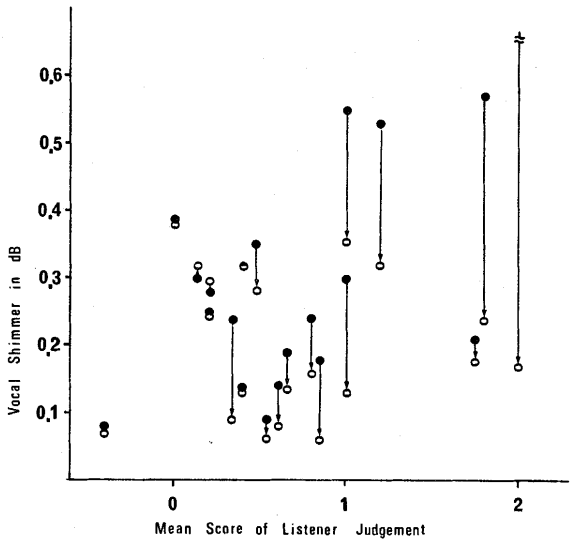

Figure 1. Values of vocal shimmer in dB. dark dot, pre-operative value; open circle, post-operative value. Ratings of listener judgement 0, unchanged; 1, slightly improved; 2, moderately improved; 3, markedly improved.

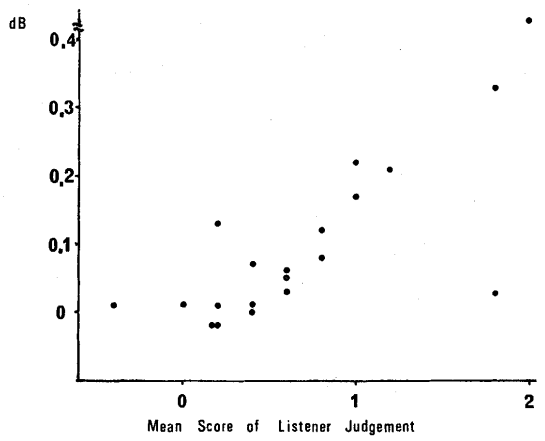

Figure 2. For each subject, the difference between pre- and post-operative values of vocal shimmer was plotted against the mean score of listener judgement on the abscissa.

is, the length of the arrows) were plotted against the scores of listener judgement in figure 2. It was found that there is a positive correlation between the two parameters ($r=0.65$ at the 1% significance level). However, some subjects showed a great deviation from the general trend, that is, the score of listener judgement did not correspond with the value of vocal shimmer. Vocal shimmer defined in this study is thought to reflect the irregularity of the fundamental cycle but the high frequency noise. Acoustically, this noise is an important factor in the perception of hoarseness. The hoarse voice is thought to have these two factors, that is, irregularity of the fundamental cycle and high frequency noise. The

ratio and degree of these two factors are various depending on the pathology of the vocal cords. If the former factor is dominant, hoarseness is well reflected in the vocal shimmer defined in this study; but if the latter factor is dominant, vocal shimmer does not correspond closely with the perceived hoarseness. This fact is thought to be the cause of the deviation seen in figure 2.

Isshiki et al.[3] made a perceptual study of hoarseness using a semantic differential technique in which they described four factors which can be related to the acoustic features of laryngeal pathology. These four factors are R(rough), B (breathy), A(asthenic) and D(general degree). In their study, laryngeal polyp was characterized by a dominant R factor. This factor is described as having a close correlation with the irregularity of the fundamental cycle. The positive correlation found in figure 2 is consistent with these reports and supports the usefulness of the vocal shimmer in the objective assessment of phonosurgery for the laryngeal polyp.

References

1) Gould, W. J.: Quantitative assessment of voice function in microlaryngology. Folia phoniat, 27: 190–200, 1975.
2) Kitajima, K. and Gould, W. J.: Vocal shimmer in sustained phonation of normal and pathologic voice. Ann. Otol. Rhinol. Laryngol, 85: 337–341, 1976.
3) Isshiki, N., Okamura, H., Tanabe, M. and Morimoto, M.: Differential diagnosis of hoarseness. Folia phoniat, 21: 9–19, 1969.
4) Lieberman, P.: Perturbation in vocal pitch. J. Acoust. Soc. Amer., 33: 597–603, 1961.
5) Lieberman, P.: Some acoustic measures of the fundamental periodicity of normal and pathologic larynges. J. Acoust. Soc. Amer., 35: 344–353, 1963.
6) Koike, Y.: Vowel amplitude modulation in patients with laryngeal diseases. J. Acoust. Soc. Amer., 45: 839–844, 1969.
7) Smith, W. R. and Lieberman, P.: Computer diagnosis of laryngeal lesion. Comput Biomed Res., 2: 291–303, 1969.
8) Crystal, T. H. and Jackson, C. L.: Extracting and processing vocal pitch for laryngeal disorder detection. J. Acoust. Soc. Amer.. 48: 118, 1970.
6) Hecker, M. H. L. and Kreul, E. J.: Decsription of the speech of patients with cancer of the vocal folds. Part 1: Measurement of fundamental frequency. J. Acoust. Soc. Amer., 49: 1275–1282, 1971.
10) Kitajima, K., Tanabe, M. and Isshiki, N.: Pitch perturbation in normal and pathologic voice. Studia Phonologica (Kyoto), 9: 25–32, 1975.
11) Hiki, S., Matsuoka, K., Kakita, Y., Imaizumi, S., Hirano, M. and Matsushita, H.: A study on acoustical analysis of hoarseness. J. Acoust. Soc. Jap., 31: 504–506, 1975.
12) Takahashi, H. and Koike, Y.: Perceptual dimensions and acoustical correlates of pathologic voices. Acta Otolaryng Suppl. 338, 1–24, 1976.

(Aug. 31, 1977, received)