Impact of topical anesthesia on acoustic characteristics of voice during laryngeal telescopic examination

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OBJECTIVE: The purposes of this study are to investigate the impact of topical anesthetic alone and with concurrent laryngeal telescopic examination on acoustic characteristics of vocal fold function. Comparison with phonation in controlled conditions may imply diagnostic information from the examination.

STUDY DESIGN: Thirty males evaluated as having a normal voice were included in the study. The subjects were asked to phonate sustained /i/ with a naturally comfortable pitch and loudness in three consecutive experimental sequences as “control condition,” “anesthetic condition,” and “telescopic condition.” Acoustic analysis of fundamental frequency, jitter, shimmer, and harmonic to noise ratio in the three different conditions were executed.

RESULTS: The mean and standard deviation of Fo in control condition, anesthetic condition, and telescopic condition were 130.1 ± 18.5 Hz, 125.7 ± 19.7 Hz, and 173.2 ± 35.1 Hz, respectively. The telescopic condition showed more negative change than that in control condition and anesthetic condition in other parameters. There was a significant difference (P < 0.001) between control condition and telescopic condition in all four parameters.

CONCLUSIONS: This study showed that anesthesia has little effect on voice performance for subjects with a normal voice. On the other hand, the acoustic characteristics changed significantly during telescopic performance. When doing interpretation of acoustic data, the abnormality of the acoustic characteristics might be the result of the procedures and not reflect vocal pathology. Laryngeal variations due to manipulation of telescope should be ruled out.

The clinical value of laryngeal telescopic in conjunction with videostroboscopic examination of the larynx for evaluation of voice disorders has been well established. Laryngeal image examination is usually performed with a rigid telescope or a flexible fiberoptic. The rigid telescope offers a clearer and sharper view of the larynx. It also provides significant magnification of the vocal folds, allowing precise documentation of the anatomical and functional changes of the larynx or vocal fold activities, such as organic lesion, hyperfunction, glottal shape, amplitude of movement, character of mucosal wave, periodicity, etc. The result has been found diagnostically useful.

Laryngeal telescopic is widely used at present. Generally the technique is performed with the patients seated straight in the sniffing or chin-up position, opening the mouth, and protruding the tongue; the examiner assists by holding the protruding tongue of the patients for the evaluating procedures. Then the patients are asked to phonate a sustained /i/ sound at comfortable pitch or consciously in a particular pitch to observe the laryngeal activity.

In clinical practice, the patients usually require minimal topical anesthesia applied to the oropharynx to reduce oral sensation and excessive gagging in order to permit the laryngeal telescope to be completed. In Peppard’s report, the use of topical anesthetic should result in improved images and enable more appropriate management of voice disorders. The common selection of a topical anesthetic is 4% to 8% xylocain (lidocain) oral spray. It had been assumed in clinical practice that the use of oral topical anesthesia would not affect laryngeal observation.

Under the procedures of laryngeal telescopic, the patients seem to be not phonating in a normal daily phonation condition, even though the patients were asked to phonate consciously at the pitch similar to habitual phonation in normal conditions. Such non-physiological phonation may alter the vocal fold function and can bias the evaluation and management of those with or without vocal pathologies.

What would be changed in acoustic characteristics under telescopic compared with that under normal control condition? The changes in acoustic data caused by the local anesthesia or telescopic procedures may seem to be disorientated to vocal pathology, thus leading to the inappropriate judgment and recommendation.
Lim et al\textsuperscript{10} reported that during performance of fibroscopic endoscopy via nasal cavity, neither the topical nasal anesthetic nor the procedure itself might alter the acoustic characteristics of phonation with /i/ sound significantly. Sulter et al\textsuperscript{12} reported that after topical anesthetic of the oral cavity with the comfortable phonation of /i/ sound during laryngeal telescopy, the averaged fundamental frequency in males was 171 Hz, which seemed higher than that of phonation in the normal male.

There were only a few studies mentioning the acoustic characteristics during performance of laryngeal telescopy, especially comparing it with the normal phonation condition.

The purposes of this study are to investigate the impact of topical anesthetic alone and with concurrent laryngeal telescopic examination on acoustic characteristics, and to see whether the procedures might have an effect on acoustic characteristics of vocal fold activities. Comparison with control phonation condition may imply diagnostic information from the examination.

**METHODS**

**Subjects**

The participants of this study were 30 male volunteers without history of laryngeal surgery, voice disorders, or upper respiratory tract inflammation within one month, and rated by auditory perception as normal voice quality. The mean age of subject was 29.7 years old, with a range of 20 to 38 years. All subjects passed standard audiometric screening test at 20 dB hearing threshold level for frequencies from 250 Hz to 8000 Hz with an audiometer (GSI 16, Clinical audiometer; Grason Stadler, Inc., Madison, WI). All subjects were perceptually judged to have normal voice quality by 2 certified speech pathologists with a six-interval scale from “normal” to “severely impaired” conditions. The variables comprised pitch, loudness, speech rate, and quality. Those who had “normal” on all the above perceptual variables were qualified in this evaluation.

All procedures were conducted in an otolaryngology clinic with ambient noise under 45 dB sound pressure level. The subjects were oriented to the test procedures and standardized instructions from the investigator. Voice samples from each subject were collected in 3 consecutive experimental sequences as “control condition,” “anesthetic condition,” and “telescopic condition.” Voice task was carried out at a naturally comfortable condition, not consciously in a particular frequency during each voice sample recording. The entire procedure was completed in approximately 40 minutes. Sony electric directional microphone (Sony ECM-MS 907, Tokyo, Japan) and digital recorder (Sony MD MZ-R900) were used to record audio signals for acoustic analysis.\textsuperscript{13}

**Voice Sample**

**Control condition.** The voice sample in normal phonation condition without anesthesia and telescopy served as the control phase in the study. Voice tasks carried out included self-introduction, counting from 1 to 10, and reading a paragraph. This sample was later used for auditory perceptual rating as a voice model by the speech pathologists. Then the subjects were asked to phonate a sustained /i/ sound at a naturally comfortable pitch and loudness 3 times, at least 3 seconds at each production. This recording was the voice sample of control condition (CC) and was used for acoustic analysis.

**Anesthetic Condition.** After control voice recording, all subjects received sprays twice of 4% xylocain (Nagashima newpeerless, Tokyo, Japan) in 3-minute intervals. The anesthetic was sprayed on the structure of the oropharynx, including base of tongue, posterior pharyngeal wall, and soft palate. A 5-minute latency was allowed for the anesthetic to take maximal effect.\textsuperscript{9,10} Voice sample of sustained phonation /i/ was then followed, which was recorded as voice sample of anesthetic condition (AC).

**Telescopic Condition.** Telescopic procedure was performed soon after the anesthetic voice sample was recorded to prevent the depletion of anesthetic effect. A certified senior otolaryngologist performed this procedure. The subjects were seated straight in a chair with their chin elevated, mouth open, and tongue protruded, extended, and held by the otolaryngologist. A 70° angle Wolf rigid laryngeal telescope (8706cj, Karl Storz, endoscope; Tuttlinger, Germany) was attached to Kay videostrobostrobic equipment (Kay RLS 9100; Kay Elemetrics Corp., Lincoln Park, NJ). The telescope was positioned into the oral cavity as far as possible. The entire picture of the glottis and vocal folds was centered in the image.

Once the otolaryngologist had introduced the telescope into the subject’s mouth, the halogen light was switched on by a foot pedal. The subject was instructed to phonate an /i/ sound at a naturally comfortable condition, not consciously in particular frequency during both halogen light and stroboscopic light, creating the same vision in which the whole vocal folds were visualized. The subject was asked to sustain production 3 times, at least 3 seconds at each production. The voice was recorded as voice sample of telescopic condition (TC). The image was simultaneously recorded to rule out organic lesions. Only the voice sample taken under the halogen light was utilized for acoustic analysis.
owing to the fact that the high-frequency noise produced by stroboscopic light would influence the result.

**Voice Analysis.** Voice samples from the vocal task of sustained phonation /i/ of CC, AC, and TC were analyzed for 4 acoustic parameters, which included fundamental frequency (F₀, Hz), jitter (%), shimmer (dB), and harmonic-to-noise ratio (H/N). The recorded voice samples were transformed to the Kay CSL 4300B acoustic analysis system with 44.1 Hz sampling rate. The most stable 2 seconds' phonation of sustained /i/ was taken for analysis.15 A one-way analysis of variance with repeated measurements was used to analyze the variables of 4 acoustic parameters, respectively. Post hoc test using Scheffe-type adjustments was conducted to determine if the significant differences for these variables were associated with the use of anesthesia and laryngeal telescope.

**RESULTS**

Table 1 showed the mean and standard deviation of F₀ in CC and AC, which were 130.1 ± 18.5 Hz and 125.7 ± 19.7 Hz, respectively. In TC, the mean F₀ was 173.2 ± 35.1 Hz. The mean F₀ of TC was apparently higher than that in CC and AC, and was out of the normal range for the male voice.

The mean and standard deviation of jitter and shimmer in CC were 0.386% ± 0.172% and 0.127 ± 0.04 dB, respectively. The mean and standard deviation of jitter and shimmer in AC were 0.468% ± 0.221% and 0.133 ± 0.039 dB. In TC, the mean jitter and shimmer were 1.182% ± 1.339% and 0.328 ± 0.263 dB, respectively. The data of TC revealed a much more negative change than those in CC and AC.

The mean and standard deviation of harmonic-to-noise ratio in CC and AC were 12.824 ± 1.892 and 11.243 ± 3.239, respectively. In TC, the mean and standard deviation of harmonic-to-noise ratio was 8.990 ± 3.322. The TC data showed a much more negative voice quality than that of CC and AC.

TC showed much more negative change than those in CC and AC in all 4 parameters. Besides, TC showed a wider range of SD for variables in the 4 parameters than those in CC and AC. The results may indicate an increased instability of the phonation mechanism during telescopy.

Table 2 showed significant difference of acoustic variables between different conditions. One-way ANOVA with post hoc test using Scheffe adjustment was utilized. Although AC showed a little more negative change for acoustic variables in all 4 parameters than those in CC, there was no significant difference between these two conditions (P > 0.05). TC showed prominent negative change for acoustic variables in all 4 parameters compared to CC and AC. All data for the 4 parameters in TC were significantly different (P < 0.001) with the data in CC and AC.

**DISCUSSION**

The result of this study showed that oropharyngeal anesthesia has little effect on acoustic characteristics of voice performance for the subjects compared with the control voice. On the other hand, the acoustic characteristics of fundamental frequency, jitter, shimmer, and harmonic-to-noise ratio changed significantly during performance of telescopy.

**Anesthesia**

The advantage of anesthesia is to reduce oral sensation and excessive gagging to permit laryngeal telescopic examination12,8,9 and enable more appropriate management decisions concerning voice disorders.9 In the study of Lim et al.,10 topical anesthesia via nasal cavity has no significant changes in jitter, shimmer, and H/N with control phonation. However, it was suspected that if the anesthetic were applied to the oropharynx, as often used for laryngeal examination using rigid telescope, a more negative and significant effect on vocal function would arise. This was often the concern for
using the anesthesia in other surveys on vocal function. In our experimental data, the acoustic parameters of Fo, jitter, shimmer, and H/N ratio showed no significant changes with control voice when oral topical anesthesia was applied for performing laryngeal telescopic. The acoustic results in this study imply that anesthesia itself may not interfere prominently with the activity of the vocal performance.

Telescopy

All the acoustic characteristics during telescopy were affected not only negatively but also significantly compared with control condition. There are several possible explanations for these endoscopic effects on vocal performance. The major reason might be the examining posture. The examining posture may result in elevating the larynx, increasing laryngeal muscle tension, and limiting tongue movement during phonation. When a rigid laryngeal telescope is inserted into the oral cavity, the event might cause “scope trauma” or “scope consciousness.” This is due to a sensation of discomfort or increased awareness resulting from mechanical stimulation of the oropharyngeal or hypopharyngeal mucosa. The consequence of physiological or psychological effects makes the normal phonation mechanism unstable and results in worse acoustic parameters. For example, the elevated larynx and the increased laryngeal muscle tension lead to an increase in Fo.

Therefore, the results of this study have clinical implications for interpretation of stroboscopic data, a potential misinterpretation of endoscopic images. For example, the increased Fo and significantly changed jitter, shimmer, and H/N ratio during telescopy may resulted from changes of vocal fold tension, vibration pattern, and supraglottic activities. These phenomena may influence parameters typically in laryngeal telescopical and stroboscopic evaluation such as hyperfunction, mucosal wave, amplitude, phase closure, and periodicity. The clinician may attribute image features such as increased vocal tension or reduced mucosal waves to vocal dysfunction rather than to the possibility of the transient effect of the endoscopic procedures itself.

Hirano stated that the videostroboscopic procedure itself may limit our ability to differentiate vocal changes in image. Other measurement techniques such as high-speed cinematography or acoustical analysis may reveal vocal changes that videostroboscopy could not.

In this study we are not emphasizing that telescopic procedures diminish the value and reliability of the diagnosis. On the other hand, we hope that with the use of acoustic analysis, readability of telescope can be increased. All subjects in the study had a normal voice and no organic lesion in the larynx. The data of F0, jitter, shimmer, and H/N in the study can be used as normal variances of male phonation during telescopic examination.

The present study has highlighted the usefulness of acoustic analysis as an indicator of vocal changes in which invasive inspection of the larynx is required. Ambiguous outcome with an abnormal image evaluation results, but normal acoustic analysis might be due to normal variation caused by the procedures performed. To avoid visual misinterpretations, and potential for inappropriate intervention and recommendations, the acoustic changes in the patient’s voice prior to and during the procedures should be considered in the interpretation of the endoscopic data.

CONCLUSION

The data revealed that the use of topical anesthesia via oral cavity showed no significant effect on acoustic characteristics of phonation in the control group. Nevertheless, the telescopic procedures themselves may be associated with prominent changes in vocal performance. The results imply the functional change of vocal fold activity. Clinicians using laryngeal telescopic for image evaluation, management, and research purposes need to take such factors into account. It may be the normal variant related to the procedure itself.

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