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TRANSILLUMINATION LARYNGOSCOPY: A NEW WAY OF EVALUATING VOCAL FOLD AND HYPOPHARYNGEAL LESIONS

AKIRA NAITO, MD

YUKI HOSAKO-NAITO, MD SEIJI NIIMI, MD, PHD

TOKYO, JAPAN

Conventional methods of observing the larynx and the hypopharynx use reflected light to illuminate the larynx. The aim of this study was to see whether transilluminating the larynx was possible in subjects with and without disease. The larynx and the hypopharynx were observed by means of a rigid scope with a low-light charge-coupled device camera without the light guide inserted. Illumination was provided by a second rigid scope attached to a light source that was held at the neck by an assistant. The larynx and hypopharynx were observed by transillumination using both constant lighting and stroboscopy in 3 subjects with pharyngeal or laryngeal lesions and in 4 normal controls. The tumors were translucent or nontranslucent in appearance. A translucent polyp became nontranslucent when overlapping the vocal fold, thus indicating that a lesion the size of a polyp could be evaluated with this method. Mucosal waves could be observed during stroboscopy with transillumination, thus allowing observation of waves and lesions that cannot be observed with conventional stroboscopy.

KEY WORDS — laryngoscopy, stroboscopy, transillumination.

INTRODUCTION

It has been more than 150 years since Garcia's[1] observation of the larynx by indirect laryngoscopy, and more than 100 years has passed since stroboscopy was invented.[2] Although new techniques such as ultrahigh-speed cinematography[3] and, recently, ultrahigh-speed video imaging[4] and videokymography[5] have been developed, all of these techniques use reflected light for illumination and thus show only surface detail. Although a lesion such as a hard mass under the mucosa could interfere with the mucosal wave or show a discolored lesion and thus indicate an abnormal state, there are very few noninvasive ways to confirm it. Also, although pharyngeal lesions can be confirmed, there are very few methods available at an outpatient clinic that can evaluate the extent and texture of the lesion.

In this article, we show a method that could augment conventional means of evaluating vocal fold lesions and hypopharyngeal lesions. The method is relatively easy to perform, is not invasive, uses instruments that are readily available, and provides results that can be seen instantaneously.

MATERIALS AND METHODS

For the laryngeal observations of subjects without lesions, the larynges of 3 male volunteers (ages 35 to 60 years) and 1 female volunteer (age 34 years) were observed with both conventional and transillumination laryngoscopy. All of the normal subjects were healthy nonsmokers who had no history of laryngeal disease. The subjects and patients were of average build. The subjects with laryngeal and pharyngeal lesions were clinically examined by means of laryngoscopy and stroboscopy. After the conventional examinations, transillumination laryngoscopy was performed.

A black-and-white charge-coupled device (CCD) camera with a minimum sensitivity of 0.1 lux (RF Systems type MD-5, Nigata, Japan) was attached to

Fig 1. Method of transillumination laryngoscopy. Along with rigid scope for observation of larynx, extra rigid scope attached to light source provides illumination at neck above cricoid cartilage.

From the Department of Otolaryngology, Musashino Red Cross Hospital (Hosako-Naito), and the Research Institute of Logopedics and Phoniatrics, Tokyo University (Niimi), Tokyo, Japan.

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CORRESPONDENCE — Akira Naito, MD, Naito Otorhinolaryngology Clinic, 4-8-13 Higashi-cyo, Koganei-shi, Tokyo, 184-0011, Japan.

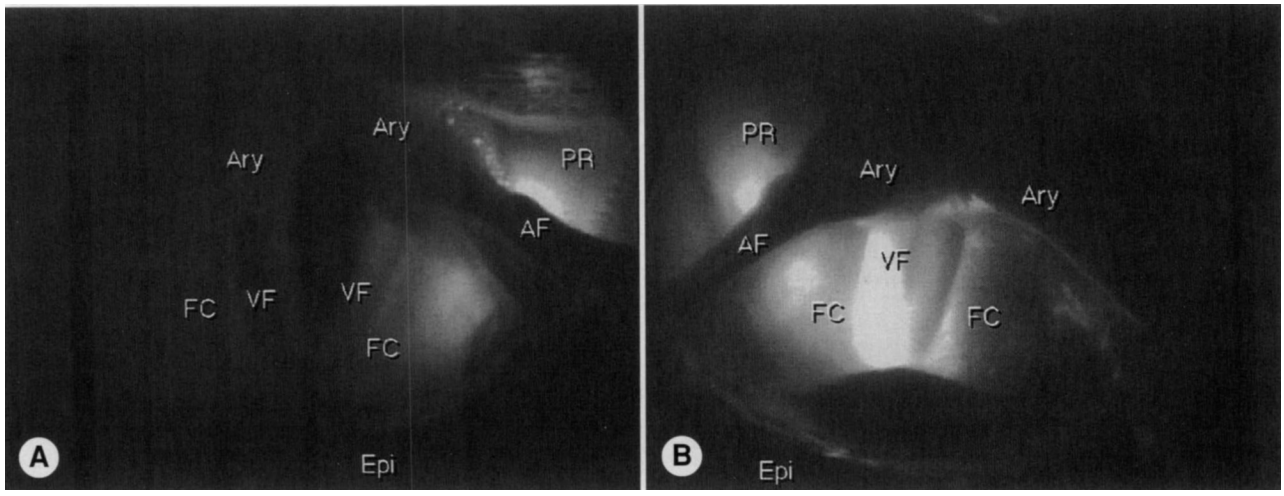

Fig 2. Views with transillumination laryngoscopy with constant light source. PR — pyriform recess, Ary — arytenoid, AF — aryepiglottic fold, VF — vocal fold, FC — false cords, Epi — epiglottis. **A)** Bubbles in pooling saliva can be seen in left pyriform recess. **B)** Illumination is slightly more medial than in A. Vocal fold can be seen more clearly.

a rigid endoscope (Nagashima Medical SFT-1, Tokyo, Japan). This endoscope was not connected to a light source. A second rigid endoscope, which provided the illumination, was connected to either an ordinary constant light source (Nagashima Medical NX150F) or a stroboscope (Nagashima Medical LS-3A). The endoscope with the camera was inserted into the oral cavity as for conventional laryngoscopy.

An assistant held the second rigid endoscope, which was attached to the light source, against the neck, above the cricoid cartilage (Fig 1). The tip of the endoscope was held perpendicular to the surface at the midline of the neck. When necessary, the endoscope was moved laterally or medially while the tip was held perpendicular against the surface of the skin. Because the light source generates heat from the tip of the endoscope, it is not advisable to keep the illuminating endoscope in the same position on the skin for prolonged periods. Our method is to wait until the observing endoscope is in the correct position in the oral cavity before applying the second endoscope to the neck for illumination. Heat generation was a problem with the constant light source; in contrast, the stroboscopic light source presented only minimal problems with heat.

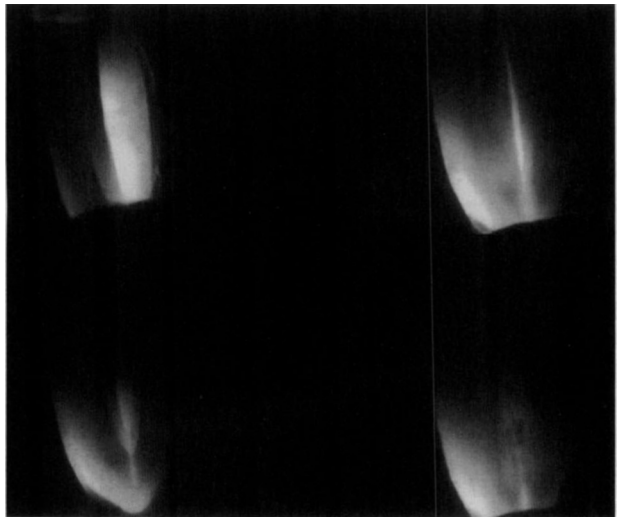

Fig 3. Transillumination laryngoscopy with stroboscopy. Vibrating mucosa can be seen. Dark spots at middle of vocal folds in lower right photo are sputum.

The images were recorded with an s-VHS tape recorder (Panasonic AG7355, Matsushita Electric Industrial Co, Tokyo) and printed on a video printer (Sony UP-2900MD, Tokyo) or captured on a personal computer via a still capture device. Other than the CCD camera, the instruments were ordinary ones used in routine outpatient clinical setups.

RESULTS

It was possible to view the larynges of all 4 normal control subjects with transillumination laryngoscopy. Figures 2 and 3 show the normal larynx of a 35-year-old man by means of stroboscopy and a constant light source. With the constant light source, not only could the vocal fold be observed, but even bubbles in a small amount of pooling saliva within the left pyriform recess could be seen (Fig 2A). The angle of the illuminating rigid scope determines the area that can be transilluminated. Figure 2B shows a slightly more medial area being transilluminated in the same subject. The vocal fold is more visible in this figure, but the pyriform recess is not.

By stroboscopy with transillumination, the mucosal wave could be seen. Figure 3 shows a series of vibrating vocal folds illuminated by this method.

Case 1. Patient 1 was a 28-year-old woman with a hypopharyngeal mass. On conventional laryngos-

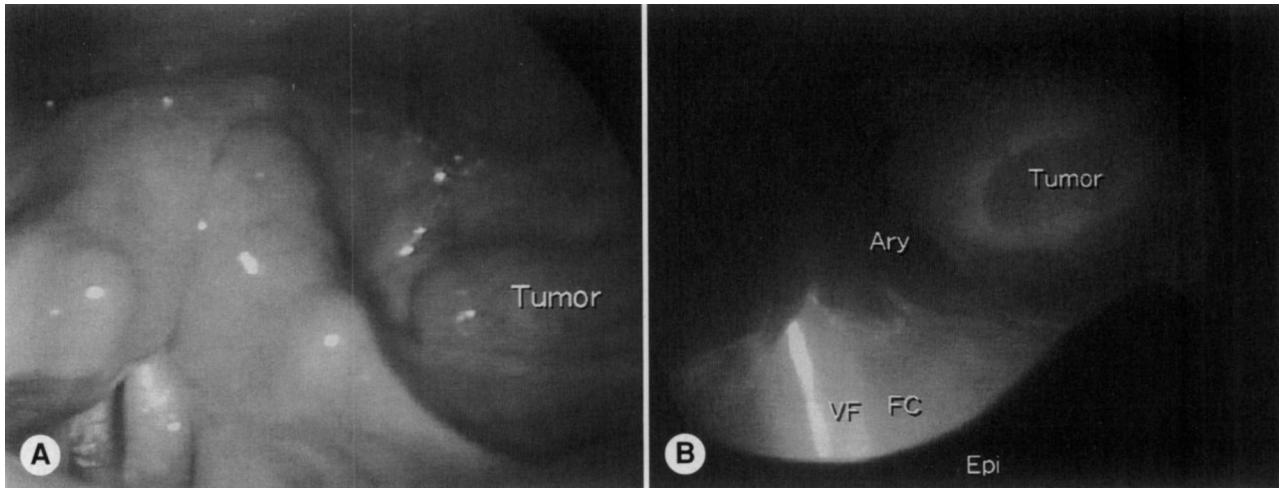

Fig 4. (Case 1) **A)** Hypopharyngeal mass. Oval-shaped mass can be seen in left pyriform recess. **B)** Hypopharyngeal mass viewed with transillumination laryngoscopy. Extent of lesion can be clearly seen in left pyriform recess. See Fig 2 for abbreviations.

copy, a tumor with a smooth surface was seen in the left pyriform recess (Fig 4A). With transillumination laryngoscopy, the tumor was seen to be nontranslucent and to have a well-defined edge (Fig 4B). Because the lesion was thought to be benign and the patient refused a biopsy, the patient is being followed up in the outpatient clinic.

Case 2. Patient 2 was a 38-year-old woman with a polyp and a cyst. On conventional laryngoscopy, the polyp was seen at the free edge of the right vocal fold. Conventional stroboscopy revealed that the mucosal wave was absent in the middle of the left vocal fold. On transillumination laryngoscopy, the polyp seemed translucent (Fig 5A), but when it overlapped the right vocal fold, it appeared nontranslucent (Figs 5B and 6). There was also a nontranslucent area in the middle of the left vocal fold that seemed to correspond to a cyst. Transillumination stroboscopy confirmed the lesion by showing that the mucosal wave was disrupted at the middle of the vocal fold. The motion was similar to that of a wave at the beach with a rock in its path. The mucosal wave was broken into 2 sections at the site of the cyst, and there was no wave at the site of the cyst. Surgery was performed, the existence of the cyst was confirmed, and the cyst was removed along with the polyp.

Case 3. Patient 3 was a 49-year-old man with a huge mass under the mucosa from the left pyriform recess to the left vestibular fold (Fig 7A). Because transillumination laryngoscopy showed a translucent mass with a relatively well-defined edge, the most probable diagnosis was thought to be a cyst.

Figure 7B shows the translucent image. The blood vessels of the tumor could be seen by transillumination at the left vestibular fold area. Surgical biopsy showed a solid mass under the mucosa, and the pathological diagnosis was a neurinoma.

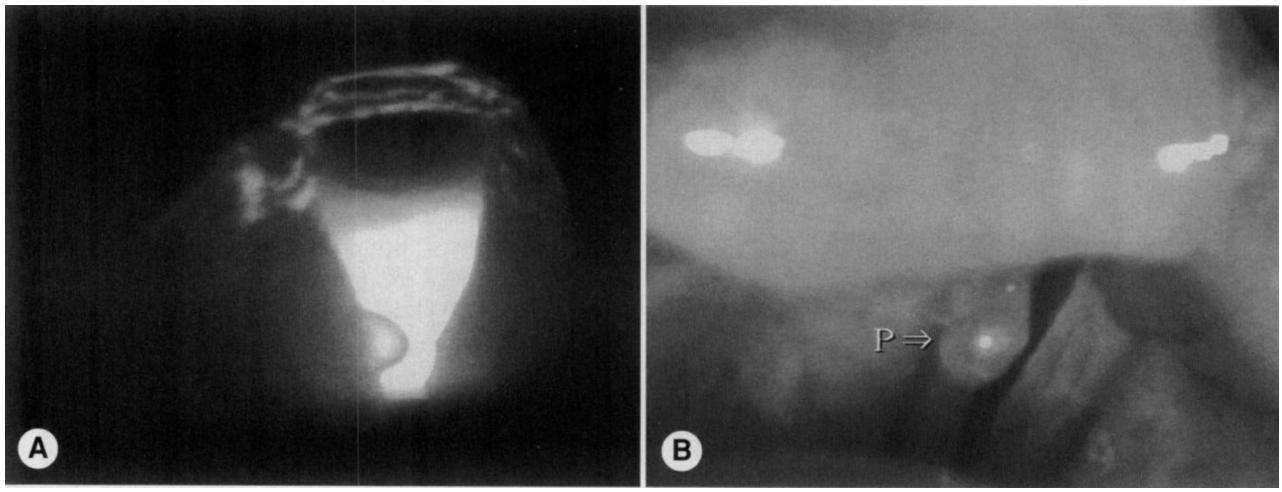

Fig 5. (Case 2) **A)** Polyp is not overlapping vocal fold. Polyp appears translucent. **B)** Polyp (P) is overlapping right vocal fold. Observation by conventional laryngoscopy.

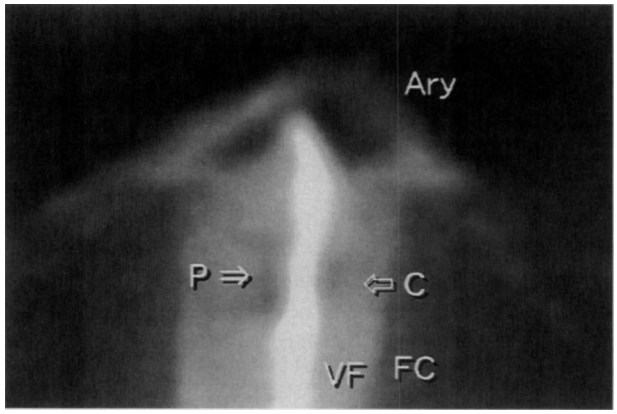

Fig 6. (Case 2) Polyp is overlapping right vocal fold. Observation by transillumination laryngoscopy. Polyp appears nontranslucent. There is also nontranslucent area in left vocal fold that seems to correspond to cyst (C).

DISCUSSION

In normal patients, the larynx and hypopharynx could be seen with relative ease with transillumination laryngoscopy, and it was thought that it would not be a difficult task to apply this method to patients with lesions. Although observation with transillumination laryngoscopy was not difficult, interpretation was difficult, as seen in case 3. Although more data are needed to correlate the type of lesion with the data obtained by transillumination, this method seems to hold some promise. The fact that in case 2, the polyp was not translucent when it overlapped the vocal fold means transillumination laryngoscopy could reveal a lesion as small as this 1- to 2-mm polyp. Also, although it is not possible with normal stroboscopy to see a mucosal wave that is hidden by overhanging vocal fold mucosa, with transillumination stroboscopy it was possible to see the mucosal wave distortion created by an embedded vocal fold lesion.

Stroboscopic views with transillumination laryngoscopy could reveal lesions that have a translucency different from that of the surrounding tissue. It is difficult to observe a lesion embedded under the mucosa with a conventional stroboscopic view; the only evidence of such a lesion is a missing mucosal wave. With transillumination laryngoscopy, both the missing wave and the actual extent of the lesion could be observed.

The type of light source and type of CCD camera used affect the images seen during transillumination laryngoscopy. In general, because light waves of longer length go through thicker tissue, a CCD camera with more infrared sensitivity would have brighter images, and conversely, a light source without infrared filters, or with more red or infrared light spectrum output, would have more translucent light. For this reason, it is important to include a notation of the type of camera and type of light source with any picture obtained by transillumination laryngoscopy. Preliminary studies with a color CCD camera confirm this conclusion. Only light of longer wavelengths is seen, so that the image is almost totally red. The effect that the type of light source and type of CCD camera have on the image has not yet been quantitatively measured, although it is currently being evaluated. The reason for this delay is that acquisition of multiple light sources and standardization of procedures have been difficult.

This method could be difficult in heavy subjects with thick necks. Although we had success in observing mildly obese patients, severely obese patients could present a challenge. A thick neck would block light, and the translucent light would not be observable. We had 1 or 2 cases out of more than 40 patients in which the neck thickness was a problem, and changes in positioning seemed to help.

We are currently using a rigid endoscope to pro-

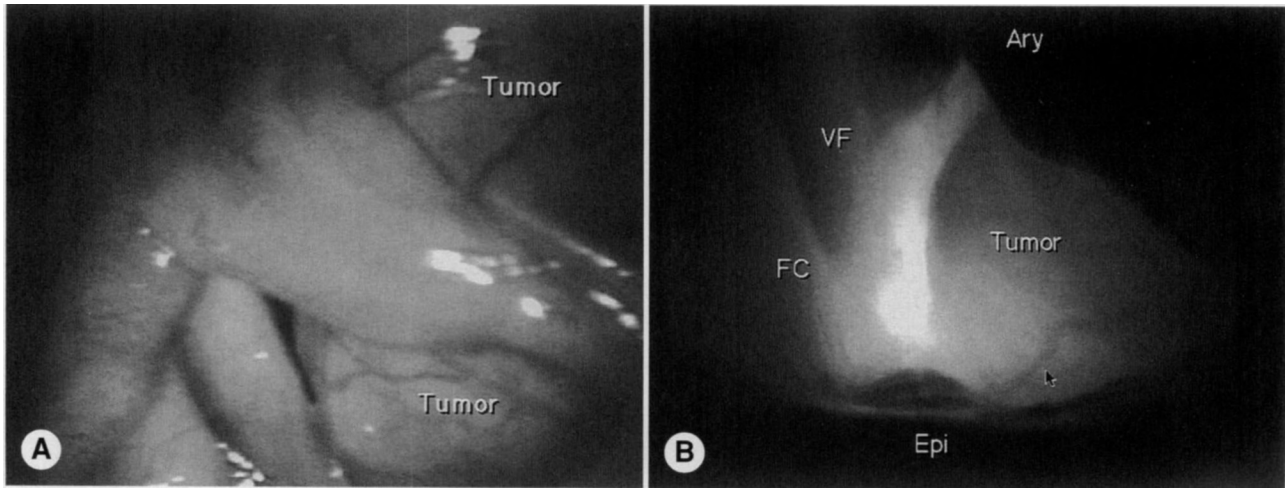

Fig 7. (Case 3) **A)** Laryngeal tumor extending from left pyriform recess to left vestibular fold area. **B)** By transillumination laryngoscopy, mass appears translucent at left vestibular fold area. Blood vessels (arrow) can be seen by transillumination.

vide illumination, but other instruments could be equal or superior to our method. We have used fiberoptically guided headlights to transilluminate the larynx, and although the amount of light was sufficient, the rigid scope was easier to use, because the angle and length of the rigid scope allow the assistant to stand at the side and not in the way of the examiner. Of course, a custom-made transillumination device could have more light fibers than a rigid scope, and could be brighter and easier to set up, but it would be more expensive and difficult to acquire. If this method gains popularity, such a device might be marketed in the future. However, one of the best points of this method is that the only device required, besides the routine otolaryngological instruments, is the inexpensive CCD camera.

CONCLUSION

Although more work is needed to make this method more useful, we believe that transillumination laryngoscopy adds information that is not readily available by conventional methods, and that it could be useful for the diagnosis of laryngeal and hypopharyngeal lesions.

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