Are High-Speed Digital Videoendoscopy Systems The Future Of Laryngology?

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Abstract

Since Hirano's original description of the layered microanatomy of the human vocal fold in the 1970s, increasingly sophisticated diagnostic and surgical techniques have evolved to address this delicate and complex structure more appropriately.[1] Innovative diagnostic modalities have grown out of an improved understanding of the critical importance of vocal fold oscillation to voice production. Videostroboscopy has evolved as one of the most practical and useful techniques for the clinical evaluation of vocal fold vibration and fulfils several important requirements of a complete voice examination. It provides useful information concerning the nature of vibration, an immediate image to detect the presence or absence of vocal pathology, and a permanent video record of the examination.

Strobolaryngoscopy takes advantage of Talbot's law (persistence of vision) by producing intermittent light flashes in relation to the speed of the vocal fold vibration.[2] The frequency of the study subject's sustained voice is picked up by a microphone and triggers the stroboscopic light source. With the provision that the vocal vibrations are periodic, a frequency of light flashes equal to the vocal frequency will produce a clear still image of the same portion to the vibratory cycle. When the frequency of the flashes is slightly less than the vocal fold vibration, causing a delay in the portion of each vibratory cycle illuminated, the illusion of slow motion is obtained. While videostroboscopy greatly expands the diagnostic sensitivity of laryngoscopy, its interpretation is dependent upon the skill and experience of the clinician and, more specifically, the diagnostic interpreter. An admitted limitation of the stroboscopic image is that vocal fold vibration must be relatively periodic to visualize a slow motion representation of the phonatory cycle.[2]

However, this limitation can be greatly reduced by combining electroglottography (uses the glottal waveform) with videostroboscopy. Efforts to extend the sensitivity of laryngoscopy to incorporate variations of wave characteristics across the glottis as well as aperiodic patterns of vibration have yielded new techniques. Videokymography (VKG) was developed in 1994 in Groningen (NL) as a low-cost alternative high-speed imaging system especially suited to examination of vocal fold vibration.[3] The system uses a special CCD video camera which can work in two different modes – standard and high-speed. In the standard mode, the VKG camera works as a standard commercial video camera with an image rate of 50 (interlaced) field per second in accordance with the CCIR TV standard. NTSCvideo standard is also available which provides the rate of 60 interlaced fields per second. In the high-speed mode, the camera delivers images from a single line (selected from the whole video field) at a rate of around 7000 line images per second. The consecutive line images are presented below each other on a monitor and create a new VKG image which shows the vibratory pattern of the selected part of the vocal folds. However, this high speed image rate is achieved at the expense of greatly reduced spatial information and this is a big drawback in videokymography.

This brings us to the “re-born” high-speed videoendoscopy systems. In fact, there have been a number of articles recently on the value of high speed digital videoendoscopy systems in laryngology. Much of this work emanates from the Karolinska Institute, Stockholm and is a reflection of their extensive experience in this rapidly emerging field.[4] In high-speed systems, the voice source is sampled at very high rates ranging from 1000 to over 8000 frames per second as compared to the 25-30 frames of conventional stroboscopic systems. With improvements in technology, its application in recent years has increased. Currently, high-speed videoendoscopy has been used with modest success in the quantification of normal and abnormal glottal vibratory patterns. It has also been used in linguistic studies, for the examination of different artistic singing styles and in patients with irregular vocal fold vibrations and in laryngectomees.[5,6,11](High-speed digital systems have also been combined with laser based measurement systems and electroglottography.[7,8,9] All these studies, highlight the possible role of high-speed systems as a tool for studying vocal physiology and glottal parameters.

However, we should view this apparent progress with a degree of caution. High-speed systems have now been around for approximately 60 years and have been plagued with numerous problems since their inception.[10] They are still very expensive and, as yet, have very limited availability at most otolaryngology and head and neck surgery departments. Although newer mathematical algorithms and cutting-edge computer systems with increased memory and storage are being introduced, these are not yet widely available. In addition, the poor image resolution of high-speed systems (even more so in videokymography) as compared to conventional videostroboscopic systems and the dull/dour black and white mode has largely blunted and limited its potential clinical use. Another major drawback is that, as yet, only a rigid scope can be used with high-speed systems. The limitations of a rigid scope are very evident whilst examining the pharyngo-oesophageal segment in patients who have undergone a laryngectomy.[11]

Until such teething problems have been overcome, conventional videostroboscopy will remain the gold standard against which other modalities will be measured. High-speed digital videoendoscopy systems undoubtedly have much promise but can only be considered complementary at present.

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References

1. Hirano M: Morphological structure of the vocal cord as a vibrator and its variations. Folia Phoniatr (Basel) 1974; 26(2): 89-94.
2. Buckmire R. Storboscopy. eMedicine 2005.
3. Svec JG, Sram F, Schutte HK. Videokyomography in 2000: the present state and perspectives of the high-speed line imaging technique. In BraunschweigT, Hanson J et al: Advances in quantitative laryngoscopy, voice and speech research. Proceedings of the 4th International workshop. Jena, April 7-8, 2000. Friedrich-Schiller University, Jena 2000;57-62.
4. Hertegard S. What have we learned about laryngeal physiology from high-speed digital videoendoscopy? Curr Opin in Otolaryngol Head Neck Surg 2005; 13:152-156.
5. Eysholdt U et al. Measurement and interpretation of irregular vocal fold vibrations. HNO 2003;51:710-716.
6. Lindestad PA et al. Voice source characteristics in Mongolian "throat singing" studied with high speed imaging technique, acoustic spectra and inverse filtering. J. Voice 2001;15:78-85.
7. Granqvist S, Hertegard S et al. Simultaneous analysis of vocal fold vibration and transglottal airflow; exploring a new experimental set-up. J. Voice 2003. 17;319-330.
8. Larsson H, Hertegard S. Calibration of high speed imaging by laser triangulation. Logoped Phoniatr Vocol 2004;29:154-161.
9. Manneberg G et al. Measurement of human vocal fold vibration with laser triangulation. Opt Eng 2001;40:2041-2044.
10. Fansworth D. High speed motion pictures of the human vocal cords. Bell telephone records 1940;18:203-208.
11. Van As CJ, Op De Coul BM et al. Value of digital high speed endoscopy in addition to videofluoroscopic imaging of the neoglottis in tracheoesophageal speech. Acta Otolaryngol 2004;124:82-89.

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