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4k Video-laryngoscopy and Videostroboscopy: Preliminary Findings

Peak Woo MD FACS

Department of Otolaryngology and Head and Neck Surgery, Icahn School of Medicine at Mount Sinai, New York

ABSTRACT

Introduction: 4K-video is a new format. At 3840 x 2160 resolution, it has four times the resolution of standard 1080 HD-video. Magnification can be done without loss of resolution. This study uses 4K video for laryngoscopy with videostroboscopy for office laryngeal observations.

Material and Method: Forty six patients were examined by conventional video-stroboscopy (S-VHS) and compared with 4K video-stroboscopy. The video was recorded on a Blackmagic 4K cinema production camera in CinemaDNG RAW format. The video was played back on a 4K monitor and compared to standard digital 3-chip video. Pathological conditions included: polyps, scar, cysts, cancer, sulcus and nodules.

Results: Successful 4K-video recordings were achieved in all subjects using a 70 degree rigid endoscope. The camera system is bulky but is performed similar to standard video-stroboscopy. Playback requires a 4k monitor. As expected, the images were far clearer in detail than standard video. Stroboscopy video using the 4 k camera was consistently able to show more detail. Two patients had diagnosis changed after 4K viewing.

Conclusion: 4K video is an exciting new technology that can be applied to office laryngoscopy. It allows for cinematic 4K quality recording of the larynx. Both continuous and stroboscopic light can be used for visualization. Its clinical utility is feasible but usefulness must be proven. This is the first report of 4K-video application in laryngoscopy and stroboscopy.

INTRODUCTION

There have been great advances in laryngeal imaging due to the improved resolution of charge coupled devices. Today's high definition video (HD) can be used for rigid laryngoscopy and stroboscopy. Commercial systems now use High definition HD at 960x720 with 720 TVL (High definition HD) for operating room endoscopy and for rigid endoscopy. Fiberoptic stroboscopy have been limited to S-VHS resolution of 560x480. 4K video is a new format that can offer cinema quality production and offers a resolution of 3840 x 2160. This is four times the resolution of existing 1080 HD systems. With the recent cost reduction of 4K cameras, we set out to see if 4K laryngeal imaging using conventional and stroboscopic light is feasible in office laryngoscopy and stroboscopy. By using 4K video, it may add to the diagnostic accuracy compared with today's standard.

METHODS AND MATERIALS

The video camera used is a commercial cinema camera that is available for cinematography. It is the Black Magic production camera 4K (Black Magic Design, Freemont Ca). It uses the interchangeable Canon EF lenses and can be adapted for hand held use by coupling the lens to the rigid or flexible endoscope by the use of an endoscopic adaptor (49 mm Male thread digital camera adapter, Precision Optical Corporation, Gardner Ma). The lens used for imaging was the Canon compact 50 mm F2.5 macro EF lens (Canon USA Inc. Melville, NY). By using the adaptor and using a Cannon macro 50 mm lens, we were able to record 4K on the 4K camera. Both flexible and rigid endoscopes can be used although the dedicated distal chip video-fiberscopes cannot be used for this purpose. We used the rigid 70 degree endoscope (Storz 8706CA, Karl Storz, Tuttlingen, Germany) for this study.

Figure 1 shows the clinical set-up during an examination with the rigid endoscope. For this study, we performed 46 standard video stroboscopy examinations using commercially available 3 chip digital CCD stroboscopy camera system (Pentax Medical RLS 9100B, 9200C Montvale NJ). This is a 5 year old system was the state of the art system in 2009. We compared the stroboscopy image quality with the examination done with the same endoscope system and stroboscope but recorded with the 4K camera. For each case, notes were made if additional details were possible that added to the diagnosis.



Figure 1. Setup and recording.

RESULTS

Table 1 lists the diseased conditions examined using the system. Forty six subjects were examined using the rigid endoscope. There were typical cases of pathology seen in a laryngology clinic. This included polyps, cysts, scar, papilloma, cancer, inflammation and sulcus vocalis. In patients who could tolerate a ridged examination, the examination is similar to the standard hand held camera. Figure 2a shows a verrucous neoplasm on a patient recorded with the standard 3-chip camera with a 560x480 resolution captured as a video frame capture. Figure 2b is the same patient recorded with the 4K camera. One can clearly see more detail in the 4K image. With a resolution of 3840 x 2160, the images captured by the 4K camera are similar in detail to an eight megapixel photograph. Figure 3a is a stroboscopy image of a patient with type I sulcus taken with the standard 3 chip CCD camera and figure 3b is the same image take with the 4K camera. Vessels are sharper and edges more easily defined, irregularities caused by subtle curvatures due to scar, sulcus and stiffness could be appreciated. Figure 4 shows a larger example of the 4k photo. In two of the cases, additional details were able to be recorded that added to the diagnosis. One case showed a small sulcus on the vocal fold margin that was not detected using the traditional equipment. The other case was a small varix that was not noticed except with review of the 4K video.

Table 1. Summary of conditions examined

Condition	Number
Polyp, nodule, cyst, varix	18
Scar and stiffness	8
Keratoses and verrucous hyperplasia	6
Sulcus vocalis	5
Laryngitis and reflux	5
Cancer and papilloma	4
Total	46

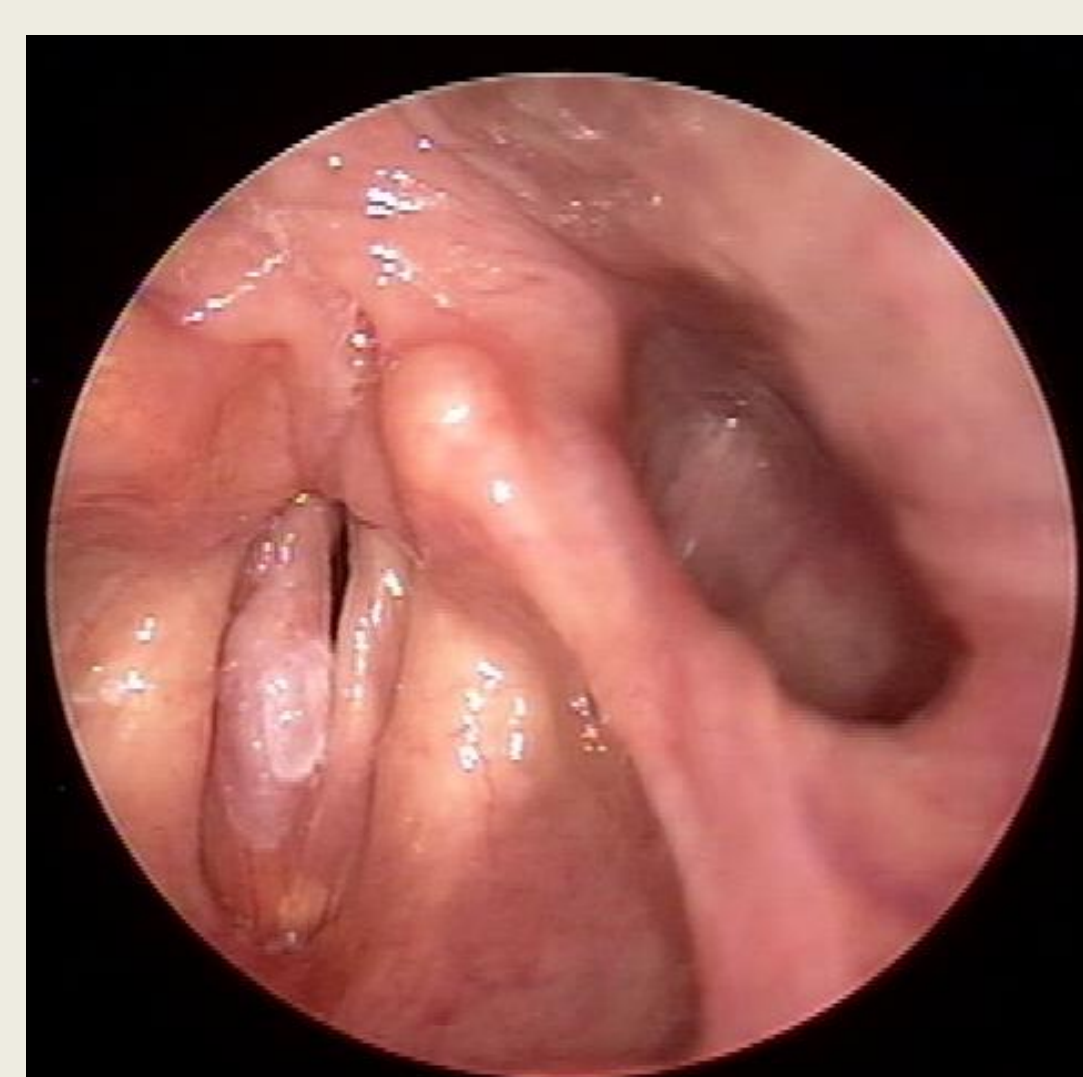


Fig. 2a 560x480 resolution

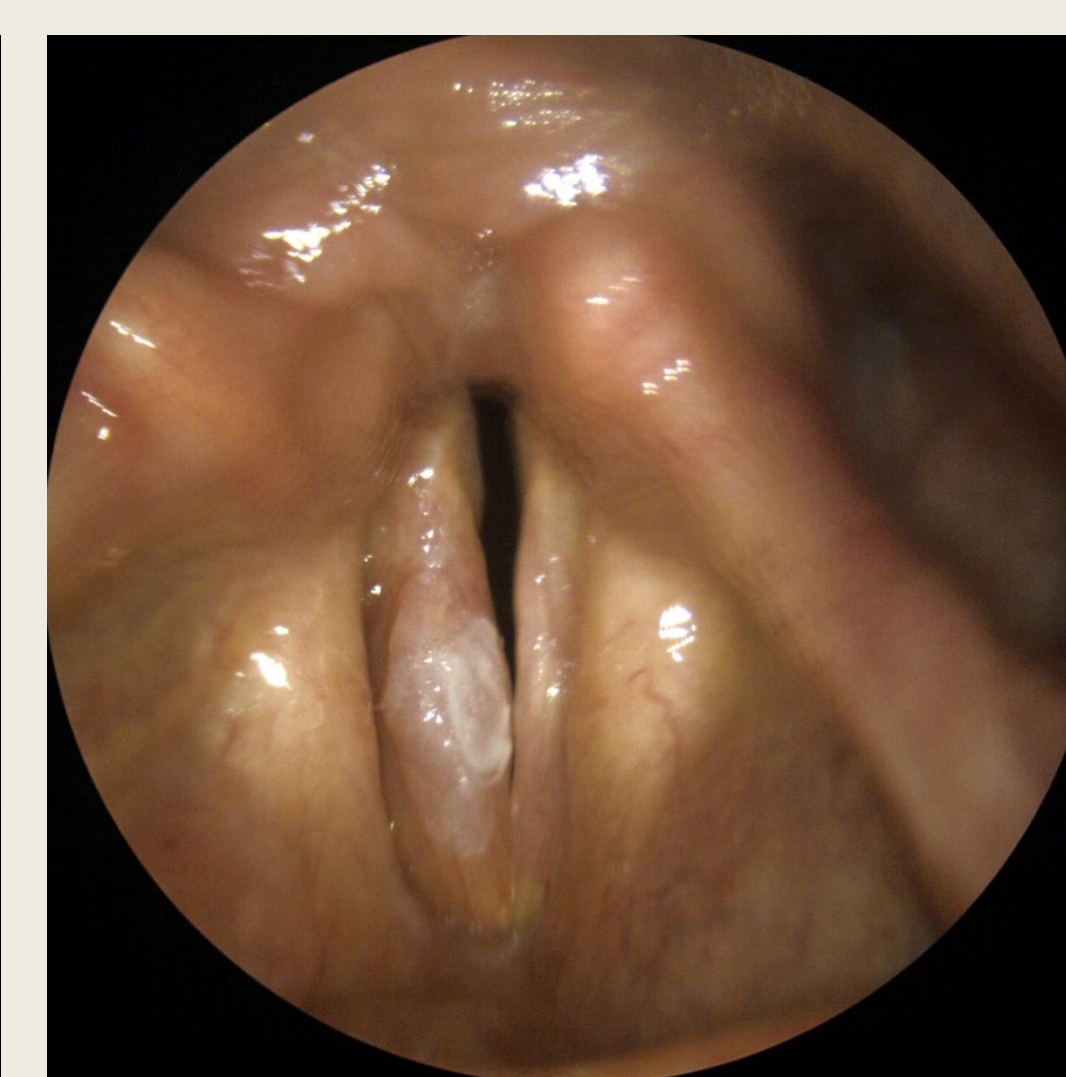


Fig. 2b 4K3840 x 2160 resolution

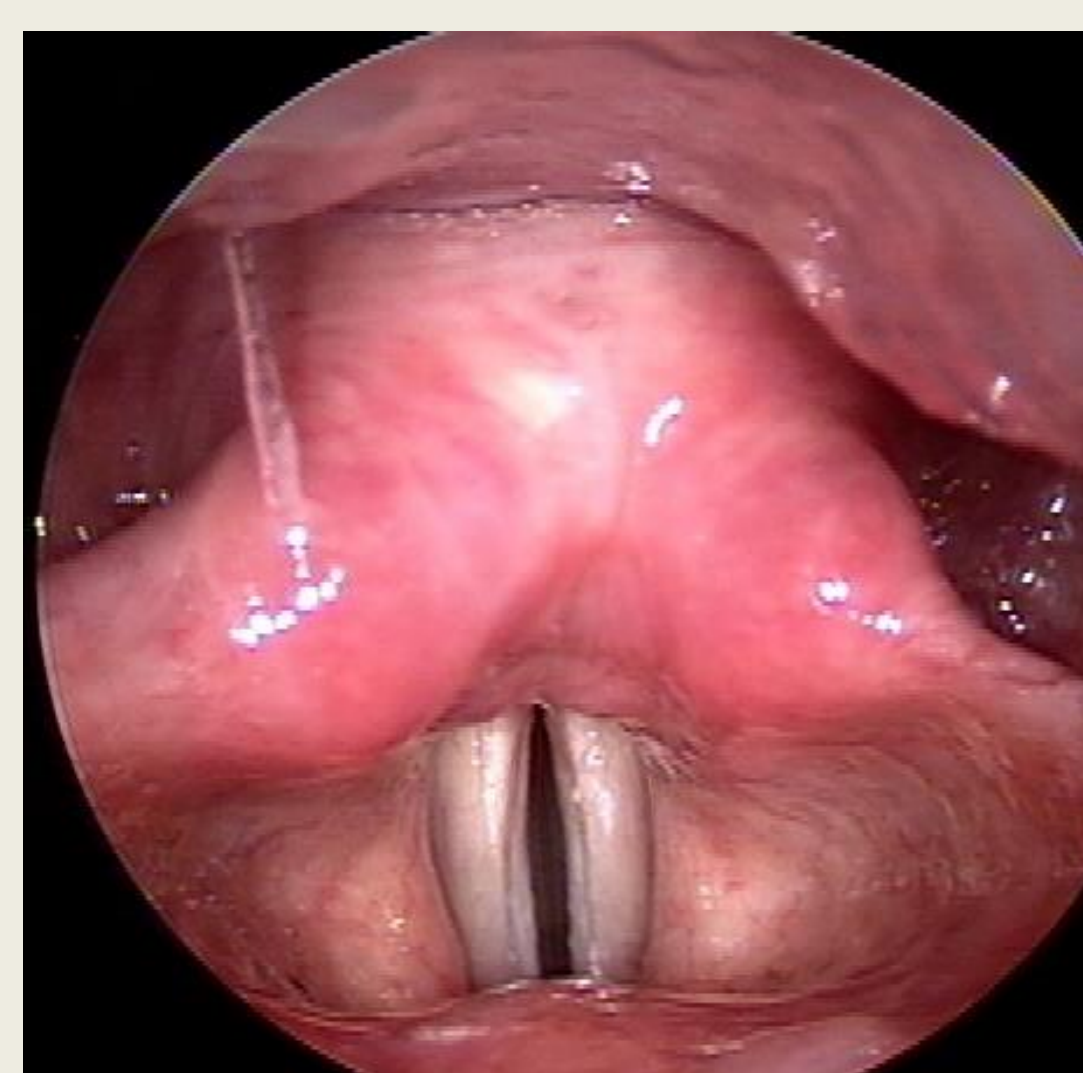


Fig. 3a 560x 480 resolution

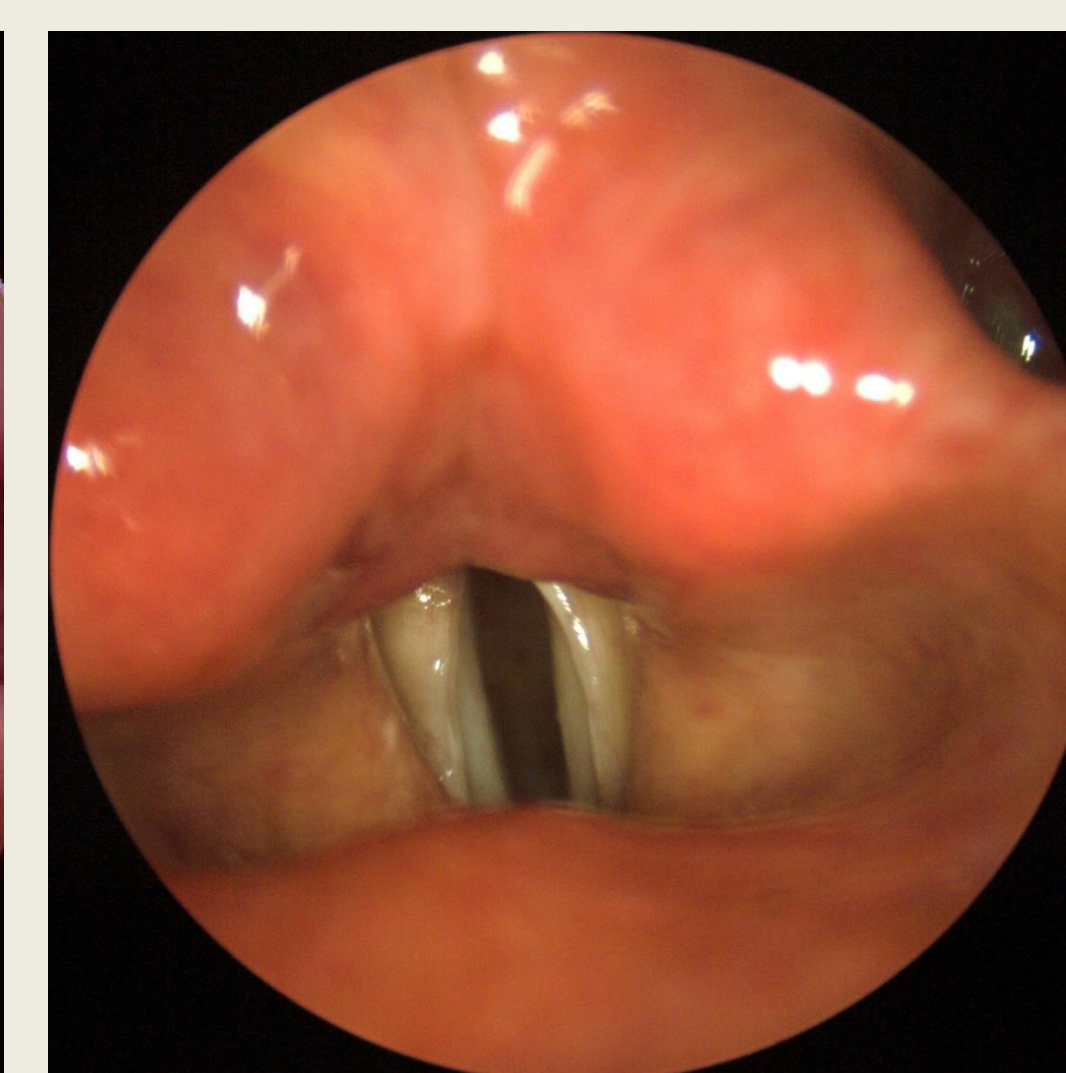


Fig. 3b 3840 x 2180 resolution

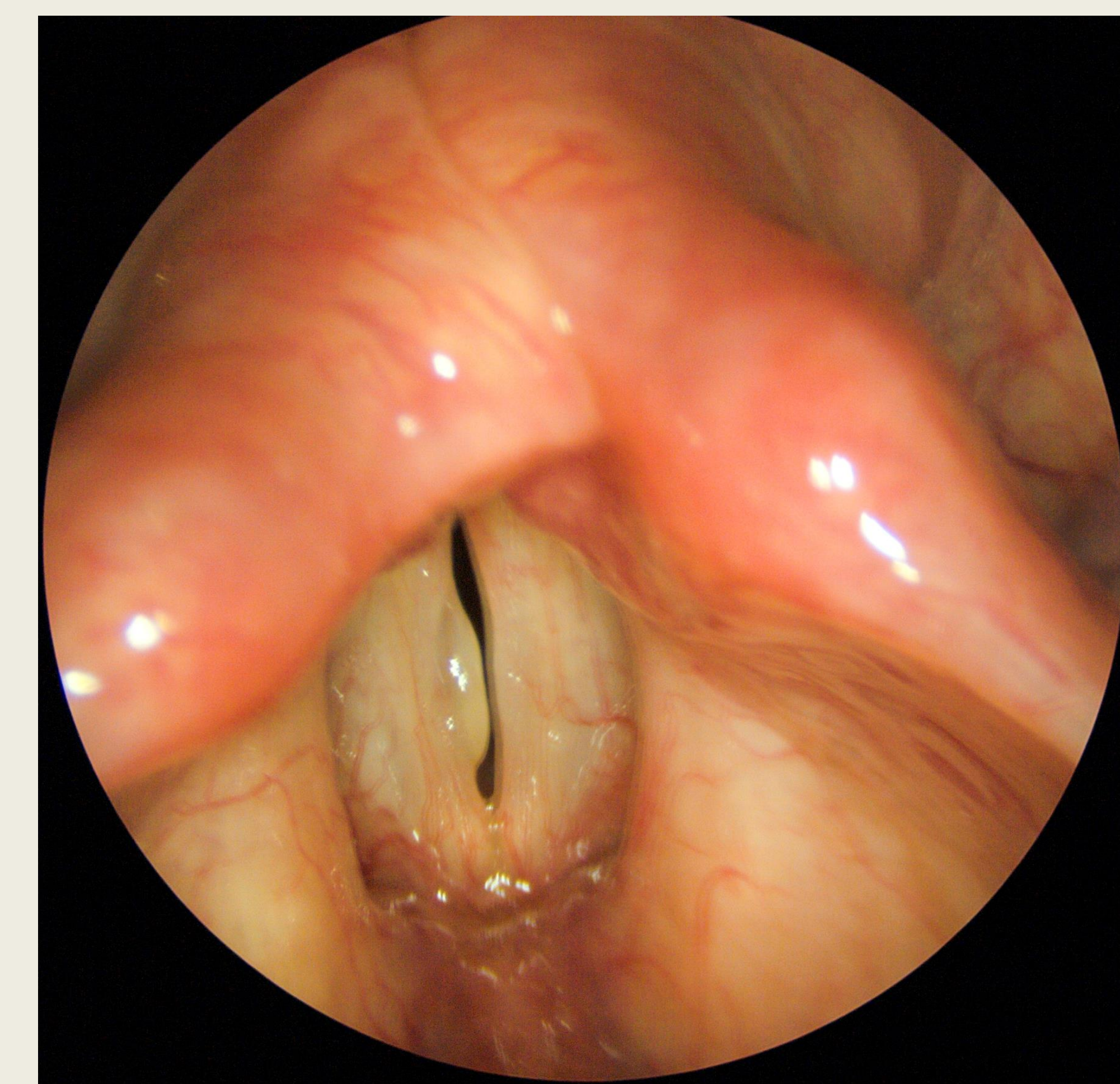


Figure 4. Polyp 4K resolution

DISCUSSION

The camera used for this study is commercially available and records at UHD resolution. UHD is a resolution of 3840 pixels x 2160 lines (8.3 megapixels). At 8.3 megapixels per frame, the camera is capturing at full photo quality of 8.3 megapixels at 29 frames per second. Unlike photo-documentation with a digital camera, the difference is the ability to record this as a moving stroboscopy image. Very minute details could be seen on the vocal fold margin. UHD is one of the two resolutions of ultra-high definition television targeted towards consumer television. UHD has twice the horizontal and vertical resolution of the 1080p HDTV format, with four times as many pixels overall. To display the 4K video, 4K monitors must be used to display the higher resolution. Both the monitor and the camera can be purchased for under \$3000. For simple recording and display of UHD video, a camera, lens, 4K display monitor, and endoscope adapter is needed. To store the video and process the video for color correction and image analysis, a high end PC based or MAC workstation is recommended. For this project, a total cost of the project, including camera and video workstation was far less than the cost of a proprietary 3 chip CCD camera.

CONCLUSIONS

A commercial 4K camera with interchangeable camera lens have been adapted for laryngeal imaging with existing stroboscope and endoscopes. The camera can be used in the clinic setting with a minimum of change to existing monitoring equipment. The images are cinematic quality and surpass resolution existing commercially available medical systems.

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CONTACT

Peak Woo MD
Address: 300 Central Park West. 1-H,
New York, NY 10024
E-Mail: peakwoo@peakwoo.com
Phone: 212 241-1004
Fax: 212 241 6101