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Short Communication

Using Low-cost Videoscopes to Obtain Accurate Video "Oral Selfies" as Screening for HPV-associated Oropharyngeal Cancer: A New Screening Technology?

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Abstract

Human papillomavirus (HPV)-related oropharyngeal cancers associated with sexual contact are increasing, with high rates in men who have sex with men. HPV-related cancers have the advantage of being frequently detectable through oropharyngeal visual examination and having much higher survival rates than classic oropharyngeal cancers. It has been demonstrated that gay and bisexual men can take smartphone oropharyngeal "selfies" of sufficient quality for screening. However, there is an issue with the inability to move the tongue to allow a clear view of the palatine tonsils, where a majority of oropharyngeal cancer cases occur. We attempted to investigate the feasibility of using commercially available videoscopes to visualize the oropharynx. Fourteen healthy volunteers used a provided low-cost commercial endoscope to video their oropharynx. Participants used the videoscope connected to a laptop and could visualize the oropharynx on the screen. Attempts were observed, and the process was noted. A focus group of participants was carried out immediately afterwards to ascertain barriers and facilitators to using the videoscopes. All participants were able to use the videoscope and obtain videos of sufficient clarity to note major oropharyngeal landmarks. The palatine tonsils were initially difficult to visualize because the tongue could not be sufficiently controlled. Participants were given time to practice using visual cues to control the position of the tongue, which helped in obtaining good videos. Videoscopes can be used effectively with minimal instruction and provide a better view than still images, as they illuminate and magnify the site. Low-cost commercially available videoscopes may be an improvement over smartphone "selfies".

Introduction

Oropharyngeal squamous cell carcinomas (OPSCCs) associated with human papillomavirus (HPV)-16 infection are increasing in incidence, surpassing the incidence of high-risk HPV infection of the cervix by 2019.[1] HPV-related oropharyngeal malignancies differ from classic oropharyngeal malignancies by having a significantly better prognosis and significantly lower associations with chronic tobacco and alcohol use.[2]

While it is generally believed that HPV-associated OPSCCs are sexually transmitted, the lack of data on sexual behaviors in many cancer registry datasets makes it challenging to study any correlation. However, Heck *et al*.[3] reported that the highest risk factors for HPV markers in OPSCC in men were sex and oral sex with another man in the past five years (adjusted odds ratio = 8.89, 95% confidence interval (CI) 2.14, 36.8). More recently, Sonawane *et al*.[4] using the National Health and Nutrition Examination Survey 2013–2016, indicated that the prevalence of oral high-risk HPV

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Fig. 1. A person sitting at a laptop with a videoscope in position. Written permission has been obtained to use this image.

in the US was significantly higher in men who have sex with men (9.5%, 95% CI 3.7–15.2) compared to heterosexual men (2.9%, 95% CI 2.2–3.6).

Potential oropharyngeal malignancies have the advantage of being visible to inspection by healthcare professionals, including physicians, dentists, dental hygienists, and nurses. Despite healthcare practitioners being aware of the risk in men who have sex with men, few perform an intraoral examination that includes the oropharynx.[4] Visual inspections for skin cancers are well-established as sensitive and specific screening methods for malignancies. It is possible that visual inspection of the oropharynx may also be both cost-effective and provide opportunities for early treatment.[5]

Intraoral examinations (including the floor of the mouth, buccal/labial surfaces, palate, lateral border, and anterior two-thirds of the tongue) provide an opportunity for dental screening for oral malignancies, although only a very small percentage of these *oral* lesions are HPV-related.[2] Artificial intelligence (AI) approaches have established that images of potentially malignant *oral* lesions can be identified with sensitivity and specificity approaching that of experienced clinicians.[6,7] *Oropharyngeal* visual examinations (including the Waldeyer ring, palatine tonsils, uvula, and posterior oropharynx), where HPV-associated OPSCC occurs, are a proposed screening method.

Ross *et al*.[8] investigated whether smartphone "oral selfies" of sufficient quality for screening could be taken by gay and bisexual men following online instructions. They reported that 28.1% of smartphone "oral selfies" were judged of sufficient quality by an otolaryngologist (Ear, Nose, and Throat) or oral and maxillofacial surgeon to potentially screen for OPSCC,[8] specifically to fully observe the palatine tonsils, the site of the majority of HPV-related OPSCC. However, half of their 113 participants agreed that using a smartphone to take an oral image was difficult.[8]

During the COVID-19 pandemic, Cai *et al*.[9] investigated whether 21 patients could take images of the oral cavity using smartphones and commercial videoscopes and reported that the patients preferred the low-cost videoscopes. We conducted a pilot study on volunteers using commercial low-cost (~$20–30) videoscopes to ascertain responses to the use of this technology, with a view to using it in a larger study to determine whether, in addition to smartphone oral "selfies," it could be used to obtain similar images.

Materials and methods

Five adult volunteers (one male, four females), who were briefed on the oropharyngeal screening project and were familiar with it, were recruited to trial the videoscope and obtain oropharyngeal images. The equipment provided included a low-cost ($30) videoscope (Depstech 86T industrial waterproof to IP67, Type-C endoscope, 6 LEDs total 100w dimmable, resolution 5MP, magnifying, diameter 0.3 inches, focal range 2.75–15.7 inches, field of view 80°) and a Windows PC laptop computer with a camera and a 14-inch screen. The videoscope is marketed for viewing plumbing and other small spaces, and it installs automatically with Android and Apple smartphones, Windows computers, and MacBooks via the micro USB, USB, and Type-C adapter, easily and quickly without requiring any app installation. The devices were purchased from a major online retailer. Participants could see real-time video images on the laptop screen, visible using the "camera" option on the computer or a smartphone. The videoscope is attached to a semi-rigid connecting cable (Fig. 1).

Participants were verbally instructed to insert the connecting cable into the laptop and open its camera. They were provided with a photographic image of the oropharynx to set next to the laptop for reference, and anatomical landmarks (uvula, posterior pharyngeal wall, palatine tonsils, tongue) of the oropharynx were labeled. The head of the videoscope was rested on their maxillary (top) central incisors, projecting no more than about ¼ inch beyond them into the oral cavity. They were then asked to record a 20-30-s video and save it. Two participants required about 30–60 s to orient themselves to the oropharyngeal anatomy and position their tongue. When comfortable, participants began recording and stopped when they believed they had included the palatine tonsils. Videos were stored on a firewalled university site.

The videoscope was disinfected between participant uses first with isopropyl alcohol medical swabs, and then immersed in 70% isopropyl alcohol for >1 m, following relevant recommendations of Centers for Disease Control and Prevention.[10] When all five participants had completed the exercise, a small focus group was conducted by the investigators to evaluate the experience and receive feedback.

A second sub-study with different participants was conducted. Participants were nine adult volunteers (six females and three males, median age 34 (range 31–42)) who were asked to take a videoscope of their oropharynx using the same explanation, equipment, and conditions as the first sub-study. They were asked to take a short (about 20–30 s) video of the oropharynx. This video was scored on a five-point scale of clarity and completeness of the oropharynx, including the palatine tonsils, with one representing uvula, posterior wall, and tonsils not visible (including those that are blurry or dark), and five representing uvula and >95% of tonsil height visible.[10]

Study materials were reviewed and approved by the University of Minnesota IRB, Study 00013973. The exercise was explained to participants, who then consented. For any images where an individual might be recognizable, a standard University photo release consent for publication was signed. No incentive was provided beyond focus group refreshments in the first sub-study.

Results

Sub-study 1

Of the five videos, the mean time to adequately capture all major landmarks was 36 s, with a median of 18 s (range 13–68 s). The focus group following the endoscope experience raised several points. First, the experience of using this particular videoscope, which was activated by plugging into a laptop, was easy for all participants. However, looking at the oropharynx was a new experience for all of them, and it was necessary to provide a picture and label landmarks (uvula, palatine tonsils, tongue, up and down).

Second, the top of the videoscope should be marked with a white dot at the lens end, to coordinate putting the white dot between the maxillary central incisors. This recommended position is best to get the best view of the oropharynx, including the palatine tonsils. For people seeing their oropharynx for the first time, a novel experience, and not knowing the landmarks, an orienting dot at the top of the endoscope would be helpful.

Third, using a videoscope was a new experience and confusing to some, and they felt it was necessary to "play around" with the videoscope for a short time to get used to it, rather than just moving directly into the video phase. Using a laptop screen while doing this to orient the participant and practice moving the tongue was helpful (Fig. 1).

Fourth, the tongue position was a common problem. Trying to move it in response to visual (rather than the usual tactile) cues was difficult and required some time to get used to seeing the various positions it could take. One participant said that it was "like trying to control a live snake held in one hand". The position of the tongue was the greatest barrier to getting a good image of the oropharynx. Nevertheless, oropharyngeal "selfies" using the videoscope produced selfies of sufficient quality to make diagnoses (Fig. 2).

Finally, the experience of taking an approximately 15-s video and saving it to the camera roll on the laptop was positive and presented no problems for the participants.

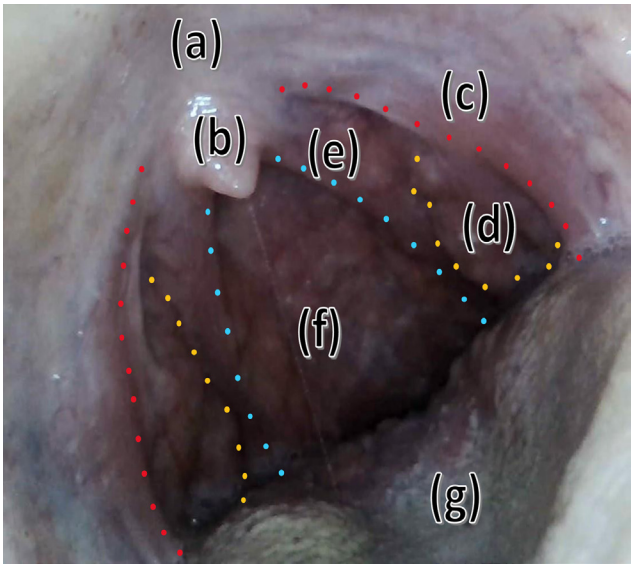

Fig. 2. Still image from a video of the oropharynx. (a) Soft palate; (b) Uvula; (c) Palatoglossal arch (anterior tonsil pillar) [red dotted line]; (d) Palatine tonsil [yellow dotted line]; (e) Palatopharyngeal arch (posterior tonsil pillar) [blue dotted line]; (f)Posterior wall of the oropharynx; (g) Tongue.

Barriers to taking good oral selfies

The major barrier to taking a good oral selfie is primarily the tongue, which can occlude the palatine tonsils.[9] Many participants expressed surprise at what the oropharynx looked like: it was a new and sometimes strange experience. They also found it difficult to match up the provided photo with what they saw, particularly the palatine tonsils, which did not always "stand out". In some cases, the endoscope was oriented upside down and had to be readjusted outside the mouth by bending the flexible cable. The major barrier was a lack of ability to control the tongue visually (which is typically controlled by tactile cues in the mouth, not visual ones) and the need for practice doing that. A benefit, however, was the ability to see the image on a laptop screen in real-time.

Sub-study 2

The nine participants were all able to take a videoscope of approximately 15 s of their oropharynx. These were graded using a five-point scale developed from the larger study and scored by an experienced dental professional who was familiar with the development of the scale.[10] The mean score of the videos was 3.1, with a median of 3 (range 1–4). A score of 3 was defined as "Uvula and < 50% of tonsil height visible").[10] This scoring scale allowed the rating of the moving image to be as easy as for a still photograph.

Discussion

The data indicate that it was relatively easy for participants to use a commercially available videoscope together with a laptop computer to make short videos of the oropharynx, which can include a clear view of the palatine tonsils and are well-lit and magnified.

Focus group data suggest that both a degree of familiarity with anatomical structures and the ability to control the tongue are important factors to consider in future studies. The tongue, composed of eight muscles (four extrinsic muscles that control position and four paired intrinsic muscles that control the shape and size of the

tongue for speaking and swallowing), is quite maneuverable but uses feedback from sensation in the mouth. People can usually perform gross maneuvers such as poking out the tongue, but not finer ones based solely on visual cues in a mirror. In this sense, it is somewhat analogous to mirror drawing.

There are three stages to the "oral selfie" maneuver. These are best described and illustrated in a training video, which we would recommend for participants.

1. Look at your mouth using the videoscope (or a mirror if using a smartphone) several times over a couple of days, using an illustration, so that you can identify the major structures of the oropharynx (uvula, throat, palatine tonsils, base of tongue). If you have had your tonsils removed (tonsillectomy), the tonsils may not be obvious, but residual tissue (between the anterior and posterior tonsillar pillars) should still be visible. Provide a good photo of the oropharynx with labeling of the major anatomical features.
2. Open your mouth in front of the laptop camera, smartphone camera, or mirror. Relax your mouth comfortably. *Lightly* place the tip of your tongue against the gums below the bottom two front teeth. Avoid tensing or pushing it, as this will cause the top of the tongue to stand up and block the view.
3. Relax your tongue while keeping the tip behind and below the front bottom teeth. Then *relax the back part of the tongue* so that it lies flat against the bottom of the mouth. You should then be able to see further down to the tonsils. Trying too hard by tensing the tongue will only cause it to rise up. Saying "Ahh-hhhh" can also help. Several participants noted that breathing through their mouths helped to open up the throat and allowed the tongue to rest on the floor of the mouth.
4. Once you have practiced these steps comfortably over a couple of days, it's a good time to attempt oral selfies. Since the tongue is a muscle, what we are doing is creating "muscle memory" to help the tongue relax and lie flat in the mouth. It needs to be practiced a few times before you can do it accurately.

Our data are consistent with those of the previous researchers,[7] who found that patients preferred taking videos over smartphone stills. Videos are a useful addition to our previous feasibility study on the use of oropharyngeal "selfies" in gay and bisexual men and suggest that adding a video option with a magnifying and LED-lighted low-cost videoscope may improve the quality and clarity of oropharyngeal "selfies".[8] The grading scale developed in our previous study was as effective with videos as with stills.[8,10] We believe that with the addition of videoscope technology, screening for OPSCC may further improve the quality of oropharyngeal images and enhance the feasibility and acceptability of screening. With the rapid development of image analysis and AI, it may be possible in the future to consider a combination of oropharyngeal "selfies" and AI screening for HPV-related oropharyngeal cancer, in addition to HPV vaccination,[11,12] especially in high-risk populations lacking access to medical and dental care and are uninsured.

Conclusions

Low-cost, commercially available videoscopes can be used effectively for HPV-related oropharyngeal cancer screening with minimal instruction. When connected to a laptop or smartphone, they provide a better view than a still smartphone image, lighting and magnifying the site. Training participants to maneuver the tongue to allow a full view of the palatine tonsils is possible. Low-cost videoscopes may be an improvement over smartphone "selfies" for obtaining quality oropharyngeal images for screening.

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Conflict of interest

No conflicts of interest are reported for any author.

Author contributions

Study concept and design (MR, CS); acquisition of data (MR, CS); analysis and interpretation of data (MR, CS); drafting of the manuscript (MR, CS); critical revision of the manuscript for important intellectual content (SB, NZ, SR, SK, AN, CF, MN, MW); study supervision (MR, CS). All authors have made a significant contribution to this study and have approved the final manuscript.

Ethical statement

This study was carried out in accordance with the requirements of the US National Institutes of Health policy 45 CFR 46. All respondents gave informed consent. The protocol was approved by the Institutional Review Board of the University of Minnesota, study number 00013973. This was a cross-sectional study and all data are anonymized.

Data sharing statement

The qualitative transcript data and videos used in support of the findings of this study have not been made available because they may identify individuals.

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