Article

Assessing the Learning Curve in Contact Endoscopy for Oral and Oropharyngeal Examination

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Abstract: The early and accurate detection of oral and oropharyngeal malignant lesions is crucial, impacting both treatment outcomes and patient prognosis. Contact endoscopy is one of the prospective methods in this respect. However, the integration of contact endoscopy into routine clinical practice is not without challenges. It requires specific skills and expertise for both performing the procedure and interpreting the enhanced mucosal images (the type of vascular patterns).
We conducted a prospective analysis over a 9-month period, involving otolaryngologists (n=18) at various stages of their careers. To assess the learning curve, we evaluated both the technical proficiency and diagnostic accuracy of participants at multiple time points: at baseline, 1 month after initial training, and at 3, 6, and 9 months.
At baseline, the average time to complete a contact endoscopy procedure was 180.7 seconds for the more experienced investigator and 185.7 seconds for the less experienced investigator, reducing to 120.2 seconds and 123.2 seconds at the 9-month assessment, respectively. Image clarity also improved, with only 34.5% of initial images deemed 'high quality', increasing to 94,5% after 9 months for more experienced investigator. The correct interpretation of the contact endoscopy findings did not depend much on the number of high-quality images.

Keywords: contact endoscopy, oral cavity malignant neoplasms, curve assessment

1. The purpose of the study

The early and accurate detection of oral and oropharyngeal malignant lesions is crucial, impacting both treatment outcomes and patient prognosis. Despite visually accessible localization, oropharyngeal and oral cavity malignant neoplasms are diagnosed in the later stages in 60% of cases, resulting in a high mortality rate and a low quality of life [1]. The standard evaluation of the oral cavity and oropharynx is a conventional oral and oropharyngeal examination without the use of additional research methods [2], that does not always allow to verify changes in the mucous membrane specific for an early dysplastic process. Thus, the search for additional minimally invasive and still effective diagnostic methods that can be used in the routine practice remains very important.

Contact endoscopy [3, 4] is one of the prospective methods in this respect. This technique involves the direct application of a magnifying endoscope to the mucosal surface, has been increasingly recognized for its ability to provide high-resolution images of superficial oral and oropharyngeal lesions [5-7]. This technique allows for the in vivo observation of microvascular patterns [5] and cellular structures [6, 8, 9], facilitating the differentiation between benign and malignant lesions with greater precision [3, 6, 10, 11].

However, the integration of contact endoscopy into routine clinical practice is not without challenges. One significant barrier is the learning curve associated with the technique. Unlike conventional endoscopic methods, contact endoscopy requires specific skills and expertise, particularly in interpreting the enhanced mucosal images (the type of vascular patterns) [5]. The proficiency in contact endoscopy is not merely a function of technical ability but also hinges on the clinician's interpretative acumen, developed through extensive training and experience.

The learning curve in contact endoscopy for oral and oropharyngeal examination has not been comprehensively studied. Understanding this learning curve is essential, as it may directly impacts

the diagnostic accuracy and effectiveness of the technique in clinical settings and gives the understanding what period is required for the investigator to get the best diagnostic result [12]. This paper aims to fill this gap by evaluating the learning process of medical professionals in using contact endoscopy for the oral and oropharyngeal examination. By delineating the learning curve, we aim to provide insights into the training needs for otolaryngologists, ultimately enhancing the diagnostic capabilities in oral and oropharyngeal pathology detection.

2. Materials and methods

Study Design and participants

This observational study was designed to assess the learning curve associated with contact endoscopy during oral and oropharyngeal examination. We conducted a prospective analysis over a 9-month period, involving otolaryngologists at various stages of their careers, from just graduated after the residency doctors to experienced doctors who have already been familiar with other endoscopic technique, however without any expertise in contact endoscopy.

Participants (n=18) were recruited from one tertiary care center specializing in otolaryngology. Inclusion criteria for otolaryngologists were: (1) a valid medical and otorhinolaryngological license, (2) at least one year of experience in otolaryngology, and (3) no prior experience with contact endoscopy. Informed consent was obtained from all participants. The study also involved healthy volunteers undergoing routine screening program for the oral and oropharyngeal pathology detection, with the consent obtained for the use of contact endoscopy and data recording. The study was approved by the Institutional Review Board (protocol number 04/2020). All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1975, as revised in 2000.

Training Protocol

A standardized training program was developed, comprising theoretical component. The theoretical component included didactic sessions on the principles of contact endoscopy, interpretation of vascular patterns, and differentiation of benign from malignant lesions [5]. Contact endoscopy was performed using ANDREA/DIAS Contact Micro-Laryngoscope, with HOPKINS® straight forward telescope 0° with 5.5 mm in diameter and 23 cm in length (Karl Storz, Tuttlingen, Germany).

Evaluation of Learning Curve

To assess the learning curve, we evaluated both the technical proficiency and diagnostic accuracy of participants at multiple time points: at baseline, 1 month after initial training, and at 3, 6, and 9 months. Technical proficiency was measured based on the time taken to complete an examination, the clarity of images obtained, and the ease of equipment handling. Considering that the investigation was done in the circumstances of screening evaluation, the "diagnostic accuracy" was assessed by comparing the revealed by the participants and actual type of the vascular pattern. So, the number of correct interpretations were counted and reported as a percentage.

Each participant is expected to perform a minimum of 5 contact endoscopy procedures per month to gain practical experience. This number is chosen to ensure that each participant has enough practice to improve their skills while not overwhelming them with the study requirements or interfering with patient care. It means that by the 3 months' time point the participants performed at least 15 procedures, for the 6 months' time point – 30 procedures and for the 9 months' time point – 45 procedures.

Data Collection

Data were collected on a standardized form, including details of each contact endoscopy procedure, such as duration, image quality, and diagnostic findings. Additionally, feedback from participants regarding their confidence and perceived proficiency with the technique was gathered through structured questionnaires.

"High-Quality Images" refers to the clarity and diagnostic usefulness of the images obtained through the contact endoscopy procedure. We considered the following criteria: (1) Clarity and Resolution: the images should be clear with high resolution, allowing for detailed visualization of the mucosal surface as allowing to distinguish subtle differences in vascular patterns. (2) Focus and Magnification: the images should be well-focused and properly magnified to reveal the necessary details of the mucosal surface and vascular structures. (3) Absence of Artifacts: high-quality images are free from artifacts such as blurring, shadows, or distortions that can obscure details and hinder accurate diagnosis. We assessed every criteria binary yes/no and classified the image as "high quality" in case of all three criteria gained "yes". In our study, the percentage of

high-quality images is used as a metric to assess the technical proficiency of the medical professionals in conducting contact endoscopy. An increase in this percentage over time indicates an improvement in the ability of the practitioners to effectively use the contact endoscopy equipment and techniques to produce diagnostically useful images.

3. Results

Participant Demographics

The study included 18 otolaryngologists (10 males, 8 females) with varying levels of experience but new to contact endoscopy. Their experience ranged from 1 to 15 years in otorhinolaryngology. Participants considered as "more experienced" have been using any type of endoscopes for more than 5 years of practice. All participants completed the theoretical and practical components of the training program. All the volunteers did not have any evident pathologies of the oral cavity and oropharynx. The contact endoscopy was performed on an outpatient basis without any prior anesthesia. The patient was in sitting position with opened mouth. The endoscope was introduced into the oral cavity, then its tip was placed on the mucosa of the following anatomical zones in sequence: the floor of the mouth, buccal mucosa bilaterally, retromolar trigone bilaterally, and anterior tonsillar arch bilaterally.

Technical Proficiency Assessment

Technical proficiency, assessed by examination duration and image quality, showed significant improvement over time (Table 1). At baseline, the average time to complete a contact endoscopy procedure was 180.7 seconds for the more experienced investigator and 185.7 seconds for the less experienced investigator, reducing to 120.2 seconds and 123.2 seconds at the 9-month assessment, respectively. Image clarity also improved, with only 34.5% of initial images deemed 'high quality', increasing to 94,5% after 9 months for more experienced investigator. Less experienced investigators got high quality images at baseline in 20% of cases, increasing to 84,7% after 9 months. The correct interpretation of the contact endoscopy findings did not depend much on the number of high-quality images.

Table 1. The value of the assessed parameters

	More experienced investigator			Less experienced investigator		
Parameter	Average time, sec.	High quality images, %	Correct interpretation of vascular pattern, %	Average time, sec.	High quality images, %	Correct interpretation of vascular pattern, %
Baseline	180,7± 1,8	34,5	63,6	185,7± 0,7	20,0	48,6
3 months	159,9± 1,4	43,6	90,8	164,0± 2,6	31,4	87,5
6 months	140,4± 1,9	67,8	97,5	145,4± 1,9	52,3	93,3
9 months	120,2± 1,0	94,5	99,4	123,2± 1,2	84,7	98,1

Subgroup Analysis

Subgroup analysis revealed that prior experience in endoscopic technologies application positively correlated with the speed of acquiring proficiency in contact endoscopy. Experienced in endoscopy otorhinolaryngologist reached a plateau in technical proficiency by the 3-month mark, while less experienced practitioners took 6 months in average. Sufficient number of correctly revealed vascular patterns for both more and less experienced doctors was gained by the 3-month time point (20 procedures).

Participant Feedback

Feedback collected from participants indicated an increase in confidence in using contact endoscopy over time. Initially, only 40% of participants felt confident in their ability to use the technique effectively; this number increased to 90% by the end of the study.

Challenges and Limitations

Participants reported challenges in the initial stages, particularly related to handling the endoscope and interpreting the enhanced images. At the same time, participants who were experienced in the use of any type of rigid and flexible endoscopes. The study's limitations include its reliance on self-reported data for some measures and the potential variability in patient cases.

4. Discussion

Interpretation of Findings

The findings of our study indicate a significant learning curve associated with the use of contact endoscopy in the examination of oral cavity and oropharynx. The improvement in both the technical proficiency, as evidenced by the reduction in examination duration and the increase in high-quality image acquisition, and the diagnostic accuracy over the 9-month period underscores the importance of structured training and continued practice.

Comparison with Existing Literature

There is no data in the literature about the learning curve assessment in contact endoscopy for oral and oropharyngeal examination. At the same time, there is data considering narrow band imaging that have some similarities with contact endoscopy, at least in case of vascular pattern interpretation. Dias-Silva et. al. reported that from the first to the last 50 videos, a learning curve was observed with a 10% increase in global accuracy. And after 200 videos, specificity for dysplasia was greater than 95%. The videos were delivered to the participants through the specially designed web-based learning system [13]. Zurek et.al. reported that a minimum of 65 narrow band imaging examinations are required to reach a plateau phase of the learning process in assessment of glottis lesions [14].

Our results align with existing literature that emphasizes the importance of experience and training in mastering endoscopic techniques. Studies in similar fields have also reported initial challenges in adopting new diagnostic technologies, gradually overcoming them with practice and experience. The positive correlation between prior endoscopic experience and a steeper learning curve in our study adds to the growing body of evidence that pre-existing procedural skills can facilitate the acquisition of new techniques.

Clinical Implications

The marked improvement in the percentage of the correctly detected vascular pattern suggests that with adequate training, the diagnostic accuracy of the method might be improved. At the same time it might become a topic of the further investigations. This is particularly relevant in early detection of malignancies, where contact endoscopy can complement conventional oral and oropharyngeal examination, potentially leading to earlier intervention and improved patient outcomes.

The study highlights the necessity for comprehensive training programs in contact endoscopy for otolaryngologists. Given the steep learning curve, especially for practitioners with less prior experience in any type of endoscopic evaluation, tailored training programs with a balance of theoretical knowledge and practical skills are essential. Additionally, the study suggests that continuous practice and exposure are crucial for maintaining and improving proficiency.

Limitations of the Study

While our study provides valuable insights, it is not without limitations. The reliance on self-reported measures for some assessments, such as image quality, might introduce subjectivity. Furthermore, the variability in patient cases could affect the generalizability of our findings. Future studies could involve a larger and more diverse participant pool and incorporate more objective measures of image quality and diagnostic accuracy.

Future Research Directions

Further research could focus on long-term outcomes of contact endoscopy training, exploring how sustained practice impacts diagnostic proficiency. Additionally, studies comparing different training methodologies could provide insights into the most effective approaches for teaching this technique. For instance, there is data in the literature about YouTube-based learning program that was feasible for training process [15]. The exploration of patient outcomes as a function of contact endoscopy use in diagnosis would also be valuable.

5. Conclusion

Our study provides an analysis of the learning curve associated with contact endoscopy for the oral and oropharyngeal examination. The findings highlight the important role of structured training and continuous practice in mastering this technique. Over the 9-month study period, improvements were observed in both technical proficiency and diagnostic accuracy among participating otolaryngoloegists. These improvements were particularly pronounced in those with prior experience in endoscopic investigations, suggesting that pre-existing endoscopic skills can facilitate the acquisition of proficiency in contact endoscopy. The reduction in examination duration and the increase in the production of high-quality images are indicative of the growing technical adeptness of the participants.

Our study also underscores the importance of training in adopting new medical technologies. Given the observed learning curve, it is imperative for medical institutions to invest in training programs that not only introduce contact endoscopy techniques but also provide ongoing support and learning opportunities for practitioners.

Despite these promising findings, the study acknowledges certain limitations, including the potential for subjective bias in self-reported measures and the variability in patient cases. These factors highlight the need for continued research, particularly studies that employ more objective assessment tools and involve a more diverse range of clinical settings and patient populations.

Application of artificial intelligence:

The article is written without the use of artificial intelligence technologies.

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