Methylene Blue Video Contact Endoscopy Enhanced with SPIES Filters in Early Detection of Malignancies of the Vocal Fold

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Methylene blue video contact endoscopy was imagined for the first time in the early '70s by a gynecologist named Hamou. He was the first one to perform contact colposcopy using methylene blue staining. Because of the poor medical optic technology at that time the method was abandoned. Prof. Mario Andreea and Oscar Diaz preformed in 1994 the first video contact endoscopy of the vocal fold. We propose a new way to enhance the video contact endoscopy's power to detect early malignancies of the vocal fold using SPIES software filters. The method will be critically analyzed.

Keywords: methylene blue, vocal fold carcinoma, contact endoscopy, SPIES filters

Hamou, a gynecologist that was the first to imagine the method of contact endoscopy [1], started performing video contact colposcopy in the early '70s. A milestone appears in 1965, when the era of modern endoscopy begins. The new Hopkins rod lens were introduced and the development of the endoscopes as we know them today debuted. Because the medical optic and medical endoscopy were at the beginning, the method was abandoned until 1994, when Profesor Mario Andreea and Oscar Diaz started performing methylene blue staining of the vocal fold and the study of the superficial epithselium using video contact endoscopes produced by the Karl Storz Company [2,3]. Since then various methods of enhancing the results of methylene blue video contact endoscopy in early detection of malignancies and in obtaining disease free margins were described [4].

More than 40% of the head and neck tumors are represented by laryngeal carcinomas, which makes it an important health issue [5]. According to the International Agency for Research on Cancer funded by World Health Organization, Romania has an incidence of the disease of 6.8:100.000 people (the 5th place in Europe) and a mortality of 4.1:100.000 people (4th place in Europe).

Surgical interventions with curative intent are among the most important progression prognostic factors in neoplasia. There are a number of studies aiming to establish integrity markers for surgical margins. Currently, the development of inflammation blood-markers, which would correlate with tumor angiogenesis [6], is also being attempted.

In Romania laryngeal cancer prevalence according to IARC is in men 14% after 1 year, 32.5% after 3 years, 50.8% after 5 years and in women 13.95% after 1 year, 34.88% after 3 years and 50.8% after 5 years.

Besides medical optic advancement the electronic revolution took place and today high definition cameras that achieve full HD resolution are available and even 4K resolutions were achieved. The quality of the obtained image is crystal clear, so every detail of the contact endoscopy examination can be observed [7].

We used in our clinic a 0 degree endoscope with 0 focal length and a magnification of 60X after staining the vocal fold with methylene blue. This allowed us to observe the modifications of the cellular field and the vascular superficial network of the vocal fold.

The main parameters that were taken into account were: the uniformity of the cellular field; the ratio between the nucleus and cytoplasm, the shape and the dimension of the cells. Having in mind that according to the angiogenesis theory a 1 mm malignant tumor starts producing endothelial growth factor in order to develop a new and important vascular network and to get more nutrients needed for the tumor to grow, we started studying the vascular superficial network as well.

We have already studied optical technologies such as Narrow Band Imaging light filters, that can be used to enhance the value of the methylene blue video contact endoscopy. The Narrow Band Imaging (NBI) filter allows an accurate evaluation of the superficial layer of the vocal fold [8].

Karl Storz introduced a new technology called SPIES in 2014 and that technology allows the surgeon to apply a number of four types (CLARA, CHROMA, SPECTRA A and SPECTRA B) of optical software filters and filters associations on the endoscopic image.

The CLARA filter will provide the surgeon with a clear endoscopic image in both light and dark areas of the lesion enhancing proper illumination of the entire endoscopic field.

CHROMA filter allows a clear differentiation between tissues and it intensifies the color contrast in the image. A clearly visible structure of the vocal fold's surface is provided, while retaining the natural color perception.

SPECTRA A and SPECTRA B filters allows the surgeon to recognize the finest structures. The bright red portions of the red colors from the visible spectrum are filtered and the rest of the colors are expanded. In that manner the surgeon can easily differentiate between two types of tissue.

Another advantage of the SPIES capable camera is the capacity of the camera to divide the image from the display into two portions. In real time, on the left part we have the original endoscopic image using white light and on the right part, also in real time, the SPIES software filtered image is displayed. Having both original white light illuminated endoscopic field and the enhanced SPIES

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software filtered image allows the surgeon to easily detect modifications in the cellular field.

Failure of radical surgery as well as unresectability indicate the need for complex systemic oncological treatments [9]. They are often associated with side effects that affect the quality of life [10]. There are attempts to develop complex multiagent systems with local application to reduce systemic adverse reactions [11,12].

The aim of our study was to enhance the power of detection of the methylene blue video contact endoscopy of early malignancies using SPIES software filters and to critically analyze the results. However, as shown by other studies [13], we do not consider that this method can replace biopsy sampling. So far, the methylene blue staining test associated with videocontact endoscopy has had promising results [14].

Experimental part

We conducted this study in The Prof. Dr. Dorin Hociota Institute of Phonoaudiology and Functional ENT Surgery.

We enrolled in our study 21 patients with suspicion of premalignant lesions of the vocal fold . The age of the patients ranged from 42 to 72 year old. The patient group consisted of 18 males and 3 females. The patients were enrolled in the study after performing trans nasal flexible endoscopy using white light.

The surgery was performed under general anesthesia with oral intubation. The laryngoscopy metallic tube with triangular section was inserted trans orally and the glottis plan could be exposed.

A rigid endoscopy examination was performed through the laryngoscopy tube using a rigid laryngeal endoscope in both white light and applying the SPIES filters on the lesion.

Methylene blue video contact endoscopy was performed using normal light and then applying the enhancing SPIES filters. Also a combination between the filters was used respecting the following protocol.

The cleaning of the vocal fold was preformed using a saline solution and after that 1% acetic acid. Methylene blue 1% solution was used to obtain a uniform staining of both vocal folds (fig. 1).

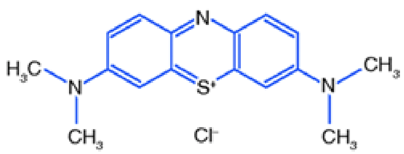

Fig. 1. Chemical formula of methilene blue

First we analyzed the normal vocal fold and then the suspected lesion of the vocal fold. The procedure was done using the rigid 0 degree laryngeal 60X magnification contact endoscope.

We performed a video contact endoscopy using white light (fig. 2), then the SPIES filters were applied.

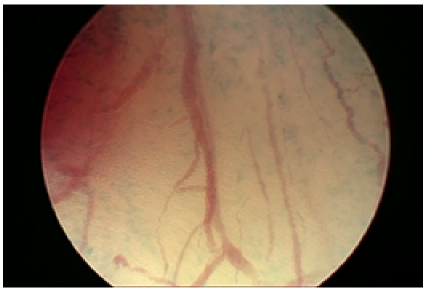

Fig. 2. Video contact endoscopy image of the vocal fold 60X magnification using white light

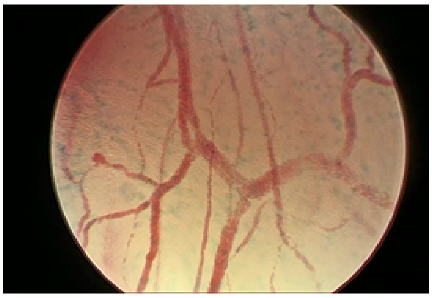

Fig. 3. Video contact endoscopy image of the vocal fold 60X magnification using the CHROMA filter

First we applied the CLARA filter, second the combination between CLARA and CHROMA, and then the SPECTRA A and SPECTRA B filters.

The characteristics of the cellular field and the design of the superficial vascular network were analyzed both in white light and the SPIES software filters as described above.

The obtained images were analyzed and critically interpreted. We performed targeted biopsies from the lesion and, after resecting the lesion using CO2 LASER surgery, a number of 6 biopsies were taken from the periphery of the resection area. Afterwards, we compared the results obtained using methylene blue contact endoscopy with SPIES enhanced video contact endoscopy and the histopathology result.

Results and discussions

The results obtained after comparison of the contact endoscopy technique using white light, SPIES enhanced methylene blue contact endoscopy and the paraffin histopathology results are shown in table 1.

The results concluded that enhancing methylene blue video contact endoscopy with CHROMA (fig. 3) and SPECTRA B (fig. 4) filters will provide surgeons more information, increasing the sensitivity, specificity and accuracy of the method.

The CLARA filter provides an increased illumination of the field and sometimes because of that some details may not be observed (fig. 5).

The SPECTRA A filter provides a darker image of the cellular field and some details are not observed because of the dark image (fig. 6).

Table 1
RESULTS OF THE COMPARISON BETWEEN THE CONTACT ENDOSCOPY TECHNIQUE USING WHITE LIGHT, SPIES ENHANCED METHYLENE BLUE CONTACT ENDOSCOPY AND THE PARAFFIN HISTOPATHOLOGY EXAMINATION

	Sensitivity	Specificity	Accuracy
Video contact endoscopy (VCE) white light	78.31%	78.71%	90.08%
VCE + CLARA	77.2%	76.32%	80.02%
VCE+ CLARA + CROMA	84.32%	86.56%	95.40%
VCE + SPECTRA A	50.22%	55.32%	40.32%
VCE + SPECTRA B	86.57%	88.43%	97.12%

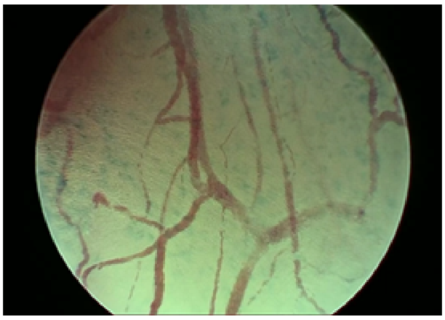

Fig. 4. Video contact endoscopy image of the vocal fold 60X magnification using the SPECTRA B filter

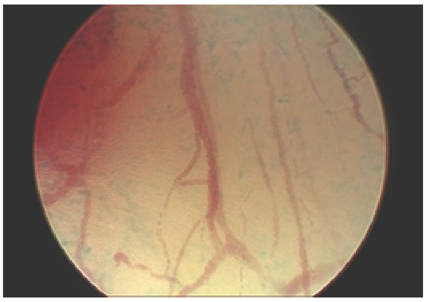

Fig. 5. Video contact endoscopy image of the vocal fold 60X magnification using the CLARA filter

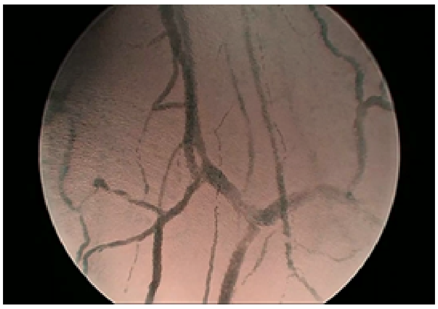

Fig. 6. Video contact endoscopy image of the vocal fold 60X magnification using the SPECTRA A filter

The paraffin histological result still remains the gold standard in histologic diagnosis of lesions of the vocal fold.

In another paper was studied the toluidine blue as a visual diagnostic method in oral premalignent lesions [15].

Conclusions

SPIES software filters enhancing of the methylene blue contact endoscopy using CHROMA and SPECTRA B filters improves the results in early detection of the vocal fold malignancies. CLARA and SPECTRA A filters provide an over respectively under exposed light of the cellular field that will not allow the surgeon to see some important details and due to that reason we have to avoid using them.

The SPIES filters technology is at the beginning and we consider that a proper learning curve will ameliorate the results.

The biopsy still remains the gold standard in determining the malignant nature of a lesion and for the time being no optical biopsy technology is able to be as accurate as the paraffin examination.

The price of the SPIES technology is relatively high, but in the next period probably the price for that technology will decrease with the development of 3D endoscopy and 4K resolution endoscopy.

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