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Original paper

The utility of Narrow Band Imaging in obtaining disease free resection margins during endoscopic surgery of the larynx

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Abstract Narrow Band Imaging (NBI) is an optical method that helps the surgeon visualize lesions that are not always visible under white light endoscopy. First the method was used in gastroenterology, almost 10 years ago, with great success. Four years ago the optical method was transferred in the ENT (Ear Nose Throat) field and now it is available on fiber optic and rigid endoscopes. The technological advancement, the introduction of new video chips capable to produce HDTV (high definition TV) images offered the surgeon the ability to obtain high resolution, dynamic images during flexible or fixed endoscopic examination of the larynx. The aim of the paper was to evaluate the utility of the intraoperative use of NBI technology in obtaining disease free resection margins during endoscopic surgery of the larynx.

Keywords Larynx, carcinoma, narrow band imaging

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Introduction

Squamous cell carcinoma is the most common laryngeal carcinoma. In men, Romania has an incidence of 14.4/100.000 (third place in Europe) and 0.4: 100.000 people in women according to the WHO statistics. The mortality is on the 5th place in Europe, 4.1: 100.000 people (WHO and International Agency Of Reserch In Cancer [1]).

Hoarseness is the main symptom of laryngeal carcinomas. The hoarseness will progress slowly, that is why every dysphonia older than 2 weeks must be examined endoscopically.

Until the 1990's the main treatment of laryngeal carcinomas was partial or total laryngectomy. After 1990 the CO2 LASER surgery was introduced and new endoscopic surgical techniques were developed. In the early years of endoscopic surgery there was much debate about the disease free resection margins that can be achieved during the endoscopic approach compared with external approaches.

The modern treatment of the laryngeal carcinoma is represented by the endoscopic approach, with the use of CO2 LASER surgery for the Tis, T1 to T3 carcinoma stages. The diagnostic and radical treatment circumvent cancer from reaching a more advanced stage that requires complex local or systemic therapies often entailing major adverse reactions (C. NITIPIR & al. [2], M. YIPEL & al. [3], C. NITIPIR & al. [4], M.V. GHICA & al. [5]).

The advancement of the radiotherapy and chemotherapy helped the organ preservation philosophy in the treatment of laryngeal carcinoma. The therapeutic decision should be made by a multidisciplinary committee by taking into account all risk factors associated with various treatments indicated (A.C. PODARIU & al. [6], C. PIAZZA & al [7], A. WATANABE & al. [8], M. KAWAIDA & al. [9], H. MATSUBA & al. [10], M. KRAFT & al. [11], O. GINCHINA & al. [12], A.N. CIUHU & al. [13], M. MANUC & al. [14]).

Despite various attempts to define serum markers appropriate for the screening of head and neck cancers, cancer removal with disease free margins remains the golden standard for favourable prognosis in these patients (A.E. STANCIU & al. [15], V.ARDELEANU [16]).

New technologies were developed in order to enhance the vision of the surgeon and to better define the laryngeal lesion with the goal of obtaining disease free resection margins [8]. Narrow Band Imaging represents an optical technology that uses an optical filter to produce specific wavelengths that are absorbed by hemoglobin and penetrate only the surface of the tissue. The result is that the capillaries are displayed in brown and the submucosal veins in cyan. The optical filter will transform the visible specter of the white light in a two frequency filtered at 415nm and 540 nm light.

The short wavelength of 415 nm will penetrate only the superficial layer of the mucosa and will be absorbed by capillary vessels. The longer wavelength of 540 nm light will penetrate deeper compared with the 415 short wavelength and will be absorbed by the veins located deeper that the capillaries (WATANABE & al. [8]).

The introduction of the high definition video chips leads to better image acquisition, more details and information regarding the targeted tissue [9].

Materials and Methods

We started using intraoperative NBI light in order to better define the laryngeal lesions during endoscopic surgery of the larynx.

The endoscopic surgery of the larynx was performed under general anesthesia. We performed a micro laryngoscopy using the medium laryngoscope or the laryngoscope designed for the approach of the anterior commissure of the glottis level.

The study was performed on lot of 23 patients with confirmed laryngeal carcinoma by the histopathological exam. We had 22 male patients and 1 female. The age of the patients was between 41 and 65 years old.

The protocol that we used consisted in rigid endoscopic examination with white light, microscopic CO2 LASER surgery, endoscopic targeted biopsies and rigid endoscopic examination of the lesion in NBI light.

The histopathological findings were compared with the results obtained from the apparent disease free resection margins, as examined in white light compared with NBI light.

We present the detailed protocol that we used as follows.

First the patient was examined by endoscopy with a rigid laryngeal endoscope of 0, 30 and 70 degree using the white light. The next step consisted in the actual intervention. For this we mounted the operating microscope and we performed surgical resection according to the lesion and supposed tumor margins visualized with white light. We performed hemostasis and we cleaned the surgery area with cold saline solutions. Next, the saline solution was completely aspirated. The endoscopic examination under white light was repeated and multiple endoscopic targeted biopsies were performed and the specimens were sent for histopathological examination.

We switched the white light with the NBI light for better defining the margins of the lesion and we performed a proximity exam. If the resection margins were considered to be "disease free" we considered that the resection of the tumor was correct.

If suspicious margins were discovered under NBI light we tried to better define the resection margins, put back the surgical microscope and an additional CO2 LASER resection was done. The surgical field was cleaned with cold saline solution after hemostasis. The same evaluation with NBI light was repeated and again, when needed, an additional CO2 LASER resection was performed after targeted biopsies.

We compared the results of the histopathological exams of the endoscopic targeted biopsies performed under white light with the ones obtained after additional NBI endoscopic exams and further resection.

We performed the following CO2 LASER assisted cordectomies [Table 1]: 3 cases of Type III Cordectomy, 6 cases of type IV cordectomy, 5 cases of type Vacordectomy, 1 case of type Vbcordectomy, 6 cases of type Vc, and 2 cases of type Vdcordectomy, according to the ELS (European Laryngologic Society) classification.

Results and Discussions

The histolopathological results revealed the following data. From the histopathological point of view, the real disease free resection margins when the resection was performed under white light with rigid endoscopic control also under white light showed that only 78.1% in Type III ELS cordectomies (Figure 1), 58.2% in Type IV ELS cordectomies (Figure 2, 3), 32.1% in Type Va ELS cordectomies (Figure 4), 58.1% in Type Vb ELS cordectomies (Figure 5), 46.3% in Type Vc ELS cordectomies (Figure 6) and 80% in Type Vd ELS cordectomies (Figure 7) were actual disease free resection margins.

Table 1. Types of CO2 LASER assisted cordectomies performed.

Type of cordectomy	Number
Type III - Transmuscularcordectomy	3
Type IV - Total or complete cordectomy	6
Type Va - Extended cordectomy encompassing the contralateral vocal fold	5
Type Vb - Extended cordectomy encompassing the arytenoid	1
Type Vc - Extended cordectomy to the ventricule	6
Type Vd - Extended cordectomy to the subglottis to a distance of 1 cm	2

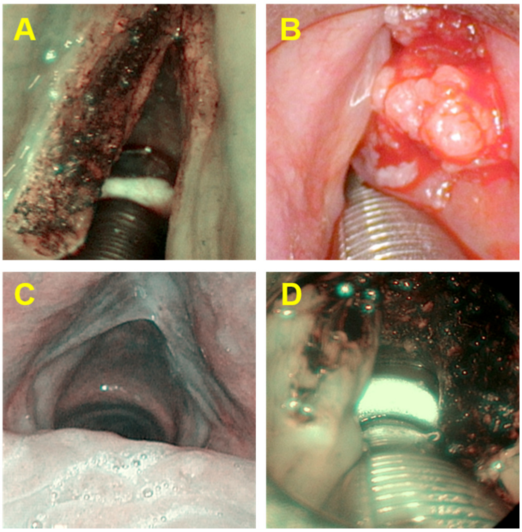

Figure 1A. Endoscopic image following an ELS III cordectomy.
Figure 1B. Endoscopic image of a laryngeal tumor requiring an ELS IV cordectomy.
Figure 1C. Endoscopic image after the ELS IV resection was performed.
Figure 1D. Type Va ELS cordectomy – endoscopic control using NBI light.

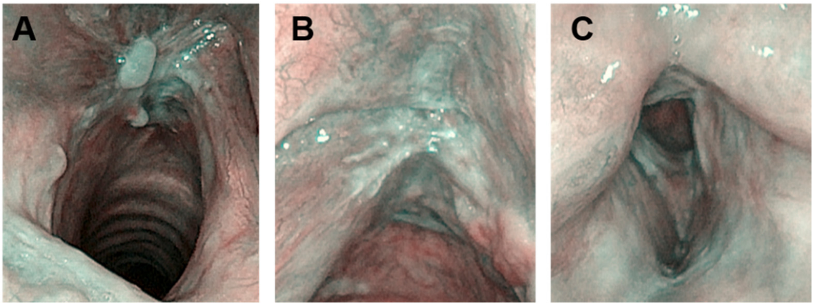

Figure 2A. Type Vb ELS cordectomy with a fibrotic scar area – NBI filter examination.
Figure 2B. Endoscopic examination with NBI filter – postoperative control following a type Vc ELS cordectomy.
Figure 2C. Postoperative result following a type Vd ELS cordectomy – endoscopic evaluation with NBI filter.

Table 2. Comparison of the histopathological results with or without NBI

Type of cordectomy	Number of patients	Disease free margins in white light	Disease free margins in NBI light
Type III - Transmuscularcordectomy	3	78.1%	100%
Type IV - Total or complete cordectomy	6	58.2%	100%
Type Va - Extended cordectomy encompassing the contralateral vocal fold	5	32.1%	92.1%
Type Vb - Extended cordectomy encompassing the arytenoid	1	58.1%	100%
Type Vc - Extended cordectomy to the ventricule	6	46.3%	96.3%
Type Vd - Extended cordectomy to the subglottis to a distance of 1 cm	2	80%	100%
Total		58.8%	98%

Comparing the histopathological results of the multiple biopsies performed under targeted endoscopic NBI light after defining the resection margins using also the NBI light, we obtained the following results [Table 2]: in type III ELS cordectomies 100%, in type IV ELS cordectomies 100%, in type Va ELS cordectomies 92.1%, in type Vb ELS cordectomies 100%, in type Vc ELS cordectomies 96.3% and in type Vd ELS cordectomies 100% of the resection margins were confirmed as disease free.

We consider that NBI light control of the resection margins adds an important value compared with the rigid endoscopic control with white light. The added value of the NBI technology in assessing disease free resection margins compared with white light illumination is: type III ELS cordectomies 21.9%, type IV ELS cordectomies 41.8 %, type Va ELS cordectomies 60%, type Vb ELS cordectomies 41.9%, type Vc ELS cordectomies 50% and type Vd ELS cordectomies 20%.

We have to underline the important added value the NBI light examination will give in high risk areas such as the anterior commissure (60%), the arytenoids (41.9%) and the ventricle (60%), where it might more difficult to obtain disease free margins.

We expect the percentage of real disease free resection margins to increase in the following period because the use of NBI light examination needs a learning curve in order to be properly used.

Further developments of the medical optic will lead to the availability of the NBI light direct in the surgical microscope. The surgeon will be able to resect the lesion under direct NBI light, which will lead to an increase in the percentage of disease free margins (M. YIPEL & al. [3]). The time necessary for the surgery will decrease, which will translate

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into lower costs. The NBI rigid endoscopic exam can be used successfully when the frozen section examination is not available. It is also useful in assessing suspicious surrounding tissues (H. MATSUBA & al. [10]).

There are more technologies on the market that apply software color filters on the endoscopic, image but the reliability is still questionable.

Conclusions

The results obtained so far show that we are going to obtain more than 39% of real disease free resection margins when using NBI light rigid optic examination compared to the white light examination. It is also very important the fact that the percentage of real disease free resection margins will increase in high risk areas such as the anterior commissure, the ventricle and the subglottis.

For all these reasons we consider the NBI light examination to be an optic, robust technology that will produce better disease-free margins, with predictable and able repetition results.

Because the NBI filter is an optical and not a software-based filter, the image obtained by the surgeon is real and not processed by the video processor.

The NBI light can be used on conventional rigid endoscopes or fiber endoscopes so beside the NBI capable light source and the compatible processor no further investment is needed it to use that technology.

In our opinion, the learning curve is about 6 months to 1 year.

The technology can be used as a fiberoptic exam, in observing early cancer, as well as in follow up exam even after radiotherapy. We observed false positive results in NBI examination but no false negative results concerning the remnant disease. Further studies must be completed using the assessment of free disease resection margins on more patients. We also studied the use of NBI light as enhancement method for video contact endoscopy of the vocal fold. NBI will amplify the contrast and the visualization of the vascular network improving the sensibility of the method.

Conflict of interest

No conflict of interest to report.

Acknowledgment

All authors have equally contributed to this manuscript.

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