http://dx.doi.org/10.35630/2199-885X/2021/11/4/ea3/crc

STUDY OF CANINE COLON NEOPLASMS USING TISSUE LUMINESCENCE ANALYSIS IN A HIGH-FREQUENCY ELECTROMAGNETIC FIELD

Received 18 July 2021;
Received in revised form 10 August 2021;
Accepted 18 August 2021;
First published 28 August 2021

***Svetlana Kaushanskaya*[1], *Alexander Gritskevich*[2], *Konstantin Korotkov*[3]✉**

[1] *Kuban State Medical University, Krasnodar;*
[2] *Vishnevsky State Medical Research Center of Surgery, Moscow;*
[3] *St. Petersburg Research Institute of Physical Culture, St. Petersburg, Russia*

✉ *korotkov2000@gmail.com*

ABSTRACT — Malignant tumors of the colon present a severe medical problem, and only their timely diagnosis can provide adequate therapy. In this work, we developed and tested a screen-ing method of endoscopic analysis of canine colon neoplasms by its luminescent glow stimulated by a high-frequency electromagnetic field. Observations were made on nine dogs with endoscopically detected tumors in the large intestine. Comparative analysis showed that benign tumor and healthy tissue areas glow at the edges in a high-frequency electromagnetic field, while malignant tumors glow over their entire site. The lumines-cence histogram of healthy tissues had a one-humped appearance, while malignant tu-mors demonstrated a double-humped character, and the brightness was higher in magni-tude. Histological analysis data confirmed the luminescence results. Research on dogs can be the basis for developing an endoscopic screening method of malignant tumors of the large intestine in humans.

KEYWORDS — neoplasm, malignant tumor, the colon, luminescence.

INTRODUCTION

Benign and malignant tumors are most common diseases of the colon, with an increasing trend [1], and only their timely diagnosis can provide adequate therapy. Endoscopic methods are widely applied for diagnosis and surgical treatment of intestinal tumors [2]. The use of fluorescence methods helps increase the informative value of endoscopic analysis [3, 4]. But the fluorescence methods have major limitations: 1) administration of fluorescence sensitizer directly into the tumor lesion; 2) creation of maximum concentration in this area (tumor/normal mucosa gradient) — a problem of selectivity; 3) phototoxicity of fluorescence sensitizer to healthy tissues outside the tumor locus [5, 6].

At present, a search for computer-aided screening technologies has been actively conducted as they can be an alternative to conventional colonoscopy after their introduction into clinical practice [7].

Luminescence in tissue can be induced by a high-frequency electromagnetic field [8]. Thus, one of the approaches in developing such a screening method can be the visualization of intestinal mucosa in a high-frequency electromagnetic field [9, 10].

Objective

The study aimed to create a screening method for diagnosing tumor-like neoplasms in the colon by visualization of luminescence in a high-frequency electromagnetic field during endoscopy.

MATERIAL AND METHODS

All experiments on animals were performed in accordance with the International Guide-lines for Biomedical Research Involving Animals, adopted by the International Council of Scientific Societies CIOMS 1985.

Endoscopic examination was performed with an Olympus colonoscope CF-H185L/I in veterinary clinic "Kovcheg" (Krasnodar, Russia) on nine 12–15 years old dogs weighing 14.7±4.2 kg and anesthetized with sodium thiopental (60 mg/kg).

In animals with tumors of the large intestine, analysis of tissue glow in a high-frequency electromagnetic field was followed by taking biopsy material for histological examination, the results of which determined the scope of surgery.

Tumor-like tissues were visualized in the high-frequency electromagnetic field for 2 seconds with a scanner KELSY-M-2011 (ELSIS company, St. Petersburg, Russia). The luminescence area was scanned, magnified by a microscope built into the scanner, recorded by a still camera (24 frames/sec; 2048×1536 resolution), and fed into a computer through a video signal digitizer. The computer program reproduced the image on the monitor screen and plotted luminance and wavelength histograms. The glow brightness was evaluated in bits, the wave-length in nanometers.

Statistical analysis of the results was carried out using "Excel" and "Statistica" programs. First, the normality of the variant distribution was determined. If the distribution law of the obtained values differed from normal, the data were presented as Me (Q1–Q3), where Me is the median, Q1 is the lower (25%), and Q3 is the upper (75%) quartiles. The nonparametric Mann-Whitney U-criterion was used for comparing two independent groups.

RESULTS AND DISCUSSION

In a healthy section of the dog's colon, a marginal glow of its wall in a high-frequency electromagnetic field was detected for all dogs. The histogram of luminescence brightness had one hump (Fig.1.1). The histogram of the luminescence wavelength reflected the beginning of the visible range (Fig. 2.1).

Polyp luminescence was also marginal; the luminescence was one-humped as well (Figure 1.2) and was more extensive than that of the healthy area (Table 1) by 37.1%. The histogram of luminescence wavelengths was at the beginning of the visible range (Figure 2.2). The min-imum limit of the luminescence range did not differ significantly from that of the healthy part of the intestine (Table 1). The maximum limit of the luminescence range was 1.7% higher than in the healthy section, and the wavelength range exceeded the range of the healthy area by 16.1%. There was no significant difference between the median wavelength ranges of the luminescence between the polyp and the healthy part of the intestine.

Thus, the differences in the glow of a dog's colon polyp from a healthy area are the stronger brightness and a more extensive wavelength range of glow in the polyp.

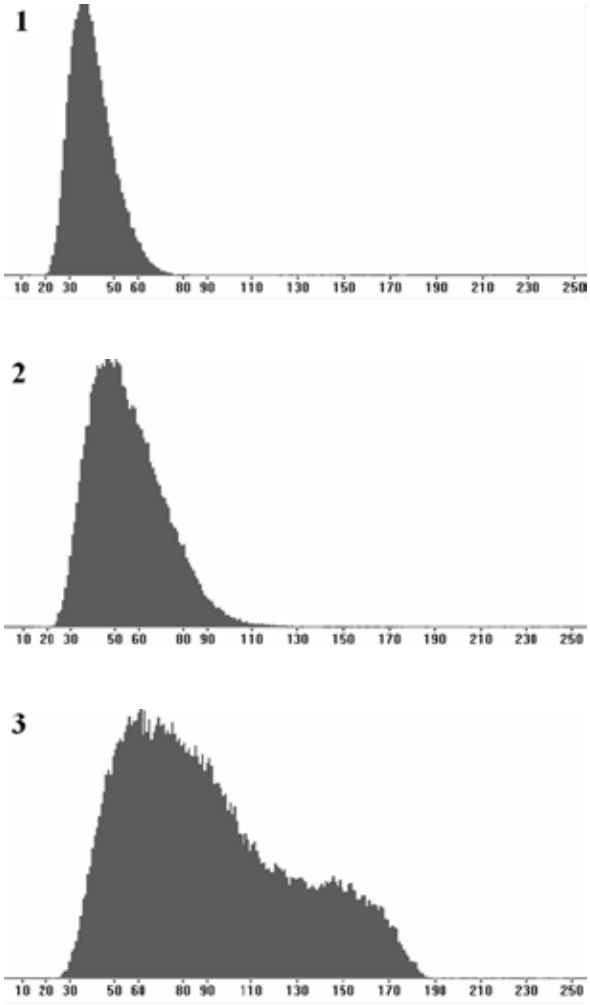

Fig. 1 *Histogram of luminescence brightness of the dog sigmoid colon (in bits). 1 — healthy section of the colon, 2 — polyp, 3 — malignant tumor*

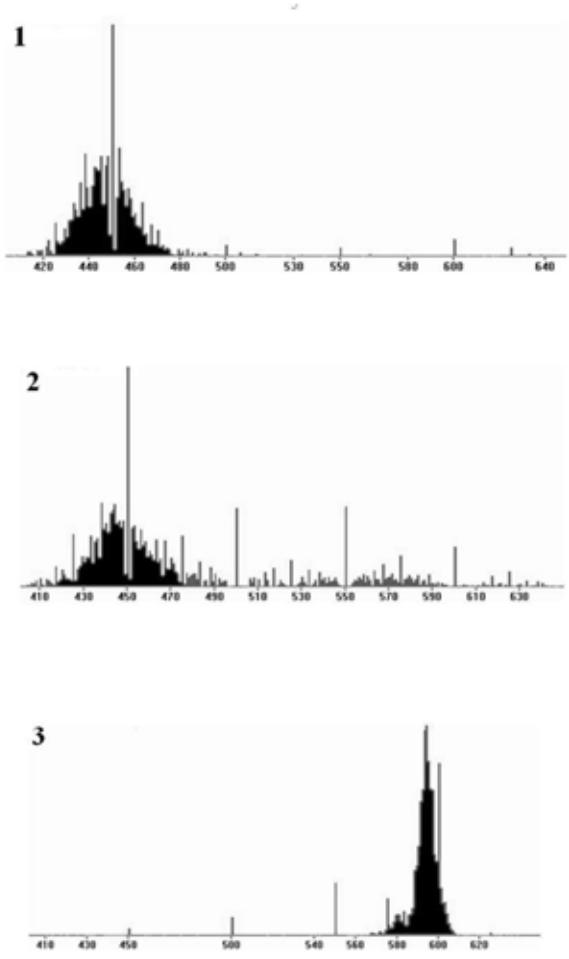

Fig. 2. *Histogram of luminescence wavelengths of the dog sigmoid colon (in nm) 1 — healthy section of the colon, 2 — polyp, 3 — malignant tumor*

Table 1. *Parameters of luminescence of different areas of the dog's sigmoid colon in the high-frequency electromagnetic field*

Glow parameters	Statistical parameters	Colon neoplasias		
		Healthy part	Polyp	Malignant tumor
		1	2	3
Luminous brightness (in bits)	Me 25% 75%	87.5 85.0 90.0	120.0 120.0 130,0 P_1 <0.01	185.0 180.0 190.0 P_2 <0.01 P_3 <0.01
Minimum limit of the luminous wavelength range (in nm)	Me 25% 75%	409.7 408.0 409.0	405.0 405.0 405.0 P_1>0.05	570.0 550.0 580.0 P_2 <0.01 P_3 <0,01
Maximum limit of the luminescence wave-length range (in nm)	Me 25% 75%	491.5 490.0 495.0	500.0 500.0 500.0 P_1 <0.01	610.0 600.0 615.0 P_2 <0.01 P_3 <0.01
Luminescence wavelength range (in nm)	Me 25% 75%	81.8 80.0 83.8	93.0 93.0 99.0 P_1 <0.01	40.0 38.0 43.0 P_2 <0.01 P_3 <0.01
Median of the wavelength range (in nm)	Me 25% 75%	450.,0 448.2 452.1	450.0 450.0 450.0 P_1>0.05	590.0 590.0 590.0 P_2 <0.01 P_3 <0.01
Diagnosis by glow parameters		Healthy part	Polyp	Malignant tumor
Diagnosis by histologic analysis		Healthy part	Polyp	Malignant tumor

P_1 — confidence interval between columns 1 and 2; P_2 — same between columns 1 and 3; P_3 — same between columns 2 and 3;

The luminescence of malignant tumor in a high-frequency electromagnetic field, along with the marginal luminescence, demonstrated an internal glow presented as a two-humped curve on the luminescence brightness histogram (Fig. 1.3). The luminescence brightness of the malignant tumor was 111.4% higher than the healthy area. The histogram of luminescence wavelength reflected the end of the visible range (Fig. 2.3). The minimum limit of the luminescence range was 39.1% higher than that of the healthy section of the intestine, and the maximum limit of the luminescence range exceeded that of the healthy part by 24.1%. At the same time, the luminescence wavelength range of the malignant tumor was less than that of the healthy area by 51.1%. The median of the luminescence wavelength range of the malig-nant tumor was 31.1% higher than that of the healthy part of the colon.

The luminescence brightness of the malignant tumor exceeded the brightness of the polyp by 54.2%. The minimum boundary of the luminescence range of malignant tumor was higher than that of the polyp by 40.2%. The maximum boundary of the luminescence range exceeded that of polyp by 22.0%. The luminescence wavelength range of cancerous tumors was less than that of the polyp by 57.9%.

CONCLUSION

The results showed that luminescence parameters of malignant tumors of the colon in the electromagnetic field in all examined animals had statistically significant differences from the luminescence parameters of healthy tissues and polyps.

Histological analysis of biopsy specimens of colon sections, polyps, and malignant tumors confirmed the diagnosis of the disease based on the luminescence parameters.

Research on dogs can be the basis for developing an endoscopic screening method of malignant tumors of the large intestine in humans.

REFERENCES

1. **Kit O.I., Gevorkyan Yu.A., Soldatkina N.V.** Modern possibilities of coloproctology: transanal endoscopic surgery // RZHGK. 2015;21;4:86–91.
2. **Brenner H., Kloor M., Pox C.P.** Colorectal cancer. // Lancet. doi: 10.1016/S0140-6736(13)61649-9.
3. **Oh G, Yoo SW, Jung Y, et al.** Intravital imaging of mouse colonic adenoma using MMP-based molecular probes with multi-channel fluorescence endoscopy. Biomed Opt Express. 2014;5:1677–1689. doi:10.1364/BOE.5.001677
4. **Urano Y, Asanuma D, Hama Y, et al.** Selective molecular imaging of viable cancer cells with pH-activatable fluorescence probes. Nat Med. 2009;15:104–109. doi: 10.1038/nm.1854.
5. **Almyashev G.G. Meltsaev, M.T. Kulaev,** Fluorescence diagnosis and photodynamic thera-py of colon cancer. // Volga Oncology Bulletin 2015;4:4–10.
6. **Burggraaf J, Kamerling IM, Gordon PB, et.al.** Detection of colorectal polyps in humans using an intravenously administered fluorescent peptide targeted against c-Met.Nat Med. 2015;21:955–961. doi: 10.1038/nm.3641.
7. **Liu Z, Miller SJ, Joshi BP, Wang TD.** In vivo targeting of colonic dysplasia on fluorescence endoscopy with near-infrared octapeptide. Gut. 2013;62:395–403. doi: 10.1136/gutjnl-2011-301913.
8. **Korotkov K.G.** Energy fields Electrophotonic analysis in humans and nature. 2012. Amazon.com Publishing.
9. **Yakovleva E G., Buntseva OA, Belonosov SS., et.al.** Identifying Patients with Colon Neoplasias with Gas Discharge Visualization Technique. J Alternative Complementary Medicine. 2015;21(11):720–724. DOI: 10.1089/acm.2014.0168
10. **Yakovleva E.G., Korotkov K.G., Fedorov E.D., et. al.** Engineering Approach To Identifying Patients With Colon Tumors on The Basis of Electrophotonic Imaging Technique Data. The Open Biomedical Engineering J. 2016, 2, 72–80. DOI: 10.2174/1874120701610010072