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Short Communication

COMPARISON OF TWO ENDOSCOPIC TECHNIQUES (Nd: YAG LASER VERSUR ARGON PLASMATIC COAGULATOR)

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In this study the comparison of the two techniques using the oral sigmoideum parts, which were resected in connection to the primary rectum carcinoma surgeries, are compared based on the experimental results and experience from the clinical use of both devices. For the experiments the Nd : MEDICOM YAG laser with the wavelength of 1.064 μm and the ERBE argon-plasmatic coagulation /(APC)/ appliances were used. The results show that while the argon plasmatic coagulation provides perfect and very safe surface coagulation results, the Nd : YAG laser is more suitable especially in the cases where evaporation and coagulation of large tissue mass is required.

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1. Introduction

Since the first gastro-enterology utilization of the ND : YAG laser the implementation range increased significantly [1,2]. The source of the working radiation is a synthetic garnet crystal enriched by the rare soil elements /neodym, yttrium/, which generates an infrared light with the basis wavelength of 1.064 μm that is transmitted by an 0.6 mm diameter optical fibre. As the infrared light can not be perceived by the human eye, the device is equipped with a semi-conducting or helium-neon laser, the rays of which are concentrated within the optical fibre and are used for the laser navigation. An infrared light laser with the wave length of 1064 um is able to penetrate approximately 6 mm into the tissue. The interaction of the laser with the tissue causes a partial evaporation and coagulation that depending on the output selected may reach the depth of up to 5 mm. In case o longer single-point interaction of the laser with the tissue the coagulated tissue vaporizes and the tissue damage is more significant. The argon-plasmatic coagulation first applied at the end of the 80-ies in Tübingen, Germany by the company ERBE represents a more recent method. Originally, this method was designed for conventional surgery large surface coagulation. Further development of the special applications enabled the utilization of this method also in the field of endoscopic treatment [1,3]. This method is based on the thermal tissue coagulation resulting from the contact of the tissue with a high-frequency electric current conducted by ionised argon. The interaction of the electric current with the tissue leads to tissue surface coagulation. The depth of the coagulated tissue depends on its electric resistance and thermal conductivity. The non-conductive water vapour is released from the coagulate tissue and the electric current further affects the vicinity of the non-conductive spot. The coagulated area is thus larger than the treated spot. As both techniques are considered to be either partially or fully competitive [4,5], our attempt was to provide experimental arguments leading to the resolution of the issue.

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2. Expetrimental

For the experiments we used the oral parts of sigmoideum of five different patients resected during the primary rectal carcinoma surgeries. In all five cases a non-irradiated and non-treated enteric tissue without macro- or microscopic malignity signs or other disorders was used. After the surgery the resected enteric tissue was stored in the saline solution at constant temperature of 5° Celsius. The experiments as such followed between 60 and 90 minutes after the resection time. The remaining material including the tumour was fixed by formol immediately after the surgery and examined using the standard histology technique. During the experiments both the argon-plasmatic coagulator application ending as well as the laser optical fibre were fixed in a simple holder. The distance between the intestine mucous membrane and the application ending and fibre was determined with the help of a micrometric meter. For the measuring of the interaction time a stop-watch was used. As compared to the fixed material, there appeared signs of autolysis, especially with regard to the epithelium, on all of the examined preparations immediately after the treatment. The depth of the enteric wall damage was measured in a standard manner by a pathologist (meter-scale placed within the ocular part of the device).

2.1 Argon-plasmatic coagulation experiments

For the experiments the ERBE – APC 300 argon-plasmatic coagulation device was used. In this device the ionised gas is conducted via a Teflon probe with a ceramic ending, in which there is located a wolfram electrode generating the coagulation current. The size of the coagulation area may be adjusted by the visual control based regulation of the output and the distance of the probe from the tissue (the colour of the ionised argon is light blue). This technique enables both the axial as well as the tangential treatment of the tissue. The coagulation depth depends on the energy used and the length of the interaction with the given spot and varies between 0.5 – 3 mm. After taking out the intestine from the saline solution, this was on a piece of wet gauze place on the indifferent electrode of the device. The pre-set probe distance was 5 mm, the selected output amounted to 90 W. The interaction time with a single spot was 10 seconds. In this way, 10 histologically examined spots were treated. In the second part of the experiment, we attempted to cause an intentional colon perforation. We increased the single spot 90 W output interaction time to 3 minutes. The coagulation mark area enlarged, yet there was no macroscopic perforation detected. After the termination of the experiment the preparation was fixed with the help of formol and a histological examination was carried out.

2.2 Laser experiments

For the laser examination experiments we used the MEDICOM ND : YAG laser with a wave-length of 1064 nm. In this device the flexible 600 um fibre, which easily passes through the endoscope tube, is used as an energy conductor. The guided laser enables an easy control of the utilization. The tissues may only be vaporised or coagulated parallel to the direction of the fibre axis. For the purpose of tangential coagulation a special easily damageable fibre is necessary. The scope of the area treated may partially be regulated by the regulation of the distance between the optical fibre and the tissue, the depth can be adjusted by the output regulation /from 15 to 100 W/ and the interaction time. The output used for our experiments equalled to the commonly clinically used output of 50 W. The distance from the mucous membrane was 10 mm, the selected diameter was 1mm. Altogether, each of the 10 spots was treated for 10 seconds. In the next part of he experiment, we attempted to cause an intentional colon perforation. This we successfully reached when treating one spot by 50 W output for seventeen seconds. The preparations were fixed by formol and dispatched for histological examination. With regard to the experiments with both devices, we precise that the interaction time was measured using a watch-stop, the application endings were fixed in a simple holder, and the distance from the sample was measured by a ruler.

3. Results

After the standard preparatory steps and dying, the histological examination of the preparations was carried out. In case of all 10 spots treated by the argon-plasmatic coagulation there were only coagulation marks detected on the enteric mucous membrane, the maximum depth of the coagulation zone did not exceed 2.5 mm. Generally, only the epithelium and the neighbouring *laminum proprium* parts were damaged. Only on the spots where we attempted to cause an intentional perforation there occurred a sub-mucous coagulation, the muscle tissue remained intact. The laser treatment caused the vaporisation of on one part of the mucous membrane, in all cases the maximum vaporisation zone depth was 2.5 mm, beneath this the coagulation zone ranging from minimum 2.9 to 3 mm maximum and reaching into the sub-mucosa was detected, the muscle tissue and the serosa remained intact.

The examination of the preparation, in which a macroscopic enteric perforation was caused intentionally proved that all enteric wall layers were damaged and the diameter of the coagulation area was 2.5 mm.

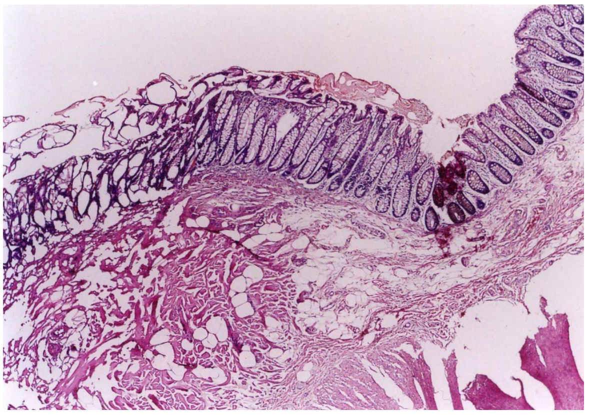

Fig. 1. Deep necrosis after Nd YAG- laser coagulation (power output 50W, duration 10 sec).

The available literature dedicated to the use of both techniques [5,6,7,8] stems from working places using in their clinical practice one or the other device. The authors of this study have experiences with both techniques that are currently used at their working places. Based on their own clinical experiences in cases where there exists a need for the vaporization of a larger mass of a tumorous tissue – i.e. also in the case of the re-canalisation treatment of the malign digestion system tumours – the authors prefer to use the Nd : YAG laser. Nevertheless, they also use the laser for the treatment of the extensive rectal adenoma, especially if the preceding partial adenoma polypectomy and the adenoma remnants argon-plasmatic coagulation was not successful.

The advantage of using the argon-plasmatic coagulation technique is its better accessibility caused mainly by the lower device acquisition price and the fact that it can also be used instead of the common electro-coagulation. The accessibility of the laser technique is significantly lower.

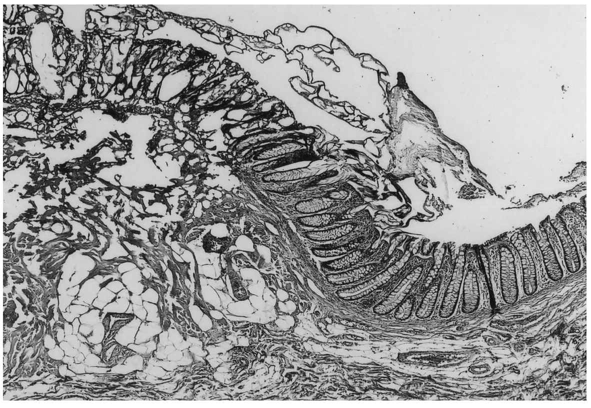

Fig. 2. Superficial necrosis of large bowel mucosa after APR coagulation (power 50W, duration 10 s).

Compared to the clinical practice, in our experiments the thermal conduction and the influence of the tissue perfusion is not considered with regard to the human colon experiments. Yet, we succeeded to achieve the identical results connected to the irreversible enteric wall damage also in case of *in vivo* experiments with animal models /9/. Even though the ex vivo experiments do not allow us to assess the scope of the reaction of a human organism to the thermal damage, they are sufficient to specify the scope of the irreversible changes, which is necessary with regard to the utilization of the device [9].

Although we did not use an animal model for the argon-plasmatic coagulation experiments, analogically we consider also the results achieved in connection to the ex vivo experiments as satisfactory conclusive.

Our results provide positive proofs on the possibility of laser utilization for the treatment of extensive tissue mass and on the achievability of immediate re-canalisation effect resulting from the vaporization of the tumor tissue. A long-term clinical experience will significantly decrease the colon perforation probability. On the other hand, the utilization of the argon-plasmatic coagulation is subject to our experimental results much more safe than it is stated in the respective literature sources.

We want also to stress that the successful use of Nd : YAG laser in surgery was demonstrated in the new devised ophtalmological system [10].

4. Conclusion

The argon-plasmatic coagulator and the Nd : YAG laser may be characterised as partially competitive techniques. At the present the argon-plasmatic coagulation is used predominantly for the majority of the endoscopic surgeries. Our experimental results lead us to the opinion that if extensive colon adenomas are treated using argon-plasmatic coagulation there is the need for an earlier treatment and more frequent subsequent endoscopic checking. Within the area of endoscopy, the optimal utilization of laser is the elimination of extensive tissue mass, especially with regard to the re-canalisation treatment or in cases where other endoscopic techniques, including the argon-plasmatic coagulation, were not successful.

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