Histological changes in prostate tissue under the influence of Dornier Medilas D UroBeam 940nm laser while applying method of modified vaporization of benign adenomatous hyperplasia of prostate

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Summary. The results of morphological ivestigation of prostate tissue after vaporization prostatectomy by Laser Dornier Medilas D UroBeam and transurethral prostate resection in patients with benigh prostatic hyperplasia is shown. We found that the successive use laser Dornier Medilas D Urobeam at power 175-250 W and transurethral resectionof prostate provides diminishing of area of coagulative necrosis which prevents formation of massive scab. At the same time the photoselective to haemoglobin as a result of vaporization draws coagulative necrosis of content of vessels in areas with unchanged stroma and prevents bleeding.

Key words: benighn prostatic hyperplasia, Dornier Medilas D UroBeam laser, morphological investigation, coagulative necrosis.

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Introduction

Laser vaporization is one of the promising modern methods of less invasive treatment of benign hyperplasia of prostate gland (BGPG) (Ruszat et al., 2008; Goh , Gonzalez, 2010; Misrai et al., 2013). Laser beaming effect on biological tissues is stipulated by transformation from light energy of laser beam to thermal energy, what resulted in tissue vaporiatization, coagulation of underlying tissues and blood vessels; due to this operation is practically bloodless (Al-Ansari et al., 2010). The effect of such an operation is based on absorption of laser energy by biological tissue, explosive boil of fluid in cells with rapid destruction of cytoplasmic membrane, what resulted in tissue vaporization. Coagulation is observed in deeper tissues only, because the capacity of lazer energy effect reduces in these prostate areas.

Vaporization is conducted in layer-by-layer manner, due to stable depth of penetration of laser beam a surgeon can keep the process under control, preventing any complications (perforation of prostatic capsule, urinary bladder) (Zhang et al., 2012). Vaporized prostate tissue is eluated through urethra together with flushing liquid. Impossibility of histological study of tissue is considered to be the only one lack of this operation.

Beaming of Dornier Medilas D UroBeam laser with the wave length 940nm has a unique effect on biological tissues due to equally intensive absorption both by oxyhemoglobin molecul**es** and H_2O molecules that provides considerable coefficient of total energy absorption by tissues (Ruszat et al., 2008).

By the manufacturer's clinical studies data, after laser "Dornier Medilas D UroBeam 940nm" usage with the help of MRI was determined the layer of coagulation thickness around the vaporization zone, which was equal 12-15mm over one week period after the treatment. And with that, in 2007, before the equipment was put to clinical use, the research of dogs' prostate was conducted, under which the thickness of coagulation layer of tissue was measured. It was established that increasing laser's capacity, causes coagulation thickness decrease. By laser capacity of 200 watt under the constant mode of operation, coagulation depth was equal to 4mm. The differences between sizes of the coagulation layer thickness in clinical and experimental research can be explained by small-size volume of laboratory animals' prostate in comparison with human beings' prostate gland, different structure of sound tissue of dogs' prostate and men's adenomatously changed prostate gland; thickness measuring of dogs' coagulation zone was made immediately after medical intervention, and in operated patients this measuring was made over one week period, when delayed response of high temperature of laser beaming could appear in tissues (Instruction for Dornier Medilas D UroBeam laser. Wessling, 2012).

Coagulation layer thickness is important in further scab formation and discharge it trough urethra. Under formation of thick layer of tissues coagulation necrosis during vaporization, rejected clumpy scab on necrosis place could cause urethra obturation and necessity of re-intervention (Kohut, Djuran, 2012). Laser beaming dosing on adenomatous tissues under the condition of adhearance to the methodology should result in maximum vaporization and minimal thickness of coagulation layer that will further ensure imperceptible for a patient scab rejection in form of small fractures (Bae et al, 2013).

Under great volume of adenomatously changed prostate gland we propose to use the combination of two methods – laser vaporization and transurethral resection (TUR), when an operation starts from laser vaporization, and later with the instrumentality of resectoscope quickly and bloodlessly ablate coagulation adenomatous tissue mass in several steps depending upon prostate volume. The mentioned methodology in addition to positive clinical performance makes possible histological examination of extracted prostate tissues, thus depriving laser vaporization of its single considerable drawback.

The aim of our study was to exam histological changes of prostate tissues under influence of Dornier Medilas D UroBeam 940nm laser applying method of modified vaporization.

Material and methods

Prostate gland tissue of 15 patients with BGPG became the material for examination. Volume of prostate gland in patients under study varied from 100 to 160ml, which formed 130ml in average. Surgical intervention was done with the instrumentality of 26 Ch Karl Storz 27040 SL resectoscope cone and insertion for Karl Storz 27040 GP laser fiber. We conducted laser vaporization of prostate central and side lobes until forming enough space for urination. Laser beaming capacity started from 175 watt and gradually increased to 250 watt. On the next stage produced necrotic tissue was cut with the instrumentality of Karl Storz 27040 GP resectoscope loop. Resected tissue was eluted from urinary bladder cavity. After moving away resectoscope, we inserted Foley 22-24 Ch. catheter.

Intake of histological material was done intraoperatively after finishing laser vaporization stage. The intake of tissues for study was done with the instrumentality of resection loop by several conductions of it from neck of urinary bladder to seminal hillock.

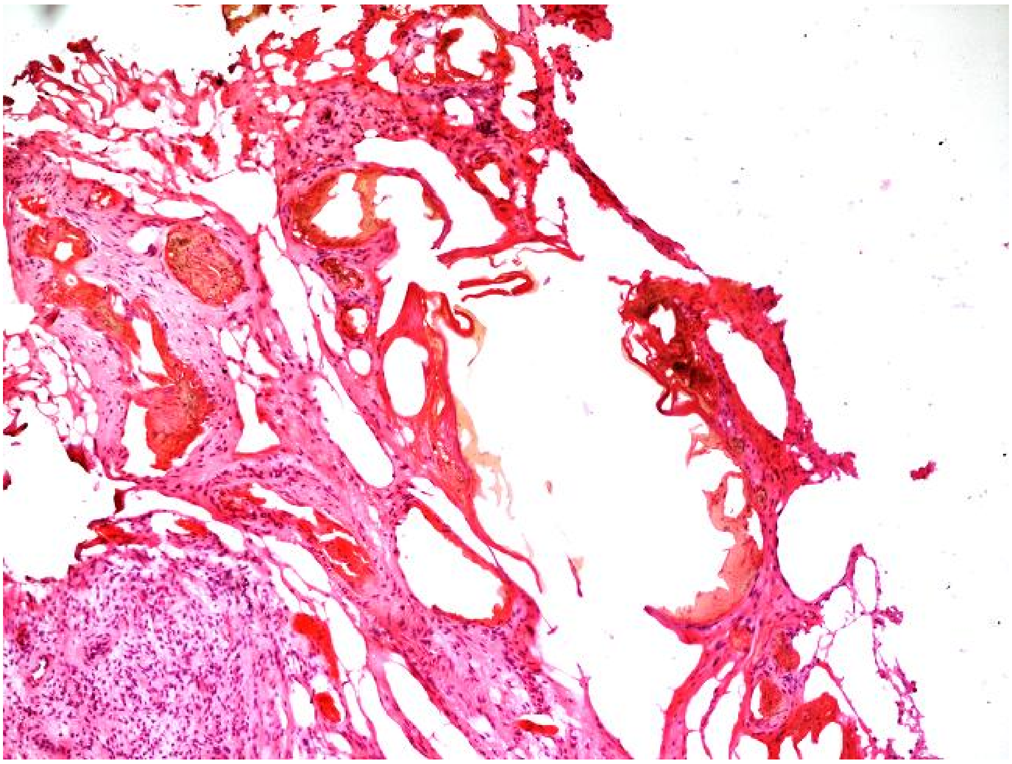
During the operation we took prostate fractures for histological examination from three zones with the instrumentality of resection loop and marked them separately: 1) resected necrotic prostate tissue; 2) resected tissue under necrotic layer (deeper section); 3) residual resected prostate tissue. Material was fixed in 10% neutral formaldehyde solution and dipped in STP-120 tissue processor of turret type. We used EC-350 station for embedding paraffin blocks, HM-340E series rotary microtome for sectioning of paraffin blocks, Robot-Stainer HMS-740 apparatus for histological specimens staining. Specimens were imbued by hematoxylin-eosin. We use Axioskop 40 microscope with Axio Cam MRc5 (Carl Zeiss) camera.

Results and discussions

Fractures of resected prostate gland of the first zone are represented by tissue with coagulation necrosis in form of separate fragments destructively changed stroma, glandulous component destroyed (Fig.1). In separate cases we noticed coagulation zone, which boarded upon saved tissue of prostate (Fig.2). As to the thickness of coagulation necrosis zone, it never spreads to the whole area of tissue of histological specimen (fractures of the first zone), which thickness didn't exceed 4-5mm; in most cases thickness of necrosis was 1-2mm. In our cases such zone can be observed under influence of laser beaming of 250 watt capacity, this confirms the data that the more powerful is laser beam capacity, the thinner is the layer of coagulation necrosis.

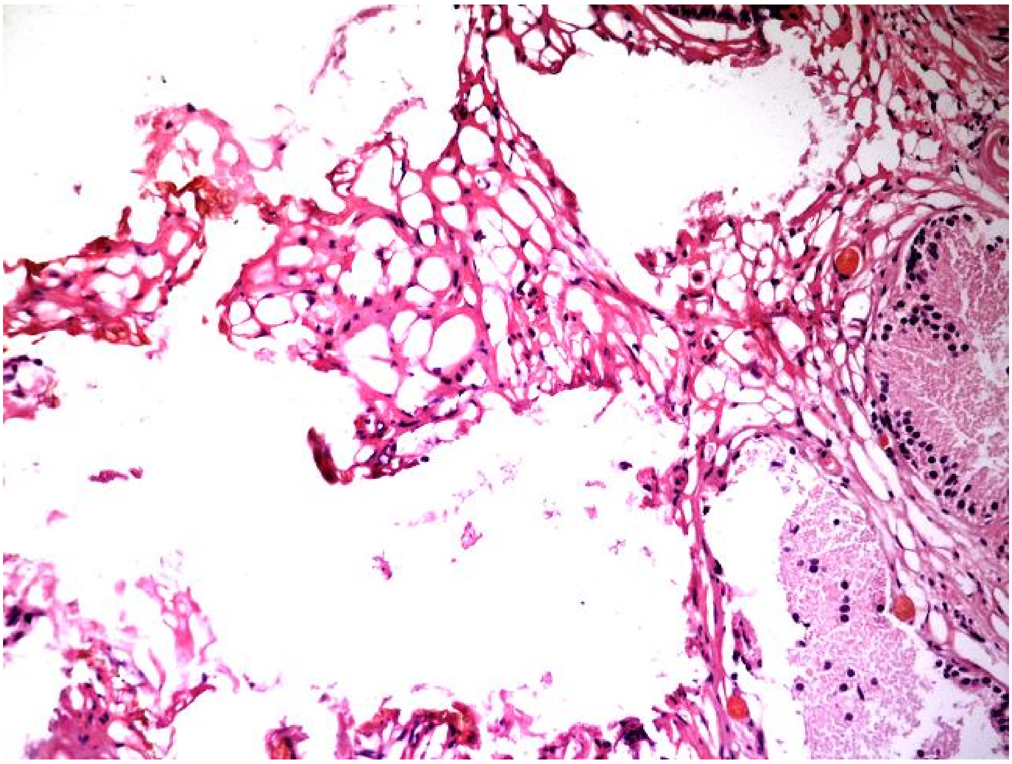
In prostate fractures of the second zone – resected tissue under necrosis layer – we observed on edges stria of coagulation necrosis in form of "fresh" coagulation scab. This thin stria of coagulation necrosis is formed as a result of tissue interaction with active electrode of resectoscope. (Fig.3).

Fig.1. Prostate tissue in necrosis zone. Hematoxylin&eosin. x100.



Source: Authors

Fig.2. Zone of coagulation necrosis at the border of saved prostate tissue. Hematoxylin&eosin. x200.



Source: Authors

Fig.3. Stria of coagulation necrosis. Hematoxylin&eosin. x100.

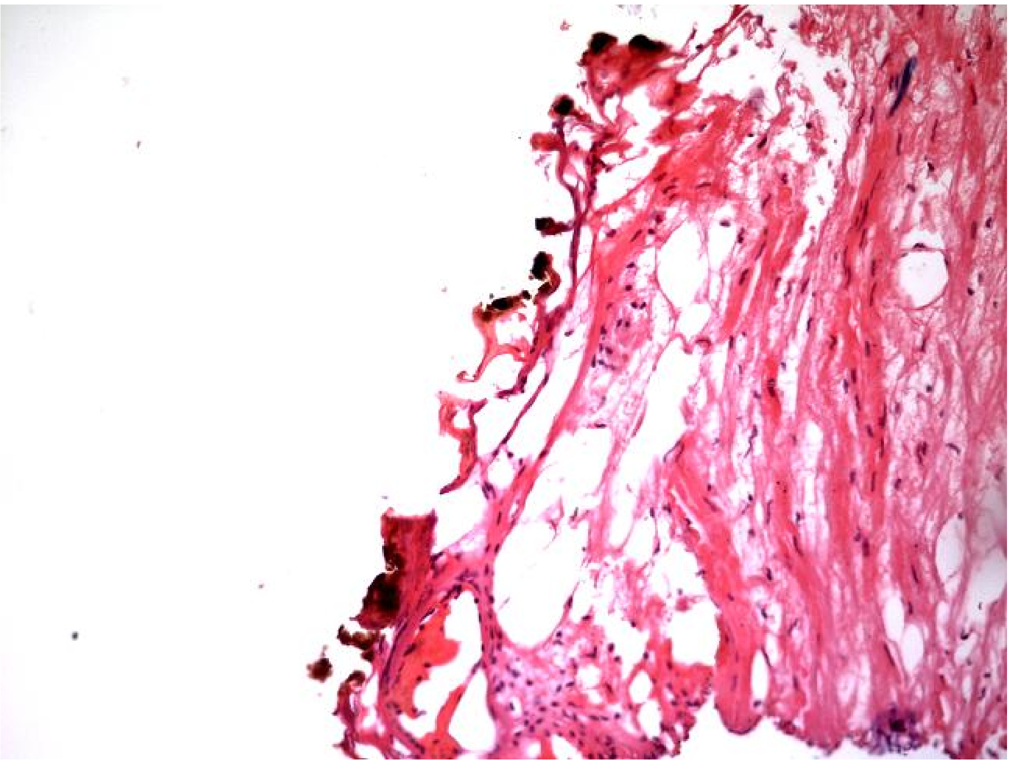


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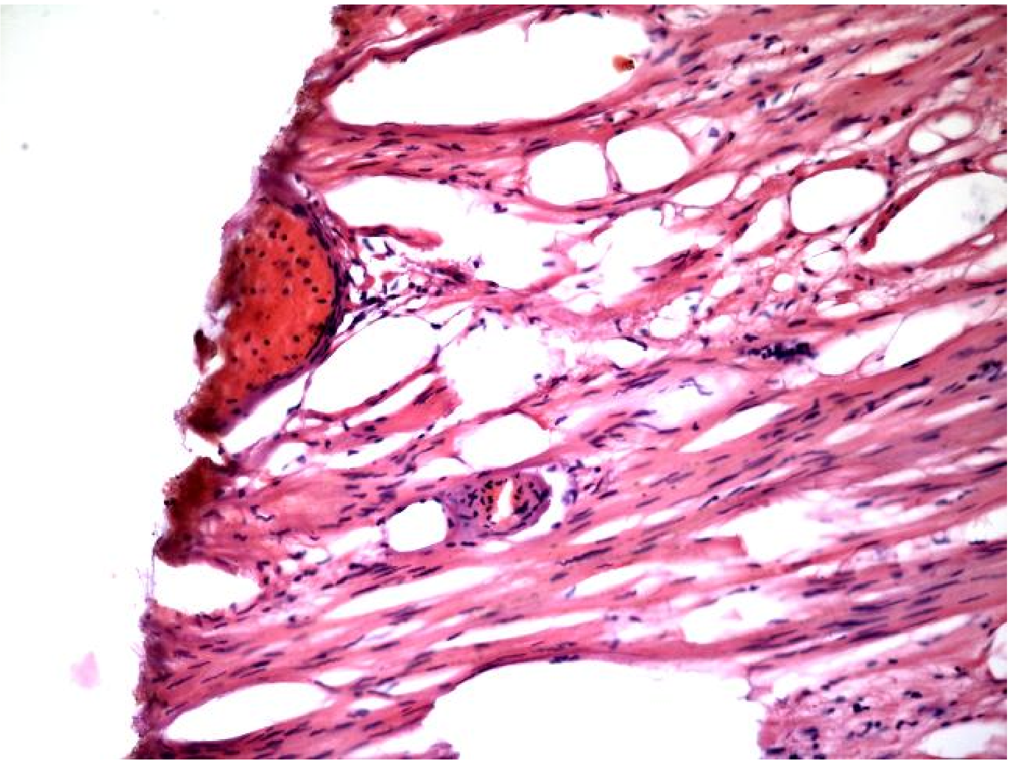
Fig.4. Stria of coagulation necrosis on the resection edge, which passes through the vessel. Hematoxylin&eosin. x100.



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So far as beaming of Dornier Medilas D UroBeam laser with wavelength of 940nm has unique features regarding the absorbing by oxyhemoglobin molecules, well vascularized areas are designed to evaporation in the first place, coagulation necrosis of which prevents blood loss. Even with saved stroma coagulation of vessels fluid takes place due to the effect of laser beaming on erythrocytes hemoglobin. Coagulation necrosis of blood vessels fluid – erythrocytes – prevents blood leakage, even when vessels component gets into risk zone (Fig.4).

In the gland tissue of resected second layer – under the necrosis zone we can rarely observe intact erythrocytes, more frequently – stases of erythrocytes and changes of erythrocytes similar to coagulation necrosis, caused by laser beam effect on erythrocytes hemoglobin (Fig.5).

Fig.5 Prostate tissue under necrosis layer – erythrocytes changes of coagulation necrosis type in blood vessels. Hematoxylin&eosin. x100.

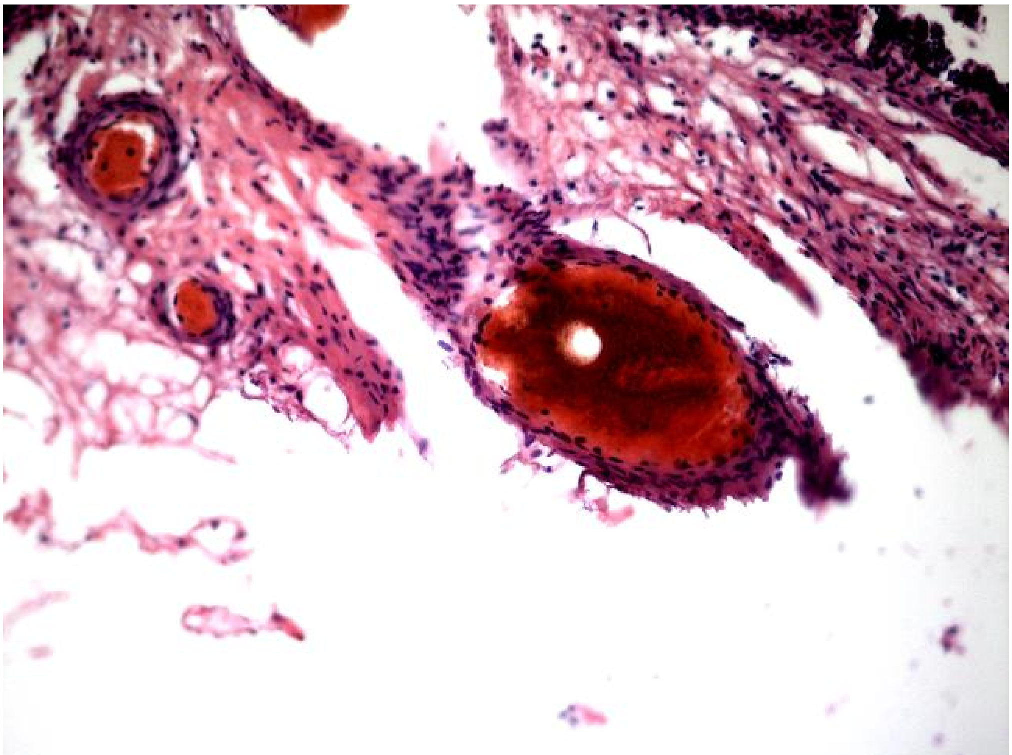

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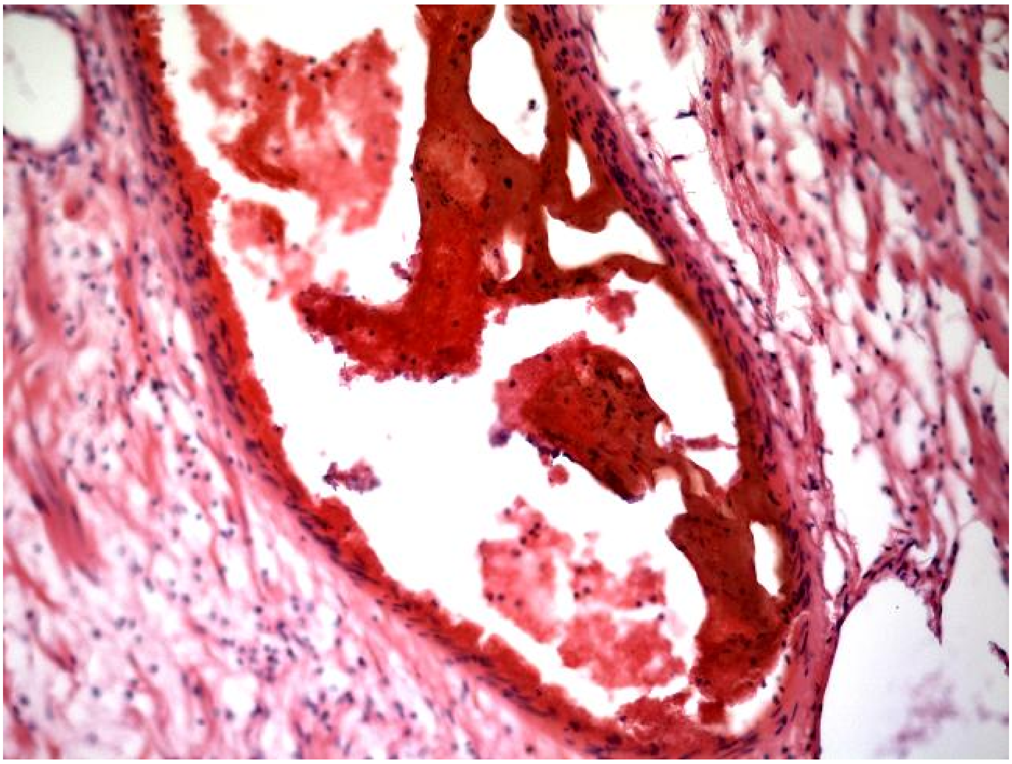
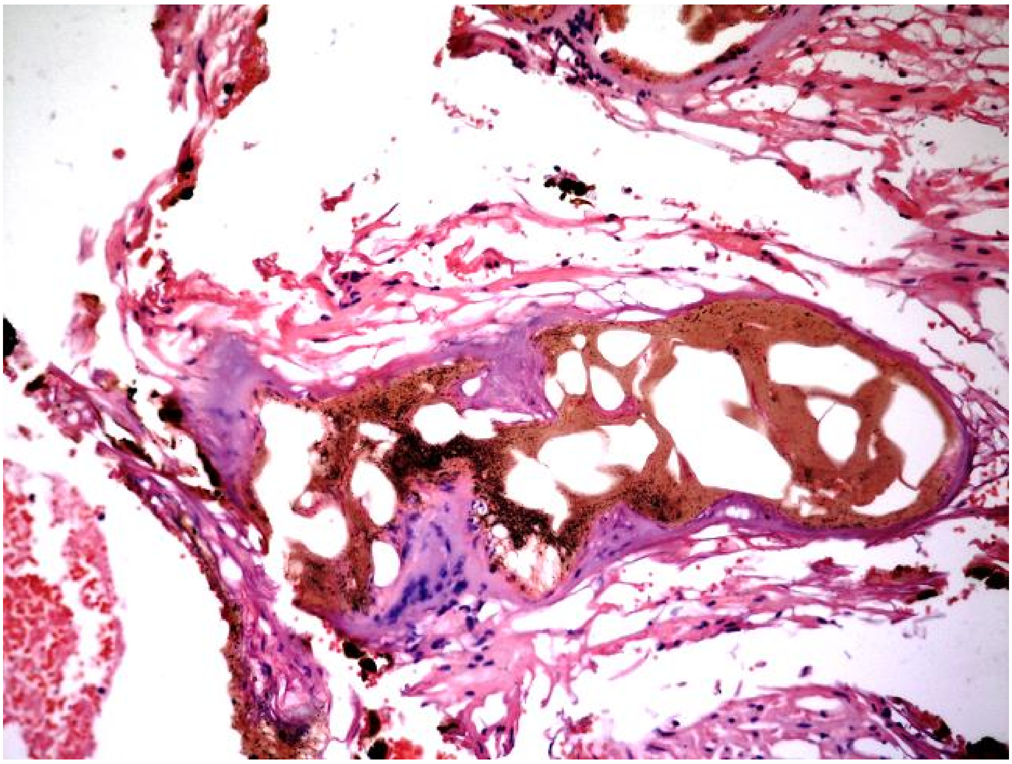
Fig.6. Prostate tissue under necrosis layer – remains of necrotizing erythrocytes in blood vessels. Hematoxylin&eosin. x200.



Source: Authors

Fig.7. Prostate tissue under necrosis layer – remains of necrotizing erythrocytes in blood vessels. Hematoxylin&eosin. x200.



Source: Authors

In some vessels we observed changes in form of residual necrosis masses in vessels lumen that prevents blood leakage by resection of tissue without signs of coagulation necrosis (Fig.6, 7).

In the third zone – of resected prostate tissue we observed unaffected prostate gland tissue with adenomatous hyperplasia.

Conclusion

Sequential usage of vaporization by "Dornier Medilas D UroBeam 940nm" laser with capacity of 175-250 watt and transurethral prostatic resection (TURP) ensures reduction of thickness of surface layer of coagulation necrosis and at the same time – coagulation necrosis of vessels fluid of underlying tissue with intact stroma that prevents blood leakage under big volume prostate and thus allows to provide similar endoscopic treatment when its size is over 80ml.

The perspective of further investigations is search of optimal factors of laser beam capacity applying it to the patients with BGPG aiming at reduction of tissue coagulation necrosis depth after vaporization and minimization the risk of blood leakage under big volume prostate resection, i.e. further improvement of the effectiveness and results of treatment.

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