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The evaluation of tissue mass loss in the incision line of prostate with benign hyperplasia performed using holmium laser and cutting electrode

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Introduction The aim of this study is to compare the changes in the incision line of prostatic adenoma using a monopolar cutting electrode and holmium laser, as well as the assessment of associated tissue mass and volume loss of benign prostatic hyperplasia (BPH).
Material and methods The material used in this study consisted of 74 preparations of prostatic adenoma obtained via open retropubic adenomectomy, with an average volume of 120.7 ml. The material obtained cut in vitro before fixation in formaldehyde. One lobe was cut using holmium laser, the other using a monopolar cutting electrode. After the incision was made, tissue mass and volume loss were evaluated. Thermocoagulation changes in the incision line were examinedunder light microscope.
Results In the case of the holmium laser incision, the average tissue mass loss was 1.73 g, tissue volume loss 3.57 ml and the depth of thermocoagulation was 1.17 mm. When the monopolar cutting electrode was used average tissue mass loss was 0.807 g, tissue volume loss 2.48 ml and the depth of thermocoagulation was 0.19 mm.
Conclusions Where holmium laser was used, it was observed that the layer of tissue with thermocoagulation changes was deeper than in the case of the monopolar cutting electrode. Moreover, it was noticed that holmium laser caused bigger tissue mass and volume loss than the cutting electrode.

Key Words: BPH ‹› holmium laser ‹› TURP ‹› prostate ‹› mass loss

INTRODUCTION

Both in the 20th and the beginning of the 21st century, transurethral resection of the prostate (TURP) has been the gold standard in the surgical treatment of prostatic adenoma [1, 2]. Surgical treatment is still used, especially in particularly large adenomas and adenomas accompanied by other urinary bladder diseases [3]. The development of new technologies in medicine, such as the adaptation of different types of lasers, has allowed for minimally invasive and safe procedures in the treatment of BPH [4, 5]. Depending on the type of laser, resection or vaporization of the prostatic adenoma tissue is performed. For this purpose, and with various results, there is a number of procedures carried out such as Holmium Laser Prostatectomy (HLP), potassium–titanyl–phosphate laser vaporization (KTP) [6], or holmium laser ablation of the prostate (HoLAP), and Interstitial laser coagulation (ILC) [4]. It must be emphasized that effective method of enucleation of prostatic adenoma is Thulium laser enucleation [7, 8]. Continuous improvement of the devices presently used to perform prostatic adenoma resection, as well as the introduction of increasingly more modern laser devices has, however, not reduced complication rates connected with their use. Among the most

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troublesome complications of laser treatments are urethrostenosis, bladder neck stenosis and fibrosis of the site of adenoma removal [5].
The aim of this study is to compare the changes which take place in the incision line of the prostatic adenoma, made with a monopolar cutting electrode and holmium laser, as well as the evaluation of the mass and volume loss of benign prostatic hyperplasia tissue.

MATERIAL AND METHOD

The material used in this study consisted of 74 preparations of prostatic adenoma, with volumes between 62 and 293 ml, the average being 120.7 ml, from 37 patients, aged 58 to 81 years (average 66.8 years), treated by transbladder retropubic adenomectomy using the Harris–Hryntschak method. Tissue material in the form of prostate gland lobes was cut in vitro. One lobe was cut using holmium laser, the other using a monopolar cutting electrode.
Each lobe was weighed separately, at room conditions, immediately after surgical removal, using an electronic scale, Radwag type XA 110/X number 278499/09, with the expiry date certificate dated on the 30th of December 2009. Then, the tissue volume of each adenoma lobe was measured using a measuring cylinder filled with water, with graduations at 10 ml.
After the measurements were made, each adenoma lobe underwent the following procedures:
– one lobe of the prostate was cut with Collins monopolar cutting electrode ERBE ICC 300 AUTOCAT 155 W; the other with holmium laser HO: YAG Omni PulseMax 80 W, using a 550 nm fiber
– after being dried with water absorbing paper, the tissue material was weighed again the tissue volume of the prostatic adenoma was measured.
Both measurements were performed at the same room conditions. After the measurements were made, the mass and volume loss of the prostatic adenoma tissue was evaluated for eachcase, monopolar cutting electrode and holmium laser.
The material was then placed into two separate containers, each filled with 10% formaldehyde. After being fixed, at room temperature, the adenoma tissue was cut into pieces and dehydrated in concentrated ethanol. Then it was stained with eosin and hematoxylin, and embedded in a paraffin block heated in a thermostat at a temperature of 45 degrees Celsius. A fixed block was sectioned into 4–micrometer pieces. Finally, the prepared material was evaluated under light microscope Olympus BX 43, at 1x40, 1x100 and 1x200 magnifications. In this way, the depth and quality of the changes made with either method was assessed. The depth of thermocoagulation was measured under the microscope using a millimeter grid.

RESULTS

Microscopic examination of specimens taken from 37 patients led to the following histopathological diagnoses:
1. In 25 preparations, benign nodular prostatic hyperplasia.
2. In 8 preparations, nodular prostatic hyperplasia with a chronic inflammatory infiltration.
3. In 2 preparations, nodular prostatic hyperplasia with foci of urothelial metaplasia.
4. In 2 preparations, prostatic adenocarcinoma.

Moreover, thermocoagulation changes, which occurred during the cutting process performed with using the monopolar cutting electrode in one lobe and holmium laser in the other, were observed in the prostatic adenoma tissue. The depth of thermocoagulation changes after the incision of the lobe with holmium laser varied from 0.0 to 3 mm, the average being 1.17 mm. When the incision was made with the monopolar cutting electrode, the depth of thermocoagulation changes was between 0.0 and 0.5 mm, the average being 0.19 mm (Table 1).
The measurements of the tissue mass and volume loss of each prostatic adenoma lobe were also made. These were taken before and after the incision of one lobe with the monopolar cutting electrode and the other with the holmium laser. The analysis of this data showed that the volume loss of prostatic adenoma tissue cut with the holmium laser was between 0 and 10 ml, the average being 3.57 ml, whereas the mass loss varied from 0.05 g to 7.8 g, the average being 1.73 g.
Where the incision was made with the monopolar cutting electrode, tissue volume loss ranged from 0 to 10 ml, the average being 2.48 ml. Tissue mass loss, ranged from 0.04 g to 3.1 g, with an average of 0.807 g. The results obtained are illustrated in table 2.
In the conducted in vitro examination, the depth of thermal changes after the incision by monopolar cutting electrode was on average 0.19 mm, and by holmium laser 1.17 mm (Table 1). Having assessed the way

Table 1. *The changes observed in the prostatic adenoma tissue as a result of the use of monopolar cutting electrode and holmium laser. The study material obtained via open retropubic adenomectomy using Harris–Hryntchak method. The incision of the material obtained via open surgery was performed in vitro*

The type of device used to cut prostatic tissue	Monopolar cutting electrode	Holomium laser beam
The depth of thermocoagulation layer	0.0–0.5 mm Average 0.19 mm	0.0–3 mm Average 1.17 mm

prostatic adenoma tissue reacted to the use of monopolar cutting electrode and holmium laser during the in vitro procedure, it can be stated that holmium laser beam causes greater thermocoagulation changes in the incision line, greater tissue volume loss and a significantly larger tissue mass loss (Table 2).

In order to carefully examine the changes taking place in prostatic tissue subjected to the activity of monopolar cutting electrode and holmium laser, all preparations were studied under light microscope (Olympus BX 43), at 40x, 100x and 200x magnifications.

Figure 1 shows a typical picture of normal, undamaged prostatic tissue at 40x magnification. Normal glandular ducts with normal cells and stroma are clearly visible.

Figure 2 demonstrates superficial thermocoagulation changes after the use of monopolar cutting electrode. There are glandular ducts with live cells containing vacuoles, large nuclei, ground substance, and a small amount of collagen fibers.

As a result of the use of holmium laser, thermocoagulation changes were observed in the incision line of prostatic tissue, both in the glandular epithelium, as well as in the stroma fibroblasts. The shape of the cells was irregular, and most were fragmented. Cytoplasmic organelles were indiscernible. In the stroma, only collagen fibers forming a net were visible. In the gland lumens, damaged basement membranes were observed. Such morphotic features are characteristic of deep thermal tissue damage.

In the microscopic examination of prostatic tissue, changes concerning the histoarchitecture of the prostatic adenoma cell itself were also observed. Holmium laser caused total damage of cellular organelles, vacuolization of cytoplasm and destruction of cellular nuclei. Only undamaged collagen fibers remained. As a result, holmium laser caused denaturation of cellular proteins and complete cell damage (Figure 3).

Where the cutting electrode was used, cytoarchitecture of the cell itself remained almost unchanged. There were small changes noticed in the cellular nucleus, namely chromatin and cellular nucleolus damage.

Table 2. *The evaluation of the changes in the prostatic tissue mass and volume as a result of the use of monopolar cutting electrode and holmium laser*

The type of device used to cut prostatic tissue	Monopolar Cutting electrode	Holmium Laser Beam
Tissue mass loss of prostatic adenoma	0.04–3.1 g Average 0.807 g	0.05–7.8 g Average 1.73 g
Tissue volume loss of prostatic adenoma	0–10 ml Average 2.48 ml	0–10 ml Average 3.57 ml

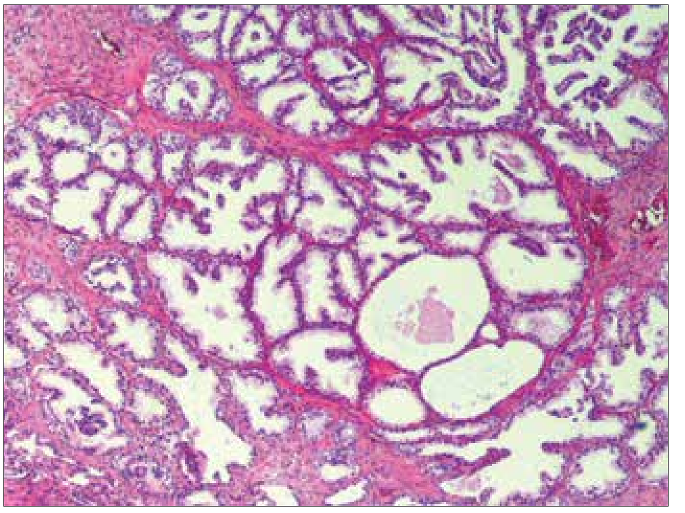

Figure 1. *Histopathological picture of benign nodular prostatic hyperplasia HE, 1x40.*

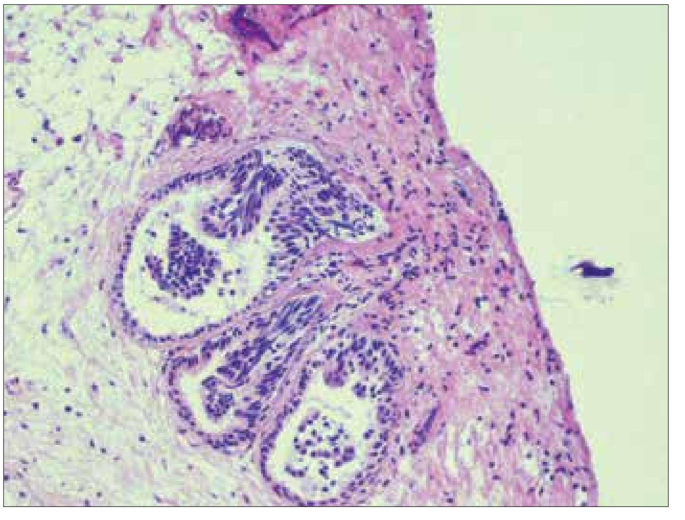

Figure 2. *Superficial thermocoagulation changes in prostatic tissue with benign nodular hyperplasia cut with the use of monopolar cutting electrode, HE 1x100.*

DISCUSSION

TURP remains the gold standard in the surgical treatment of prostatic gland disease. Despite its many advantages, intrasurgical bleeding and the possibility of damage to the urethral sphincter are still the biggest disadvantages of this method. Other complications, such as TURP syndrome, that is postprostatectomy syndrome, urinary retention, urethrostenosis and urinary bladder hyperactivity, occur sporadically [8, 9, 10]. The introduction of various types of lasers as a form of treatment of prostatic gland diseases is an attempt to find a method of minimising postoperative complications, including surgical bleeding. Owing to the use of laser en-

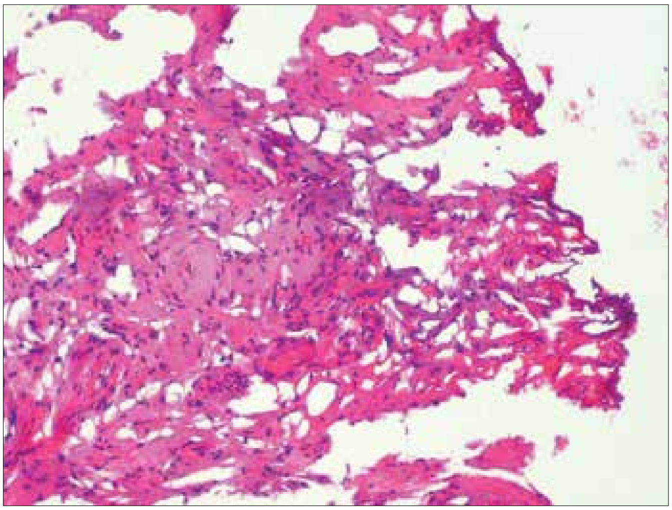

Figure 3. *Deep thermocoagulation changes in prostatic tissue with benign nodular hyperplasia cut with the use of holmium laser, intensive destruction of prostatic stroma. HE 1x200.*

ergy in treatment, now there is a minimal risk of massive bleeding. The application of holmium laser for the enucleation of the prostate is highly effective [11–14]. It must be noted, however, that other complications are possible: fever, urinary retention, perforation of the capsule of the prostate and bladder, as well as well as exceptionally TURP syndrome with hyponatremia, which are included among early complications [15, 16]. Late complications also occur: for instance, stenosis of the enucleation canal in 2.5% of cases, stenosis of the bulb of the urethra in 2.1%, and bladder neck stenosis in 0.35% [17, 18, 19]. Enucleation of the prostate with holmium laser can be recognized as an alternative to TURP in the treatment of benign prostatic hyperplasia. Analyzing the benefits of applying holmium laser in endoscopic procedures performed on the prostatic gland, we can see the reduction in urine retention in the bladder after miction by 46–49%, as well as a low complication rate, around 12.6%, in comparison to retropubic adenomectomy, where the complication rate is estimated at 20% [20, 21, 22]. It can be noted that operative bleeding during procedures performed using laser occurs in less than 1% of cases, while in the case of TURP the occurrence of such bleeding can reach 7% [23, 24]. These phenomena are mainly related to the depth and scope of the coagulation changes. In case of TURP it is around 1.11 mm. With holmium laser it is 0.4 mm, Potassium – Tytanyl – Phosphate laser 0.8 mm,and Neodymium–YAG laser 3 mm [24, 25, 26]. Such deep coagulation and penetration causes permanent tissue damage, as well as damage of mucosa, the muscular coat and stroma. There is postoperative scarring, which with time causes postoperative site stenosis. After procedures performed with the HO: Yag laser, dominant symptoms are those related to the irritation of the lower urinary tract. Other problematic complications include: recurrent urinary tract infections (in 35% of cases), postoperative urethrostenosis (2.1%), stenosis of the site of adenoma removal and bladder neck stenosis (2.5%), as well as the need for reoperation because of urinary retention in the first year, (15%), and within 3 years (40% of cases) [26, 27, 28]. The occurrence of fibrosis, and the resulting bladder neck stenosis, during laser treatment may reach 3.2% of cases, especially during procedures performed on small adenomas. Thus, in order to avoid bladder neck stenosis through fibrosis, a prophylactic incision is made on the bladder neck at 5 and 7 o'clock. This complication does not occur after TURP, probably because a definitely smaller range of thermal energy is emitted and transferred to tissues [19, 25].

After procedures performed with the holmium laser, we also observe stenosis of the bulb of the urethra caused by thermal damage [29]. The authors recommend calibration of the urethra to 30 F for 20 to 30 minutes [19]. Deep penetration of laser energy and its effect on tissue causes urinary tract irritation, and as a result urinary incontinence from urgency in the initial postoperative period in 44% of patients [9, 10, 19]. Deep penetration of laser energy causes coagulation of surrounding tissue, thus reducing the incidence of intrasurgical bleeding in the initial postoperative period [14, 17, 25]. There is a lower incidence of urinary retention due to bladder tamponade caused by blood clots. The authors also draw attention to the irrigation fluid absorption by the patient's during the procedure, and as a result, hyponatremia, which is dangerous to live. In case of the procedures performed using holmium laser the volume of fluid absorbed by blood vessels and tissue is smaller because of the deep thermocoagulation changes [2, 19].

The tests we performed confirm the possibility of the occurrence of the complications described above.

CONCLUSIONS

The depth of thermocoagulation changes in prostatic adenoma tissue is similar in the case of the application of holmium laser and monopolar cutting electrode.

The tissue volume loss of prostatic adenoma is similar in case of the application of holmium laser and monopolar cutting electrode.

The tissue mass loss is greater in the case of the application of holmium laser than in case of monopolar cutting electrode.

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