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ENUCLEATION OF HYPERPLASTIC TISSUE IN BENIGN PROSTATIC HYPERPLASIA: EVOLUTION OF METHODS

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Abstract: The review article provides data on emethods of hyperplastic tissue tissue in patients with benign prostatic hyperplasia (BPH). A brief history of the development of both traditional (simple prostatectomy or adenomectomy) and endoscopic enucleation techniques is presented. Particular attention is paid to modern transurethral surgical treatment of BPH. The features of the technique of performing holmium laser enucleation of the prostate, as one of the most radical modern methods of surgical treatment of prostatic hyperplasia, are examined in detail. Other laser and non-laser enucleation methods are also touched upon.

Keywords: BPH, endoscopic enucleation, adenomectomy, holmium laser, transurethral resection.

Introduction. Benign prostatic hyperplasia (BPH), being the most common non-cancerous disease in older men, occurs in more than 40% of men over 60 and is the most common cause of lower urinary tract symptoms (LUTS) in men [2]. Over the past decades, approaches to the treatment of BPH have undergone significant changes. Effective medicines exist, new ones appear and existing minimally invasive methods of treatment are improved. But even such a variety of methods does not solve the problem, because in many cases, due to the progression of BPH, the need for surgical treatment remains high [10].

Materials and methods. Non-systematic literature review was performed in the PubMed, Google Scholar databases using the keywords: BPH, endoscopic enucleation, adenomectomy, holmium laser, transurethral resection

Results. The history of surgical treatment of BPH, as such, begins in 1884, when Eugene Fuller performed the first suprapubic removal of prostate adenoma. In 1890, Peter Freyer reported the first adenomectomy with a mortality rate of 5%. This operation was called Freyer adenomectomy and was the “gold standard” for BPH for more than half a century.

An entire century has passed since open prostate adenomectomy (OPAE) was developed. Naturally, progress did not stand still. During this period, new methods of surgical treatment of BPH were mastered, endourological transurethral interventions were widely developed and spread, however, the nature of the complications remained largely the same [1].

Currently, the generally accepted "gold standard" of surgical treatment of BPH due to its safety and effectiveness, including long-term results, is transurethral resection of prostate (TURP) [36]. But even with TURP, complications such as bleeding, hyponatremia, and less commonly TUR-syndrome are encountered [12, 13, 39]. These complications can be avoided during bipolar TURP [14, 19, 25]. Bipolar TURP allows resection in saline. In this case, the current, in contrast to the monopolar system, does not pass through the body into the cutaneous electrode. The bipolar circuit is closed at the resection site between the active and return poles, fixed in a single unit on the resectoscope (true bipolar system) or tube (pseudobipolar system). With all the advantages of the method, a long time of resection can lead to the appearance of electrolyte disorders, which limits the possibility of TURP in patients with a prostate volume of more than 80 cm^3.

This limitation was the reason for the search for alternative methods of endoscopic surgical treatment. It is well known that open prostate adenomectomy is a truly radical method of treating patients with BPH. Some authors believe that open surgery is preferable, and has more advantages, in comparison with endoscopic techniques, as it provides simultaneous and complete removal of the adenoma [11].

The essence of an adenomectomy is the blunt separation or enucleation of the operator of hyperplasia nodes by the finger from the so-called false adenoma capsule, which ensures radicalness. It is this “anatomical enucleation” that is the key criterion for radicalness.

However, for all its radical nature, OPAE is very traumatic and is accompanied by a large number of complications. Therefore, the main direction of progressive thought working in the field of surgical treatment of BPH is the creation and implementation of a technique that combines the radicalness of open adenomectomy and minimally invasive endourological techniques. That is, the creation of an ideal method - endoscopic adenomectomy.

As early as 1983, the term transurethral enucleation (TUE) of the prostate was introduced. So, Hiraoka Y. [27] described more than 300 cases of TUE, in which he separated the adenoma from the false capsule with a blunt blade or with the tip of a resectoscope in the same way as with an open adenomectomy. At the same time, the author claims that he did not have a single case of repeated surgery for recurrence of adenoma. The 2016 European Association of Urology (EAU) guidelines for the treatment of non-neurogenic lower urinary tract symptoms caused by BPH introduced the concept of endoscopic enucleation of the prostate (EEP), which combines existing types of enucleation [30].

EEP can be divided into 2 types, depending on the technique, the radical implementation or the anatomy. One method is transurethral enucleation in a blunt way along the false capsule of the prostate gland, the so-called anatomical enucleation, which allows you to completely remove the adenoma. The second method is transurethral enucleation along the surgical capsule - i.e. TURP [27].

In general, however, speaking of anatomical enucleation, we imply the removal of adenomas along the false capsule. Endoscopic enucleation can be carried out using both laser energy (laser methods) and electrical energy (non-laser methods). Existing EEP methods, in accordance with the recommendations of the European Association of Urology (EAU), include holmium laser enucleation of the prostate gland (HoLEP) and thulium laser enucleation of the prostate gland (ThuLEP) [18], as well as methods of monopolar and bipolar electroenucleation of the prostate gland.

For the first time holmium laser was applied by scientists from New Zealand - Peter Gilling and Mark Fraundorfer. They started working with a holmium laser in 1996 [21], and in 1998 P.J. Gilling, M.R. Fraundorfer [23] presented preliminary results of holmium laser enucleation of prostatic hyperplasia with intravesical morcellation of removed tissue in 14 patients [6]. The creation and use of a morcellator has become a significant event in the use of a holmium laser. It was first used in 1996 in the United States and was originally used by gynecologists to remove bulky connective tissue formations from the abdominal cavity. It is thanks to morcellation - the ability to remove large tissue fragments through a channel of small

diameter that made it possible to create holmium laser enucleation, which changed the approach to the surgical treatment of adenoma. This fundamentally new technique pushed into the background the methods of ablation and resection [7,21]. The combination of vaporizing, hemostatic capabilities of a holmium laser with transurethral morcellation allows effective surgical treatment of large adenomas with immediate improvement in urination and a decrease in the number of complications [8].

With holmium enucleation, laser energy with a power of 60-100 W, concentrated "at the tip" of the laser fiber, allows you to dissect adenomatous tissue. In this case, the adenomatous nodes are separated from the capsule in the same way as it is done with the index finger of the surgeon during an open adenomectomy [1]. Consistently enucleated middle and lateral lobes retrogradely displaced into the bladder and subsequently evacuated using a morcellator. If it is not possible to use a morcellator, the lobes of the prostate gland are partially enucleated and then the devascularized lobes are crushed using a resectoscope and removed via the tube of the latter (the “mushroom” technique). Coagulation of bleeding vessels is ensured by removing the tip of the fiber 3-4 mm from the vessel. Saline or glycine solution is used as an irrigation fluid during HoLEP [2].

The combination of the hemostatic capabilities of the holmium laser and transurethral morcellation allows for the effective treatment of even large adenomas, providing an immediate positive urodynamic effect, as with TURP, with fewer complications. The initial use of the holmium laser in the treatment of BPH was a combination of holmium and neodymium Nd:YAG lasers - endoscopic laser ablation of the prostate. A holmium laser was used to vaporize (burn) the channel before conducting a quadrant Nd:YAG with the laser. Later it became possible to vaporize the prostate only with a holmium laser wave and used an electrode with end (side) or end glow - the HoLAP technique (holmium laser ablation of the prostate).

In recent years, HoLEP has become increasingly popular. HoLEP has several advantages over TURP, especially in patients with large prostate volumes [28]. According to EAU recommendations, with a prostate volume greater than 80 cm^3, HoLEP is the operation of choice along with open adenomectomy and bipolar enucleation [31]. Some authors have called HoLEP the new “gold standard” for the surgical treatment of prostate hyperplasia [40]. In addition, to date, holmium enucleation of prostate adenoma is positioned as a “size-independent” procedure, i.e. applicable to adenomas of any size [29,41]. Conducted scientific studies confirm the high efficiency of holmium enucleation in the elimination of infravesical obstruction due to prostatic hyperplasia. So, Elmansy H.M. [6] reports positive results of examination of patients even 10 years (62 months) after surgery, including with large prostate hyperplasia.

After HoLEP, in 2004, the method of bipolar plasmakinetic enucleation of the prostate (PkEP) appeared, then later, in the late 2000s, other transurethral methods based on laser exposure to the enucleation technique appeared: Tm:YAG (thulium laser with an aluminum yttrium garnet) vapoenucleation (TuhuEP) anatomical enucleation with support for Tm:YAG (thulium enucleation of the prostate - ThuLEP), diode laser enucleation of the prostate (DiLEP) and, finally, enucleation with a green laser “Greenlight” (GreenLEP) with lithium borate modulation (LBO).

Many of the proposed laser techniques were rejected at the initial stage of their use, as unsuitable for enucleation [24].

So, in 2010 Herrmann T.R. with colleagues [25] were the first to propose a holium-like technique for enucleation of an adenoma using a thulium laser called ThuLEP (thulium laser enucleation of the prostate). If the radiation in a holmium laser is excited by a flash lamp, in a *thulium* laser, energy is emitted in a continuously generated wave mode. Thulium ions in this case are excited directly by high-power laser diodes. Thanks to the continuously generated laser beam, the thulium laser works better in soft tissues.

The pulsating radiation of a holmium laser causes a tearing effect, while the constantly generated wave of a thulium laser allows you to smoothly excise tissues and vaporize them, achieving excellent hemostasis.

Since water is found everywhere in soft tissues and is the target chromophore, this creates a constant chromophore content in laser-irradiated tissues and leads to a uniform interaction of radiation with tissues [26].

As with HoLEP, a large number of studies have been conducted that confirm the effectiveness of ThuLEP [5]. Review of Barbalat et al. [15] showed that thulium laser enucleation of the prostate is a safe and effective procedure. Even before the development of ThuLEP, a thulium laser was used to perform vapoenucleation of the prostate gland. The ThuVEP procedure was introduced in 2008 for patients with large adenomas.

In general, ThuVEP and ThuLEP, - "twins" of laser technology, have demonstrated the full spectrum of laser exposure with enucleation techniques. Moreover, while with ThuVEP, the adenoma tissue is firstly vaporized by long-wave lasers for fast, efficient and safe enucleation, then with ThuLEP, almost blind mechanical enucleation is performed using a laser only for dissecting adhesions and mucous membranes [24].

For obvious reasons, the emergence and spread of such high-tech and promising methods, in particular HoLEP, as well as ThuLEP, has led to the appearance of many publications devoted to assessing the complications after these interventions and their effectiveness. Many centers describe the first experience of using such technologies [8]. The use of thulium laser energy for enucleation and separation of hyperplastic tissue from the capsule is accompanied by significant carbonation and leads to the fact that the operator tries to minimize the use of laser energy and carries out for the most part mechanical enucleation with a resectoscope.

A number of authors analyzed the effectiveness of HoLEP in comparison with other surgical methods for treating the prostate gland: TURP [17, 20], open adenomectomy [29, 32, 37], endovascular surgical adenomectomy [9], the results of HoLEP and ThuLEP were compared [7, 18, 38]. In 2 large meta-analyzes [33, 34], HoLEP and bipolar enucleation were compared with OPAE. They showed that no significant difference between EEP and OPAE was observed in the medium and long-term observation. At the same time, HoLEP is characterized by a shorter period of irrigation, catheterization, and hospitalization.

Discussion. With a large number of factors affecting the choice of method, in economically developed countries, preference is given to transurethral. In this regard, there are ideas about the futility of using open methods in our country. However, in many countries of the world, the traditional surgical treatment of BPH - open adenomectomy is a priority method, so it has the right to exist along with the latest modern techniques. So, according to Pevzner P.N. [10], the ratio of open and transurethral operations of prostate hyperplasia in certain regions of the Russian Federation (RF) according to different authors was as follows: according to N.A. Lopatkina in 2002 in Moscow, the ratio was 69.4% to 30.6%, in St. Petersburg according to Komyakov S.K. 64.67% to 35.33%, in Kazan according to Sitdykov E.N. the ratio is categorically inclined in favor of OPAE: 91.31% to 8.69%.

In addition, an alternative method of surgery for the treatment of prostate adenoma is used in RF: extraurethral transvesical and posterolateral urethro- and vaso-preserving adenomectomy. A distinctive feature of this technique is the preservation of the dorsal and urethral vascular plexuses and the integrity of the prostatic urethra [11].

Comparative analyzes of the results of surgical treatment of BPH are carried out haphazardly by various authors, often only by listing the complications that arose. Most often, 2 any methods of surgical treatment are compared: either transurethral (for example, TURP versus HoLEP) [17, 20], or 2 modifications of a single transurethral method, for example, HoLEP versus ThuLEP [38]. There is no systematic approach to assessing complications arising after open or transurethral interventions in BPH. There are no adequate criteria according to which it would be possible to evaluate each method even at the stage of its

development. Such criteria, in accordance with the Clavien-Dindo classification, were developed with respect to complications of endoscopic surgery of nephrolithiasis [4].

That is why today the study of the nature of surgical complications in OPAE, TURP, HoLEP, their systematization and comparative analysis in relation to each of the studied methods of surgical treatment, as well as the development of adequate measures to eliminate complications, begins to play an important role. This is necessary for the most adequate assessment of endoscopic adenomectomies.

Thus, we can clearly say that the future in the surgical treatment of BPH today is determined by modern methods of endoscopic enucleation, such as holmium and thulium, as well as bipolar enucleation of the prostate gland. However, open adenomectomy cannot be discounted either, since high-tech operations, such as HoLEP and ThuLEP, are not yet widely implemented and require high-level experience and endoscopic skills in many centers.

Conclusions. The radicalness of surgical treatment for BPH lies in the “anatomical enucleation” of the adenoma within its surgical capsule. And if with OPAE, which provides the best results, enucleation is carried out manually, blindly, then with laser or bipolar enucleation, this procedure is carried out under the control of vision, with the most complete hemostasis. That is, the so-called endoscopic adenomectomy is performed. Enucleation itself is of paramount importance, and not the energy source by which it is carried out, because the ultimate goal in all cases is precisely anatomical enucleation. Endoscopic adenomectomy using laser or non-laser techniques confidently leads the way in the problem of surgical treatment of BPH and the future lies in the improvement of endoscopic methods.

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