Chapter 48
Use of Laser in Urology

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Abstract A good understanding of laser principles is required to choose the appropriate laser for any medical application. In respect of urological interventions the most important parameters are emission-mode, wavelength of the laser and power emitted (Watt). Whereas pulsed lasers are used for both prostates and stones, continuous wave (cw) lasers are mainly used for soft tissue such as prostates, ureters, urethrae, bladder tumors, and partial nephrectomy.

Keywords Laser • Holmium • Thulium • Greenlight • Pulsed • Continuous-wave

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Introduction

Before using a laser, fundamental understanding of this technical device is mandatory. Lasers interact with tissue, no matter whether it is soft tissue or stones. The absorption process acts like a sponge for light. Laser wavelength determines the penetration depths, and the power used the degree of tissue damage. Once the incidence beam hits the targeted tissue parts of it is reflected from the surface and parts are transmitted through the tissue. In addition to that, some energy is lost when scattering internally. These effects determine the biological effect: high absorption leads to better performance, with a cw laser results in a clear cut, and with a pulsed laser in good lithotripsy. At the same time they bear the risk of collateral damage in themselves. At some steps of a procedure, "bad" absorption is desired. The beneficial side effect would be better coagulation. One can reach this goal by either defocusing of the laser beam or shorter wavelength.

Lasers are mainly applied in two fields of endourology: stones and prostates.

Stones

For disintegration of stones pulsed lasers are used. The question arises, how much power such a laser should have. The total power (measured in Watt) is not as important as the question how this power is achieved. Power is the product of Energy (Joule) and Frequency (Hertz).

There are two ways to break stones: fragmentation or dusting. To fragment a stone high energy and low frequency are used. In opposite, for dusting low energy and high frequency are used. It is advisable to start with 8 W. In consequence of the abovementioned, those 8 W could have a setting of 4 J and 2 Hz for fragmenting or 2 J and 4 Hz for dusting.

In addition to that, pulse duration and breaks between pulses play a role in the efficiency of disintegration. Wezel et al. found that reduction of the pulse length from 700 to 350 μs resulted in a higher stone disintegration (Fig. 48.1) [1, 5].

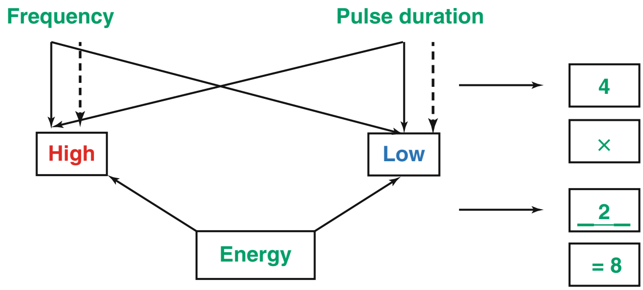

FIGURE 48.1 Manifold settings for pulsed lasers at the same power

	Ho:YAG	Tm:YAG	KTP
Immediate effect	+	+	+
Clean cut	–	+	–
Hemostasis	+	+	+
Large glands	+	+	(+)

FIGURE 48.2 Various parameters of laser effects

Prostates

Various lasers are used for the treatment of benign prostate enlargement (BPE). This is an interesting development, because lasers in this field have been discredited for many years after its uncritical use without knowledge of laser physics during the 1980s. Emission mode (cw or pulsed), wavelength and power used distinguish lasers from each other. To judge the quality of a laser for the treatment of BPE one has to check for the parameters immediate effect, clean cut, hemostasis, suitable for large glands (Fig. 48.2).

Lasers can either be used for vaporization or as a tool to remove pieces of the prostate. This can be done either by resecting or by enucleating the gland.

From a physical standpoint vaporization in BPE treatment is a so-called "vaporization". During vaporization the tissue is converted into steam, but only as deep as the penetration depth of the laser is. The underlying tissue remains untouched. Pure vaporization can be used for small prostates. The advantage is that this procedure is easy to learn, but the anatomical structures cannot be recognized, so that vaporization is often incomplete. In addition, pure vaporization is very time consuming with far less than 1 g/min of tissue removed and no histology available (Table 48.1).

To overcome this problem high Watt lasers have been introduced – with a higher risk of side effects such as capsular perforation or even scattered energy outside the prostate. Vaporization can be done with any laser, but is most typical for greenlight lasers.

The best long-term results are available for Holmium-YAG-lasers [4]. Since the 1990s, many studies published. Holmium lasers have been used for ablation, for a short time for resection, and since many years for transurethral enucleation. Its outcome demonstrated good urodynamical and symptom score results. It has been proven to be durable over many years. The drawback of holmium laser enucleation is a long learning curve due to difficult visibility as a consequence of the pulsed mode.

Thulium lasers followed Holmium lasers with a delay of 10 years [2]. The surgical procedure is identical, even so performed in a continuous wave mode, which helps to overcome the difficult visibility during Holmium procedures and consequently leads to a shorter learning curve. Large series with good outcome of all measured parameters are published.

Greenlight lasers have been promoted very aggressively [3]. A 2 year follow up of a multicenter randomized noninferiority trial comparing GreenLight-XPS laser vaporization of the

Table 48.1 Optical penetration depth varies from laser to laser

	Penetration	
Laser type	**Water**	**Tissue**
Greenlight	30 m	0.8 mm
Holmium	0.4 mm	0.4 mm
Thulium	0.2 mm	0.2 mm

prostate and transurethral resection of the prostate for the treatment of BPE has been published recently, and it showed an intermediate effectiveness and safety of GLP-XLS being similar to conventional TURP.

Conclusions

- For stones there is no doubt that Holmium lasers have stood the test of time. Most stones will be fragmented with a 10 W laser. In referral centers with many and hard stones a 20 W laser might be an interesting option.
- For prostates all three lasers have their role: Holmium in institutions where only one laser is affordable and few residents are trained; Thulium in an opposite situation, and Greenlight in high-risk patients with smaller glands.

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