Lasers in Urology

After the development of the first fiber optics endoscope in (1973), initial experiments with the argon ion laser in urology was performed. Meanwhile, the indications for urologic laser treatments have significantly increased. They extend from the external genital, the lower urinary tract (urethra), the bladder, the upper urinary tract (ureter), all the way up to the kidneys as shown in Fig. 1. In addition, very promising results have already been achieved in treating benign hyperplasia of the prostate which embraces the urethra. Various laser therapies for all these different organs require specific strategies and parameters.

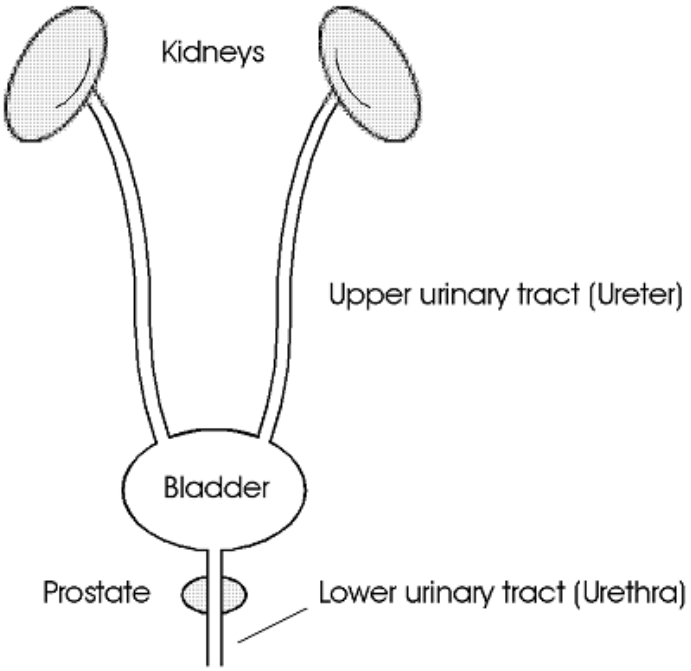

Fig. 1.Scheme of male urinary tract

The workhorse lasers of urology are primarily CO_2, argon ion, Nd:YAG, and dye lasers. CO_2 lasers are best in precise cutting of tissue. Argon ion lasers and Nd:YAG lasers are used for the coagulation of highly vascularized tumors or malformations. Among these two lasers, the Nd:YAG laser is preferably applied for the coagulation of large tissue volumes because its radiation deeply penetrates into tissues. Moreover, Q-switched Nd:YAG lasers which interact in the photodisruptive mode have become a standard tool in lithotripsy beside ultrasound fragmentation.

Frequent diseases of the lower urinary tract are stenoses induced by either inflammation, tumor growth, or unknown origins. In these cases, urethrotomy by endoscopic control is usually performed. During this conventional technique, stenotic material is removed with a cold scalpel. Unfortunately, restenoses often occur due to scarring of the tissue. Further urethrotomies are not of great help, since they only enhance additional scarring. The first recanalizations of urethral stenoses with an argon ion laser were performed in (1980). However, the results obtained were not as promising as initially expected. Then, no further progress was made until (1993) first results using a Ho:YAG laser. Meanwhile, follow-up periods of 20 months after Ho:YAG laser treatment.

Tumors of the bladder are very difficult to treat, since they tend to recur after therapy. It is yet unknown whether this is due to metastasation induced either prior to or by the treatment. Unfortunately, bladder tumors also easily break through the bladder wall. Thus, a treatment is successful only if it completely removes the tumor, does not perforate the bladder wall, and does not damage the adjacent intestine. The effects of CO_2, Nd:YAG, and argon ion lasers on bladder tissue have been compared. Among these, the Nd:YAG laser has proven to be best suited in coagulating bladder tumors. Argon ion lasers are applicable only in superficial bladder tumors. The rate of recurrence after laser treatment is approximately 1–5 %, whereas it ranges from 40–60 % if conventional transurethral resection (TUR) is performed. Even advanced tumors can be efficiently removed with Nd:YAG lasers, since the hemostatic treatment guarantees best vision. 30–40 W of laser power and a working distance between 1 mm and 2 mm. The tumor should be irradiated until it visibly pales. Afterwards, coagulated necrotic tissue is mechanically removed. For safety reasons, the remaining tissue surface should be coagulated, as well.

The laser treatment itself is extremely safe, since perforations of the bladder wall are very unlikely, and the function of the bladder remains unaffected. All transurethral treatments are performed with a rigid cytoscope and a flexible fiber.

Laser lithotripsy is a procedure to break apart kidney stones in the urinary tract. It is done with ureteroscope passed into the tubes of the urinary tract. The laser breaks the kidney stones into smaller pieces that can either be removed by the surgeon or pass out of the body in the urine.

Lithotripsy of urinary calculi is often based on ultrasound techniques. However, not all calculi are equally indicated for such an external therapy. In particular, those calculi which are stuck inside the ureter are in an extremely inconvenient location. In these cases, laser-induced lithotripsy offers the advantage of directly applying energy to the vicinity of the calculus by means of a flexible fiber. First experiments regarding laser lithotripsy have already been performed by using a ruby laser. From today's perspective, though, they were associated with severe thermal side effects. In (1983) the application of a Q- switched Nd:YAG laser was proposed. Shortly after, pulsed dye lasers were investigated at (1987). With the decrease in pulse durations, additional complications arose concerning induced damage of the fiber. The advantages of different approaches like bare fibers or focusing fiber tips were studied in the same year.

Today, dye lasers and Nd:YAG lasers are preferably used for lithotripsy of urinary calculi inside the ureter. Typically, pulse energies of 50–200 mJ and pulse durations between 10 ns and 1μs are applied. The diameter of the optical fiber varies between 200μm and 600μm. With these parameters, optical breakdown is achieved close to the target. Plasma formation at high pulse energies is associated with shock waves, cavitations, and jets. This photodisruptive interaction finally leads to the fragmentation of urinary calculi.

Since the 1980s, research in urology has increasingly focused on various treatments of the prostate. This very sensitive organ embraces the urethra. Diseases of the prostate, e.g. benign hyperplasias or carcinoma, thus often tend to handicap the discharge of urine. In (1979) the effect of Nd:YAG laser radiation on tumors of the prostate has been investigated. The latter study pointed out the extreme importance of temperature monitoring of the adjacent rectum. Usually, indication for laser treatment is given only if the tumor cannot be completely resected otherwise.

Cystoscop

A cystoscope is a thin tube with a camera and light on the end. During a cystoscopy, a doctor inserts this tube through the urethra (the tube that carries urine out of the bladder) and into the bladder so they can visualize the inside of the bladder. Magnified images from the camera are displayed on a screen where the doctor can see them.

A cystoscopy can reveal several conditions, including bladder tumors, stones, or cancer. The doctor can also use this procedure to diagnose:

- blockages
- enlarged prostate gland
- noncancerous growths
- problems with the ureters (tubes connecting the bladder to the kidneys)

A cystoscopy can also be used to treat underlying bladder conditions.

Endoscope

An endoscopy is used in medicine to look inside the body. The endoscopy procedure uses an endoscope to examine the interior of a hollow organ or cavity of the body. Unlike many other medical imaging techniques, endoscopes are inserted directly into the organ.

There are many types of endoscopes. Depending on the site in the body and type of procedure an endoscopy may be performed either by a doctor or a surgeon. A patient may be fully conscious or anaesthetised during the procedure.

Urethrotomy الإحليل

recanalizations of urethral إعادة تأهيل القنوات الإحليلية

hyperplasias

carcinoma سرطان

urine البول

Stenoses التضيق

urethra مجرى البول

stenotic ضيقي

cold scalpel مشرط بارد

conscious or anaesthetised واعية أو مخدرة

blockages الانسداد