

## Versatile applications of Holmium:Yag 30W laser in endourology

Dr. Stefano Mattioli – Clinica Columbus – Milan (Italy)

### INTRODUCTION

The application of lasers in urology for intracorporeal stone fragmentation and various soft tissue procedures sets high standards during the last ten years. Nowadays, different technologies are available for urinary stone management, among them electrohydraulic, ultrasound, pneumatic and laser lithotripsy.

Holmium:Yag (Ho:Yag) laser became indispensable in laser lithotripsy since 1990. Its predecessors in laser lithotripsy were pulsed-dye, Alexandrite and Nd:Yag laser. Ho:Yag laser succeeded in overcoming drawbacks of other lasers, enabling more efficacy to stones of great hardness.

The Ho:Yag 2100 nm is a solid state laser system. It has a great absorption in interstitial water, with optical penetration of only 0.4 mm. It has a good impact on any tissue, not depending on tissue vascularization, producing strong ablative and coagulating effects with minimal damage to surrounding tissue.<sup>1-2</sup>

The Ho:Yag laser interaction with stone is based on photoacoustic effect mainly. Since the laser has high absorption in water, it localizes the water content inside the stone, causing a plasma bubble effect. The bubbles reach the temperature of a few thousand centigrades during the lifetime of only a few hundreds of microseconds and expand, generating a photoacoustic shockwave effect, which disintegrates the stone.<sup>3</sup> The stones are removed fragment by fragment with particles smaller than 2mm, which assures the stone-free outcome. The laser combines effective energy, pulse duration in microsecond range, high repetition rate and specific type of

optical fibers, towards its maximal efficacy. The currently used stone disintegration techniques in urology, include fragmentation, coring, drilling, chipping and ablation.<sup>3,4</sup> This laser provides low coagulation depth in tissue with a clear visual field and low energy thresholds for effective stone fragmentation. Short pulse duration in microsecond range and high peak power guarantee effective lithotripsy by using optical fibers of small diameter (200 or 365 microns). It is highly effective in treating different kind of stones, among them kidney, ureteral and bladder calculi, no matter which color, hardness or composition.<sup>5,6</sup>

The Ho:Yag laser interaction with soft tissue is based on ablative and coagulative photothermal effect, which develops around the fiber tip and where the energy is released to interstitial water in tissue.<sup>7</sup> Its efficacy is strong in soft tissue urological treatments, preferably for ureteral and urethral strictures, bladder neck incisions, ureteropelvic junction obstruction, bladder tumors and many others. Longer pulse duration in near millisecond range guarantees effective cutting and ablative effects along with medium peak power, and coagulative effects along with low peak power. Optical fibers used for cutting include 365 and 550 micron fibers, for ablation 550 micron fibers and for coagulation 800 micron fibers.

The Ho:Yag 30W is a medium power Ho:Yag laser used in a pulsed operation mode. The Quanta System's Litho 30W laser is a unique solution for multiple indications. At the same time, it is a safe, cost effective solution with minimal maintenance requirements and low running costs. The technical specifications of Litho guarantee its supremacy in the market

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with the relevant parameters of energy up to 3.5 J per pulse, repetition rate up to 20 Hz and pulse duration in the range of 150÷800 microseconds.

## **OBJECTIVE**

This study scrutinizes the effect of Ho:Yag 30W for stones and soft tissue procedures. The aim of this study is achievement of the stone free effect and reduced recurrent rates related to the soft tissue abnormalities.

## **METHODS**

This clinical study enrolled 26 male and 14 female patients, aged between 46 and 73 years, treated for the following indications: 22 ureteroscopic Ho:Yag laser lithotripsies, 11 ureteral strictures, 8 bladder neck incisions and 7 transitional cell carcinoma cases. They were treated on outpatient basis under local anesthesia. All the patients passed the successful medical history, laboratory and radiological tests.

Exclusion criterion in stone fragmentation treatment was staghorn calculi, more suited for the percutaneous approach. The energies used for lithotripsy never exceeded 1 J and 15 Hz. The average stone size was 7.9 mm (the minimal stone was 4.6 mm and maximal 11 mm). The tissue fragments were small, less than 2mm, which guaranteed the stone-free effect. The stone-free effect was confirmed by radiologic examination and endoscopic visualization. In order to reach proximal or mid ureteral stones, a flexible ureteroscope along with 200 micron optical fiber were used.

In ureteral strictures, the energy of up to 1.4 J was used with the repetition rate up to 15 Hz. The endoureterotomy was performed in a retrograde fashion, while haemostasis was secured at lower laser power. The incision into periureteral fat was of full thickness 1cm upper and lower from the ureteral stricture,

below the periureteral vessels anteromedially. After the procedure the 7F ureteral stent was placed for 4 weeks. In 7 cases both lithotripsy and ureteral stricture have been performed on the same patient.

In bladder neck incisions and transitional cell carcinoma cases, maximal energy used was 1.2 J with the repetition rate up to 15 Hz. In transitional cell carcinoma, the small piece of tumor was extracted by forceps for histological examination, while the remaining tissue was vaporized by laser.

The optical fibers used with the procedures include 200, 365, 550 and 800 micron fibers with blue buffer, all of them autoclavable and reusable. The fiber is mounted through the working element, within the rigid, semi-rigid or flexible endoscopes, depending on the performed treatment.

The clear endoscopic vision is a prerequisite for the successful procedure, with a clear green pilot beam in the field. The fiber was always in gentle direct contact with tissue. Continuous and high pressure saline irrigation is used throughout the procedures, assuring flawless procedure with clear vision and minimizing the risk of TURS.

Perioperatively, all the patients received antibiotics.

The follow-up visits were scheduled 1 week, 3 months and 6 months after the laser procedure. The 6-month intervals for visits will be practiced for the first 2 years.

## **RESULTS AND CONCLUSIONS**

At follow-up visits all patients have reported improved conditions. No intraoperative complications were recorded with the involved patients. No scarring or fibrosis were seen.

The Ho:Yag laser appears highly safe and effective modality of intracorporeal lithotripsy, with short operating time and

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short hospital stay compared to alternative procedures (ex. lithoclast lithotripsy). Even the very hard stone compositions, among them calcium oxalate monohydrate, brushite and cystine were fragmented.<sup>4</sup> With harder stones, the drilling technique with creation of many superficial holes, which connection makes a cleavage plane, could help in stone disintegration. This way the risk of any damage to surrounding tissue is minimized. Stone size and its location determine the success rate of laser procedure at great extent.<sup>3</sup> The residual stone fragments, bigger than 2mm, were removed by nitinol basket, assuring the 100% stone-free rate in this study.<sup>7</sup> While using the nitinol basket for catching stone fragments, no damages were made to the urothelial tissue.

The ureteral stricture procedures were successful with no complications. At the 6 month follow up no recurrent strictures were noticed. All 11 patients had good renal function and initial stricture size was less than 1 cm, which contributed to overall success rate. The ablative effect was associated with higher repetition rates, having rather continuous plasma bubbles and good hemostasis effect. The Ho:Yag laser proved its great cutting properties and absence of collateral injuries.

The bladder neck incisions were successfully performed in 8 male patients with prostates smaller than 40g. Six months after the procedure,  $Q_{max}$  and quality-of-life scores significantly improved.

Regarding the treated transitional cell carcinoma cases, which are according to general experience associated with high recurrence and complication rates, in this study all 7 procedures were out of complications. Regarding the recurrent lesions, they were absent at the 6-month follow up. The advantage of laser in this case was less bleeding with no need for catheter drainage, minimal fibrotic reaction with absence of stricture formation contrary to electrocautery procedures.

The Quanta System's Litho 30W is a high specification laser system for versatile treatment modalities in urology. Its use is proven in many other surgical disciplines as well. The optical fiber is reusable making low overall costs. Its overall cost effectiveness becomes more significant when taking into account its multipurpose applications in comparison to other lithotripters currently in the market.

The future studies will be focused on renal caliceal calculi fragmentation, after the initial extracorporeal shock wave lithotripsy (ESWL) procedure.

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