Low power laser in the management of ureteral stones

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ABSTRACT

الأهداف: تقييم نتائج استخدام هولميوم ياق ليزر في معالجة حصوات الحالب و معدل الحصوات المختلفة.

الطريقة: تم إجراء منظار للحالب مع تفتيت للحصوات لعدد 170 مريض في المركز الطبي الدولي – قسم المسالك البولية – جدة – المملكة العربية السعودية خلال الفترة من مارس 2007م إلى أغسطس 2009م. تم قياس الحصوة عن طريق استخدام الأشعة المقطعية CT بقياس قطر الأطول للحصوة و قسمت إلى مجاميع طبقاً لموقعها في الجزء العلوي أو الأوسط أو السفلي في الحالب. استخدم منظار شبه صلب مقاس 11–8 فرنش وكذلك منظار مرن مقاس 7.5 فرنش للوصول للحصوة، ولقد تم تفتيت وتبخير الحصوات باستخدام جهاز هولميوم ياق ليزر قوة 10 وات.

النتائج: تم تفتيت كل الحصوات وتبخيرها باستخدام هولميوم ياق ليزر خلال منظار الحالب. تتراوح أعمار المرضى بين 76–21 عام بمعدل 38.6 عام. وكان عدد الذكور113 وعدد الإناث 57، ويتراوح قطر الحصوات بين 12–6 ملم بمعدل 8 ملم. و بمعدل 93 (54.7%) في الجزء السفلي من الحالب، و 26 (15.3%) في الجزء الأعلى، و 51 (30%) في الجزء الأوسط من الحالب. أوضح تحليل الحصوات في 122 مريض أن 87 مريض لديهم حصوات أوكسلات، و16 مريض لديهم حصوات حمض بولينا، و 11 مريض لديهم حصوات سستين، و 8 مريض لديهم حصوات كليس الفوسفات.

خاتمة: تفتيت الحصوات بجهاز الهولميوم ليزر ذو قوة منخفضة 10 وات آمن ومؤثر في تفتيت وتبخير حصوات الحالب ومن الممكن عمله في وحدة تنويم اليوم الواحد. مازالت أنواع الحصوات في السعودية كما هي مقارنة بالتقارير السابقة.

Objectives: To evaluate the outcome of the low power Holmium-Yag laser in management of ureteral stones, and to report the incidence rate of different types of stones.

Methods: One hundred and seventy patients underwent ureteroscopy and fragmentation of ureteral stones at the International Medical Center, Jeddah, Kingdom of Saudi Arabia between March 2007 and August 2009. Stones were measured by their largest diameter on CT and classified according to their location from the ureter to the proximal middle and distal ureteral stones. We utilized 8-11 F Semi rigid or 7.5 F flexible ureteroscopes to identify the stones, and all stones were fragmented and evaporated using a 10 watt lower power Holmium-yag laser lithotripter.

Results: All stones were completely evaporated and fragmented using the Holmium-yag laser through ureteroscopy. The age of the patients varied between 21-76 years with a mean age of 38.6 years (males 113, and females 57). The largest diameter of the largest stone was 6-12mm (mean 8 mm) and classified according to its location in the ureter into proximal (93 [54.7%]), middle (26 [15.3%]), or distal ureteral stones (51 [30%]). We performed stone analysis in 122 patients (oxalate [n=87], uric acid [n=16], cystine [n=11], and calcium phosphate [n=8]).

Conclusion: Laser lithotripsy using low power 10 watt laser lithotripter is safe and effective method for stone evaporation and disintegration, and can be carried out as a day care procedure. The types of stones in Saudi Arabia are same as it has been reported before in the literature.

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Holmium yttrium-aluminum-carnet (HO-YAG) is the most widely used laser for stone management in urology nowadays. The evaporation and disintegration effect of the HO-YAG laser relies on the water absorption of the laser waves. The length has to be close to the absorption of water (1,910 nm). Due to these characteristics, HO-YAG energy is highly absorbed in water with plasma formation occurring at low levels of energy.[1-3] The combined laser effects of photo thermal and photomechanical associated with low risk of stone push up and collateral tissue injury caused by mechanical force, means the HO-YAG laser lithotripsy can also be used safely in patients with uncorrected bleeding diathesis.[4,5] The advancement in the technology of the new rigid and flexible ureteroscopes makes it possible to treat stones anywhere in the urinary tract using the HO-YAG laser. The superiority of the HO-YAG laser over other technologies available in the market, namely, shock wave lithotripsy (SWL), pneumatic and ultrasonic lithotripters, is that it disintegrates the stone into dust or minimal fragments to obtain very small pieces that can pass spontaneously, also the new version of the laser lithotripter automatically has an operated cooling system, which allows longer time of lasing.

Methods. One hundred and seventy patients underwent ureteroscopic fragmentation of ureteral stones at the International Medical Center, Jeddah, Kingdom of Saudi Arabia in the period between March 2007 and August 2009. The Ethical Committee of the hospital approved the study and all patients gave consent prior to the study. All patients had full history review including age, gender, previous stone passage, or stone removal by endoscopic or open surgery procedure. Routine laboratory investigations including complete blood counts, renal function test, coagulation profile, ultrasonography, and an enhanced renal CT scan were also recorded. All data for the patients including age, gender, largest diameter of the stones by CT and location of the stones were collected and the mean value was calculated. Stones were measured by their largest diameter on CT were classified according to their location in the ureter into proximal, middle, or distal ureteral stones. All patients had general anesthesia, and prior to the procedures we required balloon dilatation to dilate the ureteral orifice or lower ureter in 94 patients. In the majority of our study (163 cases), a semi-rigid ureteroscopes size 8-11F was used, while a flexible ureteroscopes size 7.5F used in 7 cases. Double J (DJ) stents were inserted in all patients, and in compass basket used as antimigration device for the upper ureteral stones. Stones measuring 6-7 mm underwent conservative management for 2-4 weeks prior to ureteroscopy. Inclusion criteria were stones of diameter 6 mm or larger not responding to conservative treatment while stones of 20 mm diameter or larger were excluded from the study. All stones were fragmented and evaporated using 10 watt low power HO-YAG laser lithotripter, using 600 micron laser probe 0.8-1.2 Joules/pulse at 6-8 HZ while with flexible ureteroscopes a 200 micron probe used. Small fragments were removed using reusable endoscopic grasper or reusable baskets, and the stones sent for analysis.

Results. All stones were completely evaporated, fragmented, and removed using the HO-YAG laser and ureteroscopy. The age of the patients varied between 21-76 years with a mean of 38.6 years (113 [66.48%]) males and 57 [33.5%] females). The largest diameter of the stone was 6-12mm (mean 8 mm) and classified according to its location in the ureter into proximal (93 [54.7%]), middle (26 [15.3%]), or distal ureteral stones (51 [30%]) (**Figures 1a & 1b**). Stone analysis was performed in 122 patients, while the rest of the patients' stones were completely evaporated or we were unable to collect the very tiny fragments for stone analysis. Stones that underwent analysis were oxalate (n=87), uric acid (n=16), cystine (n=11), and 8 calcium phosphate. Thirteen patients (3 proximal, 8 middle, and 2 distal) required reoperation due to ureteral stenosis, while 4 stones migrated to the renal pelvis or lower calyces and were located using flexible ureteroscopy. None of the stones required stone fragmentation such as pneumatic or ultrasonic lithotripters or any open ureterolithotomy,

Figure 1 - Computerized tomography showing the **a**) upper ureteral and **b**) lower ureteral stone.

but 2 patients had febrile illness that required admission to the hospital. None of the patients had intraoperative complications such as ureteral perforation. The length of the operation varied between 40-70 minutes with a mean of 43 minutes. The direct success rate, which meant stone free ureter or fragments ≤2 mm on the first postoperative day in proximal ureter were 89.5%, middle 84.4%, or distal 97.8%. Thirteen patients who required second operation (namely, ureteroscopy and fragmentation of the stones by laser) were stone-free postoperative. One hundred and fifty-seven patients had their DJ stents removed in the clinic after one week by pulling the string attached to the stent. All patients were discharged from the day care unit on the same day of operation except 2 patients who developed sepsis from impacted stones and required postoperative admission.

Discussion. Continuous improvement in the field of semi-rigid and flexible endoscopes, lithotripsy devices, and ancillary instruments have contributed greatly to an increase in overall success rates of endourological treatment over shock-wave lithotripsy even in the proximal ureteral stones.[6,7] Pneumatic lithotripsy such as Swiss lithoclast was widely used for stone fragmentation in different locations in the urinary tract until laser technology showed further advancement to become superior to pneumatic lithotripsy, also many comparative studies proved that Holmium laser technology compared to pneumatic lithoclast is superior in terms of rate of stone clearance and complications.[8-10] Laser lithotripsy became available for use in the endourology in the early part of this decade, different lasers have different effects on the stones due to their pulse-length, power, plasma, and cavitations effects. Hoffman and Hartung[11] introduced the first clinically applicable laser lithotripter with pulsed HO-YAG laser. Since then many other forms of laser lithotripters such as the pulsed dye laser, alexandrite, and HO-YAG laser appeared in clinical practice.[11] The Ho-YAG laser has allowed the best stone free rates, but the total treatment cost is higher as the Ho-YAG energy is more expensive.[12-15] Kourambas et al[16] in 2001 proved that the application of 25 watt low power holmium laser supplies adequate fragmentation and incision power for virtually all endoscopic cases, while in 2007 Triantafyllidis et al,[17] proved the effectiveness of 1.8 J at 8 HZ in fragmentation of ureteral stones.[7] We applied our study using 10 watt Holmium laser machine, the system is operated at low pulse frequencies and energy levels, which are sufficient to achieve the fine-tuned performance needed in urinary lithotripsy with minor increases in the temperature at the urinary wall. Such specifications allowed us excellent fragmentation of the stones, no incidence of ureteral perforation, and low incidence of stone migration. The low power leads to less requirement for the coolant system in the machine, which is automatically operated in the machine due to its less heat production.

Our results confirm the safety and efficacy of the low power holmium laser machine in fragmentation and evaporation of ureteral stones. The availably of less cost, safe, and effective lithotripter makes it easy for each hospital to have the new technology available, especially with a high prevalence of stone disease in our country. Comparing our studies with the previously reported studies on stone analysis of patients in Saudi Arabia, our results confirm that the oxalate stone is still the most common stone followed by uric acid stone then by calcium-phosphate stones, while cystine stones are becoming more frequent than before.[18,19] One draw back of our study was not including in the design of the study the possibility of not to stent the ureter post ureteroscopy.

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