



Urinary Tract Stones Fragmentation using (2100 nm) Holmium: YAG Laser: (In vitro Analysis)

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Abstract: Urinary stones are one of the most common painful disorders of the urinary system. Four new technologies have transformed the treatment of urinary stones: Electrohydraulic lithotripsy, ultrasonic lithotripsy, extracorporeal shock wave lithotripsy, and laser lithotripsy. The purpose of this study is to determine whether pulsed holmium laser energy is an effective method for fragmenting urinary tract stones in vitro, and to determine whether stone composition affects the efficacy of holmium laser lithotripsy. Human urinary stones of known composition with different sizes, shapes and colors were used for this study. The weight and the size of each stone were measured. The surgical laser system which used in our study is Ho:YAG laser(2100nm) with four adjustable parameters (Pulsed mode, Rep rate, Power, Exposure time). After each laser irradiation, the laser parameters (different energy setting, Rep rate) and the time of each stone fragmentation were recorded and also the stones fragments were weighed and sorted using a metal ruler. All stones studied were successfully fragmented with Ho:YAG laser. Although there were differences in stone fragmentation time and ablation based on composition and sizes of the stones, in addition to factors related to laser system itself like mode of operation (single or double pulse mode) and pulse energy and pulse repetition rate and the power. The results of holmium laser lithotripsy for urinary stones have been uniformly excellent. The holmium: YAG laser has demonstrated its efficacy as a method of choice for fragmentation of urinary tract stones. Advantages include ability to fragment stones of all composition.

Introduction

Urinary stone disease continues to be a common problem worldwide and kidney stones are one of the most common painful disorders of the urinary system (Eknayan and Garabed 2004). According to the U.S. National Institutes of Health (NIH), roughly 1 person in 10 develops kidney stones during their lifetime and renal stone disease accounts for 7–10 of every 1000

hospital admissions. The total cost for treating this condition was 2 billion \$US in 2003 (Pietrow et al., 2006). Once a kidney stone forms, the probability that a second stone will form is high and the recurrence rates are estimated at about 10% per year, totaling to 50% over a 5–10 year period and 75% over 20 years (Lloyd et al., 1996).

There are several types of urinary tract stones based on the type of crystals or chemicals of

which they consist (Weaver et al., 2002). These types are listed in Table 1.

Table (1): Types and composition of urinary tract stones

Type	%	External appearance and characters
Calcium stones (calcium oxalate) (calcium phosphate)	80%	Dark colored, Rough surface, small size, very hard, Radio-opaque
Struvite stone (Magnesium-Ammonium-Phosphate.)	10–15%	Dirty,Smooth,Large size forming (Staghorn calculi),Soft,Radio-opaque
Uric acid stone	5–10%	Yellow to reddish brown, Smooth Multiple, hard, Radiolucent.
Cystine stone	1%	White-yellow, smooth, multiple,soft and radiolucent

Conventional Management

Most urinary tract stones pass out of the body without any intervention by a physician; this depends on size and location of stone (Anonymous 2008). Medical management (Conservative):- About 90% of stones 4 mm or less in size usually will pass spontaneously. There are various measures that can be used to encourage the passage of a stone. These can include increased hydration, medication for treating infection, reducing pain (antibiotics and analgesia), and diuretics to encourage urine flow and prevent further stone formation (Chang et al., 2000).

Urological interventions management:-Most urinary stones do not require surgical intervention and will pass on their own. Intervention may be needed to remove a kidney stone if it does not pass or move after a reasonable period of time (30 days) and causes constant persistent and severe pain (Macaluso, 1996). If the stone is too large to pass on its own or is caught in a difficult place it will block the flow of urine and causes an ongoing urinary

tract infection that damages kidney tissue or causes constant bleeding Methods of interventions management:-

- 1-Open Surgery (lithotomy)
- 2-Extracorporeal Shock Wave Lithotripsy (ESWL)
- 3-Ureteroscopic Stone Removal
- 4-Percutaneous Nephrolithotomy (PNL)
- 5-Ureteral (double-J) stents

The purpose of this study is to determine whether pulsed holmium laser energy is an effective method for fragmenting urinary tract stones (in vitro study), and to determine whether stone composition affects the efficacy of holmium laser lithotripsy.

Materials and Methods

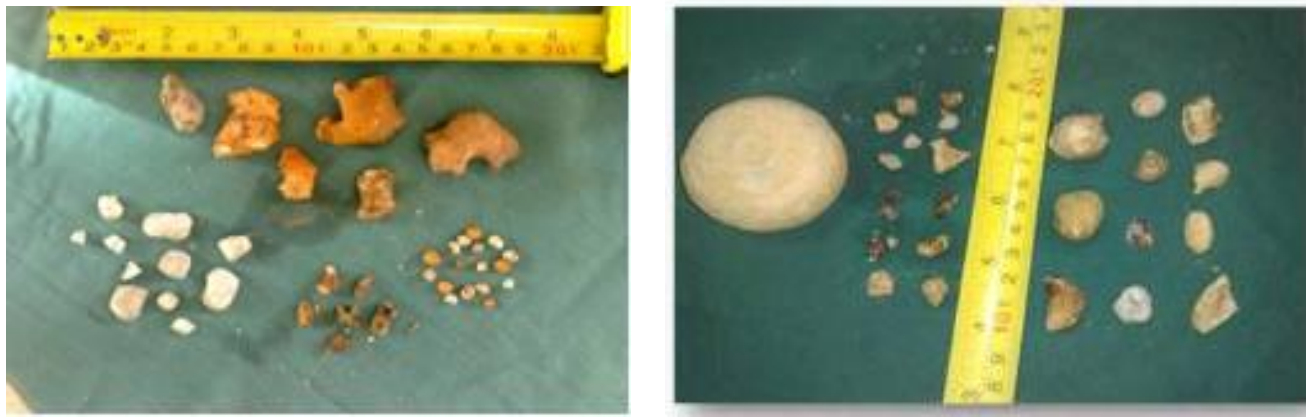
This study was carried out at the institute of Laser, University of Baghdad, on December 2010 - January 2011. In this study, an in vitro analysis of stone fragmentation using (2100nm) Ho: YAG Laser, was evaluated. Different sizes, shapes, and composition of human urinary stones were used in this study.

Materials:

STONES: Human urinary stones of known composition with different sizes, shapes and colors were used for this study, Figure 1. The weight and the size of each stone were measured. Stones were then hydrated in water for more than one week.

Surgical Laser System

The Ho:YAG laser is a solid state, pulsed laser that emits light at 2100nm wavelength. The optical absorption coefficient for water at this wavelength is approximately (40cm⁻¹) so that the holmium wavelength is absorbed significantly by water. Although the various commercial models vary slightly, the version that one chooses will depend on the intended application. The surgical laser system which used in the study is Ho: YAG laser (Trimedyne The OmniPulse-MAX™ Model 1210-VHP) with four adjustable parameters: Pulse Mode (single/double), Rep Rate (Hertz), Power (Watts), Set Time (CL or seconds).



(A) Urinary stones of different shapes

(B) Urinary stones of different sizes

Fig. (1): Collections of human urinary stones

Table (2): Laser Specifications

Laser type	(Ho:YAG) solid state, pulsed
wavelength	2100 nm
Pulse duration	350 μ sec
Energy Range per pulse	0.2 -3.5 J
Maximum power	80 watt
Aiming Beam	Red diode laser 635 nm, continuous maximum power (5 mW)
Lasing mode	Single pulse mode (5-60 Hz) and Double pulse mode (3-30 Hz)
Laser Delivery	Trimedyne holmium optical fiber devices
Cooling	Self-contained water to air heat exchange to ambient air
Approximate weight	303 kg

Methods

Hydrated stones were submerged in water, immobilized with thumb forceps, and irradiated with (2100 nm) light from a holmium (Ho: YAG) laser (Trimedyne, Omni-Pulse MAX). Laser energy was launched into a (760 μ m) diameter optical fiber and applied to the

surface of the stone in contact mode. The laser pulse width was 350 microseconds. The energy selected was varied depending on the (composition and size) of the stones. However, initial settings to fragment most stones were changed from 0.5 to 0.7 Joules at 12 to 20 Hz. The absorption of laser irradiation by the stone creates an audible “tic, tic” sound as

fragmentation occurs. In a fluid environment, the laser energy must be applied as close as possible to the stone or in what is known as the contact mode. The technique is relatively straightforward and involves placing the tip of the optical fiber on the surface of the stone using the aiming beam (red diode laser) and then activating the laser. A foot-operated switch will activate and deactivate the release of the laser energy from the lithotripter.

For all exposures, the optimum laser output was 20 W; however, the pulse repetition rate was varied from 10 to 25Hz resulting in pulse energies ranging from 0.4 to 1.0 J/pulse. Most of the exposures were done using the same power with the proprietary Double Pulse TM waveform of the laser, whereby, according to the manufacturer, twin pulses are spaced to allow the acoustic effect of the first pulse to subside before the second pulse arrives. After each laser irradiation, the laser parameters and the time of each stone fragmentation were recorded and the stones fragments were weighed and sorted using a metal ruler.

Results and Discussion

For the different compositions, sizes and shapes of urinary stones, the efficiency of the Ho: YAG laser for fragmentation of these stones at different energy settings was studied. The results of holmium laser lithotripsy for urinary stones have been uniformly excellent. Successful fragmentation of stones is achieved for most stones.

1- (To determine the effects of laser pulse mode on fragmentation time).

Two groups of three stones of the same composition (oxalate stones) were irradiated with 1J energy per pulse for a power output of 20 W in either single pulse or double pulse modes, Figures (2,3). Mean stone volume of the first group was approximately (2.13 cm^3) and the second group was (2.18 cm^3) and did not vary significantly between groups. (NOTE: The volume of the irregularly-shaped object is

determined by using water displacement method).



(A) Before laser irradiation



(B) After laser irradiation

Fig. (2): Urinary Stones: The effects of laser pulse mode.

Group 1: Includes stones(No.1,2,3) irradiated with 1.0 J/pulse, 20 W and 20 Hz. in single pulse mode.

Group 2: Include stones(No.4,5,6) irradiated with 1.0 J/pulse , 20 W and 10 Hz in double pulse mode.

And the fragmentation time, total energy used and weight loss (ablation) of the stones in either groups is calculated. The results are listed in Tables 3 and 4.

Table (3): Group 1 (single pulse mode)

Laser Parameters: PE(1.0 J/pulse),PRR(20Hz),Power(20 Watt)

Stone No.	Original weight (gram)	Weight after laser (gram)	Weight loss (gram) (ablation)	Fragmentation time (seconds) + (No.of pulses)	Total energy used (joule)
1	2.88	2.35	0.53	82(1640)	1738
2	2.38	2.05	0.33	71(1420)	1369
3	1.77	1.05	0.72	55(1100)	1059
Total	7.03	5.45	1.58	208(4160)	4166

Table (4): Group 2 (double pulse mode)

Stone No.	Original weight (gram)	Weight after laser (gram)	Weight loss(gram) (ablation)	Fragmentation time (seconds)+ (No.of pulses)	Total energy used (joule)
4	2.82	2.23	0.59	53(530)	1320
5	2.05	1.79	0.26	37(370)	976
6	2.92	2.16	0.76	49(490)	1353
Total	7.79	6.38	1.61	139(1390)	3649

Comparing the data listed in Tables 3 and 4, the following points will be concluded,

The total fragmentation time of the stones irradiated with double pulse mode (Group 2) =139 seconds (The mean =46.333 seconds) is shorter than the total fragmentation time of the stones irradiated with single Pulse mode (Group 1) =208 seconds (The mean time = 69.333 seconds). The total Energy used in Group 2 (Double Pulse mode = 3649 J) is less than the total Energy used in group 1 (single Pulse mode = 4166 J.) The total Weight loss (mass loss:

ablation) in (Group 2= 1.61g) is slightly more than total weight loss in (Group 1 = 1.58 g) .

2- (To determine the effect of laser energy per pulse on fragmentation time). Four stones of the same chemical composition (calcium oxalate) were irradiated with 0.4, 0.5, 0.625, or 1 J per pulse. For all exposures, the laser output power was (20 W)but the pulse repetition rate was varied as 25Hz,20Hz ,16Hz,or 10Hz (double pulse mode). Mean stones volume (0.7 cm³) did not vary significantly among them.



(A) Before laser irradiation

(B) After laser irradiation

Fig. (3): Urinary Stones: The effect of laser energy per pulse

The fragmentation time of stone irradiated with 0.4J/pulse was (55 seconds), which was significantly longer (approximately 5 times) than the fragmentation time (12 seconds) of stone irradiated with 1.0J/pulse. Similarly, the deposited energy for fragmentation was

significantly greater for stone irradiated with 0.4J/pulse (1140 J) than those irradiated with 1.0J/pulse (237 J). So by increasing the laser energy per pulse, the fragmentation time of the stone will be shorter and the total energy used will be less. These results are listed in Table 5.

Table (5): The effect of laser energy per pulse on fragmentation time

Stone No.	Laser Parameters	Fragmentation Time (seconds) +No. of(pulses)	Original weight (gram)	Weight after Laser (gram)	Weight loss (gram)	Total energy (joule)
1	PE=0.4 PRR=25 P=20	55(1375)	0.45	0.23	0.22	1140
2	PE=0.5 PRR=20 P=20	42(840)	0.65	0.14	0.51	759
3	PE=0.625 PRR=16 P=20	23(368)	0.63	0.34	0.29	474
4	PE=1.0PRR=10 P=20	12(120)	0.64	0.53	0.11	237

NOTE: Laser Parameters: PE = Pulse Energy (J/pulse), P=Power (watt) PRR =Pulse Repetition Rate(Hz) (Double Pulse mode)

3-To determine the effect of laser energy per pulse on stone ablation: (Mass loss or weight loss). A single big urinary stone of (calcium oxalate) Figure 4, was irradiated with different energy per pulse subsequently 0.4, 0.5, 0.625, and 1 J/pulse. For all exposures, the laser output was 20 W and the time was fixed (30 s), but the

pulse repetition rate was vary 25Hz, 20Hz, 16Hz, or10Hz (double pulse mode).The original stone weight 66.83g , the volume of the stone was approximately (49cm³).After each pulse energy, the amount of weight loss (ablation) and the total energy used were recorded. The results are listed in Table 6.

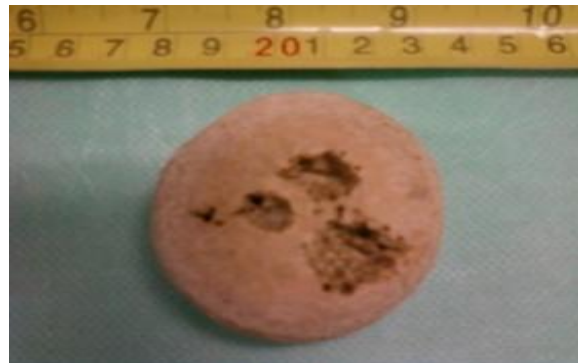


(A) Big Bladder stone before laser irradiation (B) Original weight before laser =66. 86 gram



(C) Step 1: P.E=0.4J, PRR=25Hz, p=20
weight=66.73 gram
weight loss=0.13 gram

(D) Step 2 : P.E=0.5J, PRR=20Hz, p=20
weight=66.45 gram
weight loss=0.28 gram



(E) Step 3 : P.E=0.625J, PRR=16Hz, p=20
weight=66.05 gram
weight loss=0.40 gram

(F) Step 4 : P.E=1.0J, PRR=10Hz, p=20
weight=64.83 gram
weight loss=1.22 gram

Fig. (4): The effect of increasing laser energy per pulse on stone ablation (weight loss).

(A and B: Bladder stone weight before laser irradiation, C, D, E, and F: Steps showing the effect of increasing laser energy per pulse on stone ablation (weight loss)., G: Final weight after laser irradiation =64.83 gram.



(G) Big Bladder stone: Final weight=64.83 gram

Table (6): The effect of laser energy per pulse on stone ablation (weight loss).

Steps	Original weight (gram)	Laser Parameters	Weight after Laser (gram)	Weight loss (gram) (ablation)	Total energy used (joule)
Step 1	66.86	PE=0.4 PRR=25 P=20	66.73	<u>0.13</u>	528
Step 2	66.73	PE=0.5 PRR=20 P=20	66.45	<u>0.28</u>	599
Step 3	66.45	PE=0.625 PRR=16 P=20	66.05	<u>0.40</u>	586
Step 4	66.05	PE=1.0 PRR=10 P=20	64.83	<u>1.22</u>	612

From the above table we concluded that:-The weight loss (ablation) of the stone irradiated with 1.0 J/pulse was (1.22 gram) which is 10 times more than the weight loss (ablation) of the stone irradiated with 0.4 J/pulse (0.13 gram) within the same time (30 seconds). So by increasing the energy per pulse, there was significant increasing in weight loss of the stone. The deposited energy used for stone irradiated with 1.0 J/pulse was (612 J) which is slightly more than the delivered total energy used for stone irradiated with 0.4 J/pulse (528J). So by increasing the energy per pulse, there were no significant differences among delivered total energy within the same time (30 sec.), but the effect on weight loss is significantly difference.

4-(To determine the effect of stone composition on fragmentation time).

Stones of different chemical composition (calcium oxalate, calcium phosphate, urate, and struvite) were irradiated with the same laser Parameters (1.0 J/pulse Holmium laser energy, power output 20 W and PRR 10 Hz, double pulse mode). Stone volume and weight slightly varied among stone composition group but did not vary significantly between them. After laser irradiation, the fragmentation time of the calcium stones (oxalate=73 s, phosphate=31 s) was significantly longer than the fragmentation times of other stones (Struvite=15 s, Urate=18 s). Similarly, the delivered total energy for

fragmentation was significantly more for calcium stones compared to the other stones, and this may be due to difference in the composition of these stones which contain more calcium component (harder stones).



(A) Before laser



(B) After laser

Fig. 5: The effect of stone composition on fragmentation time (NOTE: Stone no.1= Struvite no.2= Urate no.3= Calcium phosphate no.4= Calcium oxalate).

Table (7):The effect of stone composition on fragmentation time.

Stone Type	Original weight (gram)	Fragmentation Time(seconds) + (No. of pulses)	Weight after Laser (gram)	Weight loss (gram)	Total Energy used (joule)
Struvite stone	1.38	15 (115)	0.91	0.47	310
Urate stone	1.21	18 (180)	1.03	0.18	595
Calcium phosphate	1.25	31 (310)	0.93	0.32	998
Calcium oxalate	1.26	73 (730)	0.92	0.34	1764

NOTE: Laser Parameters: PE=1.0 (J/pulse), P=20 (Watt), PRR=10 Hz (Hz), (double pulse mode)

Discussion

All stones studied were successfully fragmented with Ho:YAG laser energy. Although there were differences in stone fragmentation time and ablation based on composition and sizes of the stones, in addition to factors related to laser system itself like mode of operation (single or double pulse mode) and pulse energy and pulse repetition rate and the power.

The results of Holmium laser lithotripsy for urinary stones were uniformly excellent (Razvi et al., 1996, Dogan et al., 2004, Grasso and Chalik., 1998, Matsouka et al., 1999, Taari et al., 1999, Costello et al., 2000 and Scarpa et al., 1999).

The holmium laser pulse energy had an effect on lithotripsy time and stone ablation. The stones irradiated with 1.0J/pulse were fragmented approximately 5 times faster, and stone ablation 10 time more as compared with those irradiated with 0.4 J/pulse.

During this part of the experiment, the holmium laser output power was constant at 20 W, while the pulse repetition rate varied from 10 to 25 Hz. Therefore, the lower pulse energies are a result of a faster pulse rate.

Although these laser operating parameters introduce a confounding variable, these findings are similar to those described for in vivo

lithotripsy of human stones, where pulse energies less than 1.0 J/pulse are recommended (Spore et al., 1999).

Power density is determined by laser energy, pulse duration, and the diameter of the laser fiber.

To return to basic principles, it is apparent that to alter the power density of laser light, it is necessary to change elements of the equation that determines it .

The elements of the equation are :-

- 1) The energy at the source
- 2) The core diameter of the fiber, and
- 3) The duration of the pulsation.

$$\text{Power Density} \propto \frac{\text{pulse energy}}{\text{pulse duration} \times \text{fiber diameter}}$$

The pulse duration (350 μs) and the fiber diameter (760 microns), both are fixed in our study, so the only way to increase the power density is by increasing the pulse energy.

The work of Costello et al (2000) has shown 100% success rate. The holmium laser essentially will fragment all stones regardless of composition, size, color or shape (Jou YC. et al., 2005).The final determinant of success of laser for intracorporeal lithotripsy is not the laser itself but other factors such as stone location,

stone size and difficulty of access because of associated anatomical abnormalities or ureteral narrowing. Because lithotripsy was successful for stones of varying composition, pre-existing knowledge of stone composition will not be necessary for using the holmium laser for lithotripsy. The holmium laser is especially helpful since the laser fibers can be used in small caliber ureteroscopes. Now with the 200 µm fiber, almost any stone in any region of the renal collecting system can be accessed in a retrograde fashion. The main limitation of the holmium laser is its overall cost. However when one considers its multi purpose, multi specialty use, this device may in fact become cost effective. It is a solid state laser with minimal maintenance. However it's potential for soft tissue damage during use must always be kept in mind (Johnson DE et al., 1992). Lasers for intracorporeal lithotripsy were first used in the late 1980's but were limited in power by the diameter of the fiber optic used. Larger fibers diameters meant more power, but they were more rigid and less suited to the environment which demanded flexibility and freedom of movement.

By 1983, the basic principles and problems of using the laser for stone fragmentation were known.

Continuous wave lasers created too much heat and caused tissue damage and were inappropriate for use for stone fragmentation.

Effective use of lasers for calculi depended on the ability to transmit the energy through optical fibers (delivery system).

It was necessary for the laser to act on the stone by creating a shock or a stress wave that overcome the tensile strength of the stone.

The shorter the laser pulsation, the less the ablated volume will be.

The Holmium:YAG laser is one of the most commonly used lasers and has been universally accepted as the standard for intracorporeal lithotripsy. Multiple recent studies have demonstrated that holmium: YAG laser lithotripsy is superior to electrohydraulic lithotripsy, ultrasonic lithotripsy, and pneumolithotripsy in terms of stone fragmentation and complications (Johnson DE et

al., 1992, Matsuoka K et al., 1995 and Marks AJ and Teichman JM. 2007). Using 2150-nm light energy in a pulsatile fashion, this thermal laser produces a vaporization bubble at the tip of low-water-density quartz fibers. Even with the small 150 to 200-µm fibers, the energy delivered is sufficient to fragment all types of urinary stones into fine dust and small pieces that can then pass easily through the urinary tract (Johnson DE et al., 1992). Therefore, hard stones in difficult locations (lower-pole calyx) can be treated using a small-diameter fiber that is easily deflected with the ureteroscope (Johnson DE et al., 1992). Holmium laser energy is rapidly absorbed by water, creating a vaporization bubble that has minimal effects on adjacent tissue (2-3mm from the fiber tip). These qualities result in minimal adjacent tissue trauma. However, direct contact with tissue should be avoided unless tissue resection is planned. In addition, sufficient cooling irrigant through the endoscope should be used to prevent adjacent thermal soft-tissue effects. Holmium laser lithotripsy is more effective than other endoscopic lithotripters for large and complex stone.

The mechanism of stone fragmentation with the Ho:YAG laser :

Other lasers used today for intra corporeal lithotripsy include the pulse-dye laser and the Alexandrite laser (Pearle MS et al., 1998), both of which cause stone fragmentation through a plasma-mediated shock wave.

In contrast, there is evidence suggests that the mechanism for stone fragmentation with the holmium laser mainly results from a photothermal ablation effect with only a secondary shockwave or cavitation effect. Zhong et al (1998) have used high speed photography and acoustic pressure measurements to compare stone fragmentation with pulsed dye laser and Holmium laser. As compared to the spherical cavitation bubble and strong shockwave emission produced by pulsed dye laser, the longer pulse duration of the Holmium laser produces an elongated bubble with a much weaker shock-wave emission (Jansen ED et al., 1996). Therefore, it seems that, stone

fragmentation must be more dependent on a thermal effect that causes “stone vaporization”. It is conceivable that with each laser pulse, photons generated by the laser machine are transported through the fiber up to the irrigation solution, which absorbs and transfers them to water in the stone, where luminous energy is ultimately transformed to thermal energy and released as heat. This reaction creates high temperatures on the stone surface thereby effacing a small area of stone. The process is repeated at each laser pulse. When the laser tip is gently moved over the stone surface (stone painting or vaporizing). Once stress fractures develop within the stone, the relatively weak shockwave emission may also contribute to the fragmentation process by breaking up the stone along these weakened cleavage planes. A number of investigators have commented that Holmium laser lithotripsy occurs through a “drilling effect”, whereby small bits of stone are vaporized, emitting a fine stone dust in which no evident fragments can usually be recognized (Yiu et al., 1996, Razvi et al., 1996 and Grasso., 1996). A significant advantage of the weak shockwave pressure as compared to the other lasers is less retropulsion of stone fragments. To minimize retropulsion during Holmium: YAG lithotripsy, it is recommended that small diameter fibers and modest energy levels must be used (Lee et al., 2003).

Conclusions

Laser lithotripsy has developed from possibility to reality over the course of 20 years. The laser is a promising tool for the treatment of urinary calculi. The Holmium:YAG laser has demonstrated its efficacy as a method of choice for fragmentation of urinary tract stones. Advantages include ability to fragment stones of all composition producing smaller stone fragments, this would diminish the degree of invasiveness and provide a real alternative to extracorporeal shock wave methods.

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تفتيت حصى المجاري البولية بواسطة ليزر الهولميوم ياك 2100 نانومتر (دراسة خارج الجسم)

لطفی غلام عوازلی علی شکر محمود

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الخلاصة: المقدمة: يعتبر مرض حصى المجاري البولية من أهم وأكثر الأسباب الشائعة التي تؤدي إلى الام حادة في الجهاز البولي. هناك أربعة طرق وتقنيات جديدة أحدثت تغييرات في كيفية علاج حصى المجاري البولية، وهي تفتيت الحصى بواسطة جهاز الهايدروليك، تفتيت الحصى بواسطة السونار (أمواج فوق الصوتية)، تفتيت الحصى بواسطة الأمواج خارج الجسم و تفتيت الحصى بواسطة الليزر. الهدف من الدراسة: تقييم كفاءة جهاز الليزر (هولميوم ياك 2100 نانومتر) في تفتيت حصى المجاري البولية خارج الجسم، بالإضافة إلى دراسة تأثير أنواع حصى المجاري البولية على كفاءة جهاز الهولميوم ياك ليزر المواد والطرق: تم اختيار حصى متعددة للمجاري البولية للأنسان بمختلف الأحجام والأشكال والألوان والأوزان ومعرفة تراكيبها الكيميائية وتم تعريضها إلى اشعاع جهاز الهولميوم ياك ليزر (2100 نانومتر) من النوع النبضي بقيم مختلفة للطاقة والتردد النبضي ووقت التعرض للأشعاع مع حساب الوقت اللازم لتفتيت الحصى مع ايجاد الأوزان المفقودة لكل حصاة من خلال قياس وزن كل حصاة قبل وبعد التعرض إلى شعاع الليزر، النتائج: أظهرت الدراسة ان جهاز الهولميوم ياك ليزر (2100 نانومتر) يستطيع تفتيت جميع أنواع حصى المجاري البولية بنجاح والفترة الزمنية اللازمة للتفتيت تعتمد على التركيب الكيميائي وحجم الحصاة بالإضافة إلى قيم وأعدادات الليزر مثل النوع النبضي الثنائي ومقدار الطاقة لكل نبضة والتردد النبضي المختلفة لجهاز الهولميوم ياك ليزر. الاستنتاجات: ان استعمال جهاز الهولميوم ياك ليزر (2100 نانومتر) يمثل اختيار ممتاز يمكن استعماله في تفتيت جميع انواع حصى المجاري البولية.

تفتيت حصى المجاري البولية بواسطة 2100 نانومتر هولميوم ياك ليزر (دراسة خارج الجسم)

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الخلاصة المقدمة: يعتبر مرض حصى المجاري البولية من أهم وأكثر الأسباب الشائعة التي تؤدي الى الام حادة في الجهاز البولي. هناك أربعة طرق وتقنيات جديدة أحدثت تغييرات في كيفية علاج حصى المجاري البولية، وهي تفتيت الحصى بواسطة جهاز الهايدروليك، تفتيت الحصى بواسطة السونار (أمواج فوق الصوتية)، تفتيت الحصى بواسطة الأمواج خارج الجسم و تفتيت الحصى بواسطة الليزر. الهدف من الدراسة: تقييم كفاءة جهاز الليزر (هولميوم ياك 2100 نانوميتر) في تفتيت حصى المجاري البولية خارج الجسم. بالإضافة الى دراسة تأثير أنواع حصى المجاري البولية على كفاءة جهاز الهولميوم ياك ليزر. المواد والطرق: تم اختبار حصى متعددة للمجاري البولية للأنسان بمختلف الاحجام والاشكال والألوان والاوزان ومعرفة تراكيبها الكيميائية وتم تعريضها الى اشعاع جهاز الهولميوم ياك ليزر (2100 نانوميتر) من النوع النبضي بقيم مختلفة للطاقة والتردد النبضي ووقت التعرض للأشعاع مع حساب الوقت اللازم لتفتيت الحصى مع ايجاد الاوزان المفقودة لكل حصاة من خلال قياس وزن كل حصاة قبل وبعد التعرض الى شعاع الليزر، النتائج: اظهرت الدراسة ان جهاز الهولميوم ياك ليزر (2100 نانوميتر) يستطيع تفتيت جميع أنواع حصى المجاري البولية بنجاح والفترة الزمنية اللازمة للتفتيت تعتمد على التركيب الكيميائي وحجم الحصاة بالإضافة الى قيم وأعدادات الليزر مثل النوع النبضي الثنائي ومقدار الطاقة لكل نبضة والتردد النبضي المختلفة لجهاز الهولميوم ياك ليزر. الاستنتاجات: ان استعمال جهاز الهولميوم ياك ليزر (2100 نانوميتر) يمثل اختبار ممتاز يمكن استعماله في تفتيت جميع انواع حصى المجاري البولية .