Original Article

Comparison between the Holmium Laser (Made in Iran) and Pneumatic Lithotripsy in Patients Suffering from Upper Ureteral Stone between 1-2cm

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Abstract:

Introduction: The aim of this study is to compare holmium laser (LL) with pneumatic lithoclast (PL) in patients with upper ureteral stones and their ability to destruct the stones and making the patient stone free. We also compare the duration of these procedures and their complications, such as urosepsis, perforation, and pushing the stone backward.

Methods: This has been a clinical randomized trail study in 26 patients with upper ureteral stone more than 1 cm. Patients were divided into 2 randomized groups, each treated with one of the following approaches: pneumatic lithoclast(14 patients), or holmium laser(12 patients). The goal of lithotripsy was to break the stone into particles less than 3 mm. IVP (Intravenous Pyelogram) was performed 4 weeks after.

Results: The immediate stone free rate was 100% in LL group and 42.9% in PL group (P=0.001). Stone pushing back was 0% in LL group and 57.1% in PL group. Complications such as a perforation, or urosepsis, or bleeding were not seen in any of these groups. Fever more than 38º C was observed in 1.8% in LL, and 3.8% in PL group (p=0.56). After 4 weeks no complication was seen in IVP.

Conclusion: According to our experience, for upper ureteral stones larger than 1 cm, lithotripsy with holmium laser is preferred approach with high success rate and low complication.

Keywords: success rate; ureteral stone; lithotripsy

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Introduction

Although urinary stone disease is one of the most common afflictions of modern society, it has been described since antiquity. With westernization of the global culture; however, the site of stone formation has migrated from the lower to the upper urinary tract, and the disease once limited to men is increasingly becoming gender blind. Revolutionary advances in the minimally invasive and noninvasive management of stone disease over the past 2 decades have greatly facilitated the ease with which stones are removed (1).

Minimally invasive treatments are used when the stone blocks urinary path, or when it causes severe pain, resistant to medical therapies.

One of these minimally invasive approaches is pneumatic lithotripsy which has benefits, such as less expensiveness and a wide safety. It also has some complications, such as pushing the stone backward and inability to be used with flexible ureteroscope. Ballistic lithotripsy relies on energy generated by the movement of a projectile. The Swiss Lithoclast, introduced in the early 1990s, was the first ballistic lithotripter (2-4).

The other approach is Holmium Laser which is nowadays used with a high rate of safety and success as the Gold Standard. The holmium laser is a solid-state laser system that operates at a wavelength of 2140 nm in the pulsed mode. Pulse duration of the holmium laser ranges from 250 to 350 μ s and is substantially longer than the pulse duration in pulsed-dye lasers. The holmium laser is highly absorbed by water. The zone of thermal injury associated with laser ablation ranges from 0.5 to 1.0 mm. Holmium laser lithotripsy occurs primarily through a photo-thermal mechanism that causes stone vaporization. The holmium laser is one of the safest, most effective, and most versatile intra-corporeal lithotripters. Further advantages of the holmium laser include its production of significantly smaller fragments compared with other lithotrites. Holmium laser lithotripsy results in small stone debris, which is easily irrigated, and reduces the need for extraction of the fragments with basket or grasping devices. The holmium laser produces a weak shockwave, which reduces the likelihood of retropulsion of the stone or stone fragments, compared with EHL or pneumatic lithotripters (5).

The aim of this study was to compare holmium laser with pneumatic lithoclast in patients with upper ureteral stones between 1-2cm and their ability to destruct the stones, and making the patient free of stone. We also compared the duration of these procedures and their complications, such as urosepsis, perforation, and pushing the stone backward.

Methods

This was a clinical randomized trail study in 26 patients with proximal ureteral stone admitting in Shohada-e Tajrish medical center from autumn of 2009 till autumn 2010. Patients were divided into 2 randomized groups; LL group (12 patients) and PL group (14 patients).

Each group was treated with one of these approaches: pneumatic lithoclast, or Holmium

Laser type	Pulsed Holmium Laser
Wavelength	2.1μm
Power To Tissue	Up to 40W
Pulse Length	Up to 2 ms
Repetition Rate	< 20 Hz
Aiming Beam	650 nm (red), <1 mW
Cooling system	Water cooled
Electrical Requirements	~220 V, 15A, Single phase
User Interface	LCD (in colour)
Dimension (cm), weight (kg)	65×85×125, 105kg

Figure 1. Holmium laser was manufactured by institute of LASER science and technology related to Iran's atomic energy organization.

laser. We used an 8 fr semi-rigid ureteroscope in both groups.

Patients with a stone bigger than 2 cm or smaller than 1 cm, and patients with pelvic or calyx stones and mid or distal ureteral stones, as well as those with active UTI (Urinary Tract Infection) and fever were excluded from the study.

The Holmium-YAG LASER was manufactured by institute of LASER Science and Technology related to Iran's Atomic Energy Organization (Figure 1).

The pneumatic lithoclast was Swiss lithoclast. Ultra-sonography and IVP (Intravenous Pyelogram) were performed before surgery. The patient was placed in lithotomy position and after the insertion of 0.038 inch floppy tip guide wire through ureter, s/he underwent ureteroscopy and lithotripsy. The goal of lithotripsy was to break the stone into particles less than 3 mm. We evaluated immediate stone free rate by direct vision during ureteroscopy. IVP was performed 4 weeks after. A questionnaire was completed based on the results of each approach. And the data were analyzed by SPSS software. Qualitative data were analyzed by Chi-square, and quantitative data were analyzed by independent T-test and Mann Whitney test.

Results

Patients' mean age and stone size were the same in both groups with no statistical difference. (Table 1).

Mean duration of lithotripsy was 12.6 ± 13.7 min in the LL group and 4.2 ± 7.9 min in PL group which was longer in a significant form in the PL group (P=0.029). Immediate stone free rate was 100% in the LL group and 42.9% in the PL group (P=0.001). Stone pushing back was 0% in the LL group and 57.1% in the PL group. Complications such a perforation, or urosepsis, or bleeding was not seen in any of these groups. Fever more than 38ºC was observed in 1.8% in the LL, and 3.8% in the PL group (P=0.56). After 4 weeks no complication was seen in IVP (Figure 2).

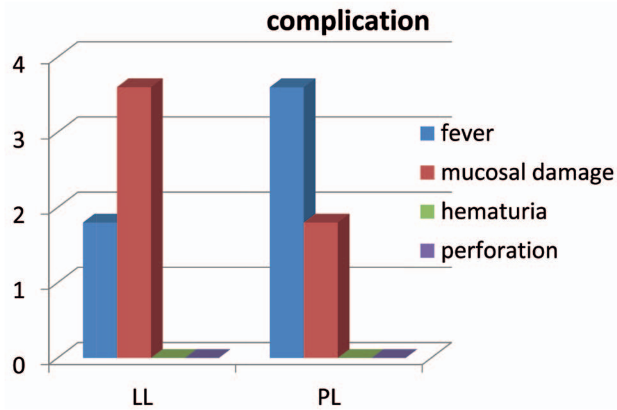

Figure 2. Comparison of complication between group LL and PL.

Table 1. Comparison of mean age and sex ratio and mean stone size between LL group and PL group

Variable	LL group	PL group	P value
Mean Age (yrs)	35.9 ± 13.4	36.4 ± 12.5	0.9
Sex Ratio (M:F)	44:12	40:16	0.54
Mean Stone Size (cm)	11.7 ± 2.9	12.1 ± 3	0.58

Discussion

The goal of the surgical treatment of patients suffering from ureteral calculi is to achieve complete stone clearance with minimal attendant morbidity. Improvements in surgical technology, such as SWL, rigid and flexible ureteroscopes, the holmium: YAG laser, and basket devices, have greatly augmented the urologist's ability to efficiently treat such patients, regardless of the size or location of the ureteral calculus. Each modality has its own advantages and disadvantages. Bapat et al. compared the success rates and complications of Lithoclast and holmium laser-assisted ureterorenoscopy (URS) in managing upper-ureteral stones. They retrospectively analyzed the records of 394 patients with upper-ureteral stone who underwent ureteroscopic lithotripsy. In 193 patients (mean stone size 12.3 mm), pneumatic lithotripsy was used; in 201 patients (mean stone size 11.5 mm) laser lithotripsy was performed. Patients were monitored as outpatients at 2 weeks, 3 months, and then annually with kidney, ureter, and bladder (KUB) radiographs and ultrasonographies. Stone fragmentation into fine pieces that pass eventually was assessed at 2 weeks. This did not include proximal migration of a stone or fragments that required auxiliary treatment. This occurred in 166/193 (86.01%) patients in the lithoclast group and in 195/201 (97.01%) in the laser group. Ureteral perforations were nine in the lithoclast group and six in the laser group. Auxiliary procedures included SWL (27/193

[13.98%] patients in the lithoclast group and 4/201 [1.99%] patients in the laser group), or repeated URS (two in the lithoclast group). Urosepsis after URS occurred in 11/193 patients in the lithoclast group and 5/201 patients in the laser group. In our study, the fragmentation rates of holmium laser-assisted ureteroscopy were significantly better in the upper ureter. The complications and the need for auxiliary procedures were significantly less for holmium laser-assisted ureteroscopy, when compared with pneumatic lithotripsy (6). In another study, Manohar et al. compared the results of the Swiss Lithoclast System with the Holmium: yttrium-aluminum-garnet (Ho: YAG) laser for ureteral lithotripsy for management of upper ureteral stones. Fifty patients were randomized into two groups: Lithoclast classic 2 (n = 25), and Ho: YAG laser (n = 25) between January 2005 and January 2007. An 8/9.8F semi-rigid ureteroscope was used in all procedures with lithoclast 2, and either an 8F or 7F was used in patients who underwent laser lithotripsy. Patients were analyzed for fragmentation time, stone-free rate, stone up-migration, intraoperative complications, and auxiliary procedures. Average stone size was 9.63 ± 2.46 mm2 and 10.17 ± 2.28 mm2 with overall stone-free rates of 84% and 88% (P = 0.41), respectively, for laser and lithoclast 2 groups. Stone up-migration was 24% and 16% (P = 0.82), mean stone fragmentation time was 9.82 ± 7.58 and 7.86 ± 3.25 minutes (P = 0.12), and stone fragments requiring ancillary procedures were 16% and 12% (P = 0.99), respectively, in the laser and lithoclast 2 groups. Postoperative hematuria (up to 72 hours) was significantly (P = 0.04) prolonged in the laser group (36%), compared with the lithoclast 2 group (8%). Three patients in the lithoclast 2 group had instrument breakage. Both Ho: YAG laser and lithoclast 2 were equally efficient in managing ureteral stones with effective stone clearance, minimum morbidity, and reduced stone up-migration (7). Overall, literature shows excellent results for ureteroscopic lithotripsy using the Holmium laser for proximal ureteral calculi,with a mean stone –free rate of 95%, associated with a low perforation and stricture rate (8).

Conclusion

According to our experience, for upper ureteral stones with a size of 1-2 cm, lithotripsy with Holmium laser is the preferred approach with a high success rate and low complication, while pneumatic lithotripsy has a lower success rate due to high rate of retropulsion.

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