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ORIGINAL ARTICLE

Comparison of Ho:Yag laser and pneumatic lithotripsy combined with transurethral prostatectomy in high burden bladder stones with benign prostatic hyperplasia

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Summary *Objectives:* To compare the efficacy and reliability of Ho:YAG laser lithotripsy (HLL) and pneumatic lithotripsy (PL) in the treatment of bladder stones in patients with benign prostatic hyperplasia and stones $\geq$ 20 mm who were transurethrally treated in the same surgical session.
Methods: We studied the data of patients with benign prostatic hyperplasia and $\geq$20 mm bladder stones who were treated with transurethral resection of the prostate and cystolithotripsy in the same session, obtained between January 2010 and February 2014 from three urology clinics. All patients underwent bipolar plasmakinetic (PK) transurethral resection of the prostate. For treatment of the bladder stone, either HLL or PL was applied. A total of 62 patients were divided into two groups: PK-PL (Group 1, n = 29) and PK-HLL (Group 2, n = 33). The data of both groups were analyzed for stone dimensions, stone fragmentation time, total operating time, hospitalization duration, prostate dimensions, success rates, and complications.

Conflicts of interest: The authors of the study declare no conflicts of interest.
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Results: Group 1 included 29 patients with a mean age of 70 ± 7.6 (range, 57–85) years, whereas Group 2 included 33 patients with a mean age of 67.5 ± 10.5 (range, 45–84) years. In Group 1, five patients had mucosa injury, one patient had residual stone, and one patient had bladder perforation. In Group 2, three patients had mucosa injury, three patients had postoperative fever, and one patient had residual stone. Total operation time and stone fragmentation time were significantly lower in Group 2 ($p < 0.05$). The remaining analyzed data were similar ($p > 0.05$).
Conclusion: PK-HLL using a single shaft without the need for repeated access has the advantages of shorter fragmentation and operation time.

1. Introduction

Bladder stones comprise 5% of all urinary system stones and generally originate from bladder outlet obstruction (BOO), neurogenic voiding dysfunction, infection, or foreign bodies.[1] In the past 10 years, there has been a significant reduction in the incidence of bladder stones associated with a developed diet and the use of modern antibiotics.[2] BOO is the most common predisposing factor for the formation of bladder stones and is seen in 45–79% of all patients diagnosed with bladder stones.[3–5]

The formation of bladder stones caused by benign prostatic hyperplasia (BPH) related to BOO is a frequently encountered event in elderly males. Combined methods including transurethral resection of the prostate (TUR-P) applied for BOO and endoscopic removals of stones are used in treatment.[6] Different energy sources are used for the fragmentation of bladder stones, but there are very few studies in the literature comparing these energy sources. The aim of this study was to compare the efficacy and reliability of Ho:YAG laser lithotripsy (HLL) and pneumatic lithotripsy (PL) in the treatment of bladder stones in patients with BPH and stones ≥ 20 mm who were treated in the same surgical session using the transurethral route.

2. Material and methods

We retrospectively evaluated the records and computer data of patients who underwent TUR-P and cystolithotripsy in the same surgical session for a diagnosis of BPH and bladder stone ≥20 mm at three different urology clinics between January 2010 and February 2014. The study included patients who were treated using HLL after the purchase of the device. In the past, PL was used for all cases. The exclusion criteria were previous prostate surgery, bladder stone <20 mm, multiple bladder stones, bladder tumor, neurogenic bladder, or urethral stricture. Urine culture was examined for all patients, and they were admitted for surgery, sterile. Bipolar plasmakinetic (PK) TUR-P was applied to all patients for BPH treatment. For treatment of the bladder stone, either HLL or PL was used. A total of 62 patients were included in the study. According to the treatment modality, the patients were divided into two groups: PK-PL (Group1, $n = 29$) and PK-HLL (Group 2, $n = 33$).

All patients were evaluated preoperatively with the International Prostate Symptom Score form. Routine anesthesia tests were applied. Prostate volume and postvoiding residual urine volume were defined on transabdominal ultrasonography (USG). Patients with residual urine volume >300 mL were examined urodynamically to exclude a diagnosis of acontractile bladder. Uroflowmetry was applied to all patients except those with urinary retention. Again, to exclude a diagnosis of acontractile bladder, urodynamic examination was applied to patients who were hospitalized with urinary retention. To determine the number and size of the stones, kidney–ureter–bladder radiography (KUB) and USG were applied. The dimensions of the bladder stone were digitally measured by the greatest diameter on KUB or calculated with USG.

Both groups were statistically evaluated in respect of the demographic characteristics of the patients, stone dimensions, stone fragmentation time, total operating time, hospitalization duration, prostate dimensions, success rates, and complications according to the modified Clavien classification system. Stone fragmentation time was calculated as the time taken to remove the stone fragmented with the aid of a lithotriptor from the bladder.

2.1. Surgical technique

Routine cystouretroscopy was applied to the patients in Group 1 in the lithotomy position with a 22F cystoscope (Karl-Storz, Tuttlingen, Germany). Then, stone fragmentation was performed with a metallic 4.5F pneumatic lithotriptor, which was advanced inside the cystoscope (Elmed Vibrolith Plus, Ankara, Turkey). The lithotriptor was used at a pressure of 4 bars and a frequency of 8 seconds. Following the stone fragmentation, the pieces of stone were removed with an evacuator, the cystoscope was removed, and TUR-P was applied with a 26F bipolar PK resectoscope (Gyrus ACMI, Southborough, MA, USA).

The patients in Group 2 were treated in the lithotomy position with a 26F resectoscope (Circon ACMI, Hamilton, OH, USA). First, routine cystouretoscopy was applied; then by sending a 550-μm Ho:YAG laser fiber (Sphinx; LISA, Katlenburg-Lindau, Germany) inside the resectoscope shaft, cystolithotripsy was applied. The laser was used at an energy level of 1.6 J and a frequency of 10 Hz. The pieces of the fragmented bladder stone were removed with an evacuator. Then, without removing the shaft, TUR-P was applied with bipolar PK technology (Gyrus ACMI).

In all patients, at the end of the operation, a 22F three-way Foley catheter was installed and the bladder was irrigated. Bladder irrigation was continued for 12–24 hours until the color of the urine was clear, and then the irrigation was terminated.

Patients were evaluated on the 1st postoperative day in respect of hemogram and metabolites. The residual stone was evaluated on postoperative Day 1 with KUB and USG. The Foley catheter was removed from the patients on postoperative Day 3 or Day 4.

2.2. Statistical analysis

Statistical analyses were performed using SPSS, version 20.0 (SPSS Inc., Chicago, IL, USA). Student *t* test was used for parametric variables, and the Mann–Whitney *U* test was used for nonparametric variables. A p value <0.05 was accepted as statistically significant.

3. Results

Group 1 comprised 29 patients with a mean age of 70 ± 7.6 (range, 57–85) years and Group 2 comprised 33 patients with a mean age of 67.5 ± 10.5 (range, 45–84) years. Three patients in Group 1 and four patients in Group 2 had presented at the emergency department with acute urinary retention. A urethral Foley catheter was inserted in these patients. In two of the Group 2 patients with urinary retention, there was bilateral hydronephrosis and uremia. Two weeks after the placement of the Foley catheter, the blood urea and creatinine values returned to normal, and hydronephrosis was observed to have recovered. In both groups, age, prostate size, stone size, and duration of hospitalization were found to be statistically similar ($p > 0.05$). When total operation time and stone fragmentation time were examined, the times were statistically significantly shorter in Group 2 compared with Group 1. The demographic characteristics and surgical data of the patients are shown in Table 1.

In Group 1, superficial bladder mucosa injury that does not cause loss of vision developed in five patients. Also in Group 1, distension in the abdomen was observed during surgery in one patient who was then determined to have intraperitoneal bladder perforation, and stone fragments had migrated into the abdomen. This patient was treated with open surgery. Postoperatively, residual stone was determined in one patient in Group 1, and reoperation was applied. In the postoperative follow-up, two patients were observed to have a high temperature. Following urine culture for these patients, antibiotic treatment was started.

In Group 2, superficial bladder mucosa injury that does not cause loss of vision developed in three patients, and three different patients had a high temperature. Following urine culture for these patients, antibiotic treatment was started. A residual stone was determined in one patient, and reoperation was performed. The complications for both groups according to the modified Clavien classification are shown in Table 2.

4. Discussion

The treatment method for patients with BOO-related bladder stones remains controversial. TUR-P applied together with transurethral cystolithotripsy or percutaneous cystolithotripsy in the same surgical session is the most frequently preferred method. However, this treatment choice varies depending on the experience of the surgeon, the available surgical equipment, and the size and number of the stones.[7] For endoscopic stone fragmentation, different energy sources are used such as ballistic, ultrasonic, pneumatic, electrohydraulic, and laser.[8]

Pneumatic lithotriptors have been used for many years in urological endoscopic stone treatment. However, together with the developments in technology, more alternative energy sources have emerged in endoscopic stone treatment. During cystolithotripsy with pneumatic lithotriptors, repeated entrances and exits cause bleeding in the prostatic tissue. Therefore, visual problems are created during PL.[7–9] In addition, the operating time is prolonged owing to this clouding of the visual area.[7] In a study by Ener et al,[10] transurethral cystolithotripsy was applied using a pneumatic lithotriptor, and the mean stone size was reported as 3.5 ± 1.6 cm and the operating time as 68.1 ± 22.7 minutes. In Group 1 of the current study, the mean stone size was determined as 28.8 ± 7.69 mm, the total operating time was 127.7 ± 18.4 minutes, the stone fragmentation time was 56.93 ± 14.04 minutes, and the success rate was 93.1%. Although the presence of BPH causing BOO in our study patients prolonged the stone fragmentation time, the stone fragmentation time values of the current study are similar to those reported in the literature.

Table 1 Demographic characteristics and surgical data of patients.

	Group 1 (n = 29)	Group 2 (n = 33)	p
Age (y)	70 ± 7.6	67.5 ± 10.5	0.269
Prostate volume (cm^3)	65.2 ± 12.1	65.45 ± 12.7	0.938
Stone size (mm)	28.8 ± 7.69	31.4 ± 8.9	0.221
Total operation time (min)	127.7 ± 18.4	109.42 ± 19.76	<0.0001[a]
Stone fragmentation time (min)	56.93 ± 14.04	40.36 ± 13.7	<0.0001[a]
Hospitalization duration (d)	3.6 ± 1	3.5 ± 1.1	0.784

[a] Statistically significant, $p < 0.05$.

Table 2 Complications in Groups 1 and 2 according to the modified Clavien classification system.

Complications	Group 1 ($n = 29$)	Group 2 ($n = 33$)	Modified Clavien score	p
Urinary tract infection	2 (6.89)	3 (9.09)	1	—
Superficial bladder mucosa injury	5 (17.24)	3 (9.09)	1	—
Bladder perforation	1 (3.44)	0	3B	—
Residual stone	1 (3.44)	1 (3.03)	3B	—
Total	9 (31.03)	7 (21.21)		0.337

Data are presented as n (%).
Statistically significant, $p < 0.05$.

In a study by Shah et al[11] on endoscopic cystolithotripsy using TURP and Ho:YAG laser in the same surgical session on 32 patients, the mean stone size was 34.6 mm, the mean prostate weight was 52 g, and the mean operating time was 97.7 minutes. de la Torre et al[12] reported outpatient cases of HL cystolithotripsy and Green Light Laser prostatectomy to have the following outcomes: mean stone size, 23 mm; prostate volume, 56.5 cm^3; operative time, 115 minutes. In Group 2 of the current study, the following results were noted: mean prostate volume, 65.45 $\pm$ 12.7 cm^3; stone size, 31.4 $\pm$ 8.9 mm; total operating time, 109.42 $\pm$ 19.76 minutes; stone fragmentation time, 40.36 $\pm$ 13.7 minutes; success rate, 97%. Although the prostate volume and stone size were larger than those reported by de la Torre et al,[12] the total operating time was found to be shorter, which is thought to be attributable to the different energy source used for TUR-P.

Un-no et al[13] compared the efficacy and reliability of Ho:YAG laser and Swiss Lithoclast in the treatment of bladder stones, and although both lithotriptors were determined to be both effective and reliable, the conclusion they reached was that the Ho:YAG laser may be more preferable in the treatment of large bladder stones. In the current study, the better visual image obtained in Group 2 is thought to have contributed to the stone fragmentation time being statistically significantly shorter in Group 2 compared with Group 1.

The success rates of both groups were found to be statistically similar. According to the modified Clavien classification system, complications were seen in nine patients of Group 1 (31.03%), whereas complications were seen in seven patients of Group 2 (21.2%). No statistically significant difference was determined between the two groups when the complications were compared according to the modified Clavien classification system ($p = 0.337$). In one patient in Group 1 and one patient in Group 2, the complications were evaluated as Clavien 3b, and all the other complications were Clavien 1.

Although there was no statistically significant difference between the groups in terms of prostate volume, stone size, and demographic characteristics, the difference in total operating time and stone fragmentation time was determined to be statistically significant. Stones measuring $\geq$20 mm were broken into larger fragments with the pneumatic lithotriptor, and these fragments needed to be fragmented repeatedly. Compared with the Ho:YAG laser, the pneumatic lithotriptor created larger fragments, causing difficulties during their removal. In the prostatic median lobe, in particular, manipulation of the rigid pneumatic probe is difficult. In Ho:YAG laser cystolithotripsy, the stone is broken into much smaller fragments, which are easier to remove from the bladder. It is easier to remove the fragmented stone pieces with the 26F resectoscope shaft compared to the 22F cystoscope. In addition, the more flexible structure of the laser fiber compared to the pneumatic probe makes it easier to separate the stone fragments even in the presence of the median prostate lobe.

Another advantage of cystolithotripsy with Ho:YAG is that both TUR-P and cystolithotripsy can be performed from the same shaft. In PL, first the cystoscope is inserted then after the bladder stone treatment it has to be removed, whereas for the TUR-P procedure, it is necessary to reenter with the resectoscope shaft, which extends the operating time.

5. Conclusion

Compared to pneumatic cystolithotripsy, Ho:YAG laser cystolithotripsy using a single shaft without the need for repeated entrances and exits, has the advantages of shorter fragmentation and total operating time, and treatment for both BPH and bladder stones $\geq$20 mm can be applied. Nonetheless, there is a need for further prospective randomized studies with greater patient numbers.

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