Comparison of Pneumatic and Laser Lithotripsy in the Endoscopic Treatment of Upper Ureteral Stones

Üst Üreter Taşlarının Tedavisinde Pnömatik ve Lazer Litotriptör Kullanımının Karşılaştırılması

Üst Üreter Taşı Tedavisi / Upper Ureteral Stone Treatment

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Özet

Amaç: Üst üreter taşlarının semirijit üreterorenoskop ile endoskopik tedavisinde, pnömatik ve holmiyum lazer litotriptör kullanımının karşılaştırmayı amaçladık. Gereç ve Yöntem: Çalışmaya toplam 74 hasta dahil edildi. Balistik lithotriptör kullanılan 33 hasta Grup 1 ve lazer litotriptör kullanılan 41 hasta Grup 2 olmak üzere hastalar 2 gruba ayrıldı. Her iki grup taş boyutu, operasyon süresi, postoperatif hastanede kalış süresi, taşsızlık oranı ve komplikasyon oranları açısından karşılaştırıldı. Bulgular: Tüm hastaların yaş ortalaması 47.6 yıl idi. Ortalama taş boyutları Grup 1 ve 2'de sırası ile 16.4mm ve 11.0mm idi (p=0.043). Bir aylık takipler sonrasında Grup 1 ve 2'deki taşsızlık oranları sirası ile %78.7 ve %80.5 idi (p=0.391). Grup 1'de 1 ve Grup 2'de 2 hastada minör komplikasyon (Clavien I-II) saptandı. Grup 1'de 3 hastada üreteral perforasyon nedeni ile majör komplikasyon gelişir iken (Clavien 3a ve 3b), Grup 2'de majör komplikasyon saptanmadı. Tartışma: Bulgularımıza göre lazer litotripsi daha güvenli olarak kabul edilebilir. Merkezlerinde lazer litotriptör bulunan kliniklerin üst üreter taşlarında bu yöntemi ilk tercih olarak kabul etmeleri gerektiğini düşünüyoruz.

Anahtar Kelimeler

Üst üreter taşı, endoskopik tedavi, litotripsi, lazer

Abstract

Aim: We aimed to compare the success rate of the use of a pneumatic and a holmium laser lithotripter for endoscopic treatment of upper ureteral calculi with semirigid uretero-renoscopy (URS). Material and Method: A total of 74 patients were included in this study. The patients were divided into two groups; a ballistic lithotripter was used for group 1 containing 33 and a Holmium-YAG laser lithotripter for the remaining 41 patients in group 2. Both groups were compared in terms of stone size the duration of the operation, postoperative hospitalization time, stone-free rate and complications. Results: The mean age of the patients was 47.6. The mean stone size in groups 1 and 2 were 16.4mm and 11.0mm, respectively (p=0.043). The mean stone-free rate groups 1 and 2 were 78.7% and 80.5% respectively at the approximately 1 month follow-up (p=0.391). In group 1 two patients and in group 2 two patients had a minor complication (ClavienI-II). In group 1 three patients had major complications due to ureteral perforation (Clavien 3a and 3b). No major complications (Clavien III-V) occurred in Group 2. Discussion: Based on these findings laser lithotripsy can be regarded as safer. If laser lithotripter is available in medical centers, we argue that it should be the first choice for the treatment of upper ureteral stones.

Keywords

Upper ureteral stone, endoscopic treatment, lithotripsy, laser

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Introduction

In the endoscopic treatment of ureteral stones the gold standard method is semirigid uretero-renoscopy (URS) accompanied by a stone crushing process. The highest success rate is obtained in the treatment of lower ureteral stones [1]. For lower ureteral stones the success rate was approximately 95-100% and 90-95% for stones mid-ureter. Recently, for upper ureteral stones, in the literature there have been reports of success rates varying between 70-100% [2,3].

The endoscopic treatment of upper ureteral calculi can be challenging either due to difficulty in reaching the stone or more likely as a result of push-back. For stone fragmentation, various energy sources are used, such as; electrohydrolic, pneumatic and Holmium-YAG laser. Parallel to technological developments, the most preferred energy sources are pneumatic and laser lithotripters [4,5].

The present study reports on the success of the pneumatic and holmium laser lithotripter methods for the endoscopic treatment of upper ureteral calculi using a semirigid URS in our clinic.

Material and Method

A total of 74 patients who had undergone semirigid URS due to the existence of upper ureteral stones in our clinic between January 2009 and August 2013 were included in this study. The energy source for the 33 patients in group 1 was the Ballistic lithotripter (Vibrolith™, Elmed Medical Company, Turkey) and for the 41 patients in group 2 the energy source was a Holmium-YAG laser lithotripter (SphinxX™, Lisa, Germany).

All the patients were preoperatively evaluated with X-ray KUB (Kidney, ureter, and bladder), urinary ultrasonography, and non-contrast computed tomography or intravenous urography (IVU), or both. In stone size measurement, the dimension of the largest stone in the IVP or X-ray KUB was used for the radiopaque stones and in the abdomen ultrasonography or computerized tomography for the radiolucent stones.

All the patients were evaluated with urinalysis and culture. Patients with an infection were treated with appropriate antibiotics in accordance with the preoperative urine culture based on the antibiotic susceptibility. Other patients underwent an operation following the appropriate antibiotic prophylaxis under general anesthesia. For the stone fragmentation, a pneumatic lithotripter (Vibrolith, Elmed, Ankara, Turkey) was used until May 2012 and the holmium-yttrium-aluminum-garnet (Ho: YAG) has been used since that date.

Operations were performed with a 9.5 F semirigid ureteroscope (Karl Storz, Germany) under the guidance of a 3-5F ureteral catheter. The fragmentation process was continued until all the stone particles were reduced to a size of 3 mm or less. A ureteral or JJ (4.8-6F) stent was placed in patients determined as necessary by the surgeon (such as edema, mucosal damage or prolongation of operation). The stents were removed after a 3 or 4 week postoperative period. One month after treatment all the patients were evaluated using an X-ray KUB or IVU. Patients who had stone fragments at the size of 3 mm or less were considered to be stone-free. Both groups were evaluated and compared in terms of age, gender, stone size, duration of the operation, the postoperative hospitalization time, stone-free rate and complications.

Statistical analysis

Statistical Package for the Social Science for Windows (SPSS, Chicago, IL) version 13.0 software was used for statistical evaluation of the results. Descriptive statistics were given as mean± Standard deviation. Chi-square, Fisher's Exact and Mann-Whitney tests were used to compare the group parameters. A p value of less than 0.05 was considered significant.

Results

The mean age of all the patients was 47.6±14.9 (range:16 to 80) years. The mean age of the groups 1 and 2 were 48.1±15.6 (range: 22 to 88), and 47.2±14.5 (range:16 to 77) years, respectively. Twenty-three patients were female and 51 were male. In groups 1 and 2, the F/M ratio was 9/29 and 14/27 respectively and there was no statistically significant difference between groups. The mean stone size in groups 1 and 2 were 16.4±7,7 mm (range: 5 to 30) and 11±2.9mm (range:5 to 17), respectively (p=0.043). The mean duration of operation in groups 1 and 2 were 58.9±35.8 minutes (range:20-160) and 38.7±12.8 (range: 20 to 70) minutes, respectively (p=0.035). The mean postoperative hospitalization days in groups 1 and 2 were 1.8±1.8(1-9) and 1.20±0.5(1-3), respectively (p=0.483). These results are summarized in Table 1.The average residual stone size in group 1 was 12.5±2.1 mm (10-15) and 6.5±1.7 mm (5-10), in group 2 (p=0.004). The mean stone-free rates for group 1 and 2 were 78.7% and 80.5% respectively approximately at the 1 month follow-up with no statistically significant difference (p=0.391) (Table 2). In group 1, ureteral perforation, requiring open surgery, occurred in 2 patients during URS. In group 1 only one patient with ureteral perforation was treated with a JJ stent. In group 2 there was no ureteral perforation or other procedure that required open surgery. In four patients in group 1 and 1 patient in group 2 a stone push-back was observed. These two patients with push-back were directed to Extracorpore-

Table 1. Demographic data of the groups.

	Group 1 (n=33)	Group 2 (n=41)	Total	p value
Mean age±SD(year)	48.1±15.6	47.2±14.5	47.6±14.9	0.461+
Sex (Female/Male)	9/24	14/27	23/51	0.630#
Mean stone size (mm)	16.4±7.7	11.0±2.9	13.4±6.1	0.043+
Duration of operation (min)	58.9 ±35.8	38.7±12.8	47.7±27.5	0.035+
Postoperative hospitalization (day)	1.8±1.8	1.20±0.5	1.4±1.3	0.483+

+Mann-Whitney test, #Chi Square

Table 2. Stone free rate and residual stone size of the groups.

	Group 1 (n=33)	Group 2 (n=41)	Total	P value
Stone free rate (%)	78.7	80.5	79.6	0.391#
Mean residual stone size±SD (mm)	12.5±2.1	6.5±1.7	8.5±3.4	0.004+
Major peroperative complications	3/33	0/41	3/74	0.006*
Push-back	4/33	1/41	5/74	0.165*

+Mann-Whitney test, #Chi Square, *Fisher-Exact test

al Shock Wave Lithotripsy (ESWL) and in 3 patients, retrograde intrarenal surgery (RIRS) was performed.

In group 1, two patients had a fever of over 38°C and one patient who had undergone open surgery developed a wound infection (Clavien I-II). Two patients switched to open surgery and 1 patient placed JJ stent due to ureteral perforation was considered Clavien 3b and Clavien 3a complications, respectively. In group two, 2 patients had a fever (over 38°C) (Clavien I-II). There were no major complications (Clavien III-V) in Group 2. There was no bleeding which required a blood transfusion in either of the groups. In the first month after the operation, one of the two patients who had ureteral stricture in group 1 underwent open surgery and the other had ureteral perforation. In group 2 there was only one patient who had a ureteral stricture. No perioperative complications were observed. (Table 3)

Table 3. Per-operative and postoperative complications.

	Group1 (n=33)	Group2 (n=41)
Fever	2	2
Hematuria	0	0
Need for open surgery	2	0
Transfusion	0	0
Ureteral stricture	2	1

Discussion

Today, in upper ureteral stones, the first choice is ESWL for stones with a size below 10 mm stones and ESWL or ureterorenoscopy for stones over 10 mm. The stone free rate is 70-89% for ESWL and 81-84% for rigid-semirigid URS [2,3].Youssef et al., compared ESWL and semirigid URS in a total of 427 patients with upper ureteral stones. They found the stone free rate to be 83.7% in the ESWL group and 88.4% in the semirigid URS group. The need for retreatment was 65% in the ESWL group and 2.3% in the URS group (p<0,001). The complication rates were 4.7% and 14% respectively in the ESWL and URS groups. The authors commented that ESWL is safer and less -invasive whilst URS is more effective and has a lower requirement rate for re-treatment [6].

In the endoscopic treatment of ureteral stones, pneumatic lithotripter has long been used during semirigid URS in many medical centers [7,8]. The success rate of pneumatic lithotripters for ureteral stones has been reported to be approximately 95-100%. This success rate is reduced as the localization becomes closer to the upper ureter [9,10]. In a study by Sozen et al, a total of 500 patients who had undergone semirigid URS with a pneumatic lithotripter. This was administered as a primary procedure in 124 patients (24.8%) and as a secondary procedure in the remaining 376 patients after ESWL. The overall stone free rate was 94.6%, however it was found to be 83.3% for upper ureteral stones. The authors reported that either after unsuccessful ESWL treatment or as a first line of treatment, semirigid URS with pneumatic lithotripter provided safe and effective treatment for ureteral stones [11]. Gunlusoy et al., reported that in a study consisting of 1296 patients, the success rates of pneumatic lithotripsy for upper, middle, and lower ureteral stones were 90.5%, 93.1%, and 98.1%, respectively (P < 0.05) [12]. In another recent study by Razzaghi et al., 112 patients were divided into a Ho-YAG laser (n=56) and a pneumatic group (n=56) and the mean stone size was found to be 11.7 and 10.0 mm respectively. In addition, the average stone fragmentation time was 13.7 minutes and 7.9 minutes (p<0,001) (4) with stone free rate of 100% and 42.9% in the Ho-Yag and pneumatic groups respectively. In a study by Jeon et al., data from patients who had undergone URS with pneumatic lithotripter (n=26) and laser lithotripter (n=25) were evaluated. In the early postoperative period the stone free rate was found to be 73.1% and 96.0%, respectively (p<0,049). After 3 months, this rate was 84.6% and 96.0% respectively (p=0,350). The mean operating time was found to be 76.9 minutes and 49.8 min respectively thus being significantly lower in the laser group (p=0.003) [13]. We did not examine the stone free rate in the early postoperative period. However, after 1 month after the operation, our stone free rate of 78.7% in pneumatic group and 80.5% in laser group (p=0.391) was similar to the findings in the literature. Similar to the current literature, our operating time was significantly lower for the laser group (58.9 min in group 1 vs 38.7 min in group 2, respectively, p=0.03).

One of the major disadvantages of semirigid URS is high possibility of stone push-back [14,15]. In a study by Razzaghi et al., while stone push-back was not detected in the laser lithotripter group, it was detected in 10 patients (17.9%) in the pneumatic lithotripter group. The authors reported that, particularly in upper ureteral stones, laser lithotripsy was established to be safer and more effective than the pneumatic lithotripter [4]. Similarly, Garg et al., found that the stone push back rate was 16% in the pneumatic lithotripter group and there was no such case [16]. In the present study, stone push back was found in 4 patients (12,1%) who had undergone pneumatic lithotripsy and in only one patient (3,2%) who had received laser lithotripsy. In recent years, in view of the aforementioned findings, particularly in upper ureteral stones, there is a tendency, in upper ureteral stones, to use laser lithotripsy.

There are many studies reporting a negative correlation between stone size and the success of treatment. However, there are also studies which report no association between stone size and success of treatment [17]. In our study, the groups were not analyzed separately according to their stone size. We think that the residual stone size was higher in the pneumatic group and this was associated with the larger preoperatively stone size. In our study, although there was no significant difference between the stone-free rates in the two groups, the most important difference was seen in the complication rates, and switch to open surgery was determined to be higher in patients in the pneumatic lithotripsy group. In pneumatic lithotripsy, the stone must be compressed between probe and mucosa. This is the most common cause of ureteral perforation [18,19]. However, this problem hardly occurs in laser lithotripsy procedure due to the semi-contact fragmentation [20,21]. Mucosal tissue lesions can be ignored because the tissue depth is very low during fragmentation with laser probe [22,23]. Razzaghi et al., found no difference was found between the pneumatic and laser lithotripsy groups in terms of complication rates [4]. However, Jeon reported that the complication rate was 7.7% in his study in relation to the pneumatic lithotripsy group, and there were no complications in the laser lithotripsy group [13]. In our clinics,

the arrival of the laser lithotripter in May 2012 has marked a major shift the choice of treatment by the surgeons.

To date, Open surgery was needed in two patients using pneumatic lithotripter. The larger average size of the stone in this group may also have affected the results. None of the patients in the laser lithotripsy group needed open surgery. Consistent with the current findings, according to our results the laser is safer. Degirmenci reported that in the proximal ureteral placement and impaction of the stones, the complication rate increases by 2.4 times and 4.3 times, respectively [24]. A study published by Binbay et al., compared the use of pneumatic and laser lithotripsy in impacted ureteral stones. A stone free rate was reported to be 80% and 97.5% respectively (p=0.03). The mean operating time was 48 and 30 minutes, respectively, which was significantly lower in the laser lithotripsy group (p<0.001) [25]. In this study, it was emphasized that the use of Ho:YAG as an intracorporeal lithotripter during the ureteroscopic management of impacted ureteral stones is highly efficient with high success rates, regardless of the location of the stone . In the present study, ureteral stones have not been evaluated separately according to whether or not they are impacted. However, the stone-free rate and the average duration of operation are consistent with these findings.

In conclusion, the overall success rate is high for the treatment of upper ureteral stones with semirigid URS. In terms of the success of the treatment, pneumatic and laser lithotripsy are effective methods. However, considering the duration of the operation, possibility of push-back and complication rates, laser lithotripsy can be regarded as safer. If the laser lithotripter is available in medical centers, we propose that it should be the first choice in the endoscopic treatment of the upper ureteral stones.

Competing interests

The authors declare that they have no competing interests.

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