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Comparison of Retrograde Intrarenal Surgery and Shock Wave Lithotripsy in the Treatment of 10-20 mm Lower Calyceal Stones: Retrospective Clinical Study

10-20 mm Alt Kaliks Taşlarının Tedavisinde Retrograd İntrarenal Cerrahi ve Şok Dalga Litotripsinin Karşılaştırılması: Retrospektif Klinik Çalışma

Fatih Kürşat YILMAZEL[a], Emre ŞAM[a], Fatih AKKAŞ[a]

[a]Department of Urology, University of Health Sciences Erzurum Regional Training and Research Hospital, Erzurum, TURKEY

ABSTRACT Objective: In our study, we aimed to compare the results of retrograde intrarenal surgery (RIRS), and shock wave lithotripsy (SWL) in the treatment of 10-20 mm lower calyceal stones. **Material and Methods:** The data of 42 patients who underwent RIRS or SWL for 10-20 mm solitary lower calyceal stones in Erzurum Regional Training and Research Hospital Urology Clinic between January 2018 and September 2019 were retrospectively analyzed. Twenty patients were treated with RIRS and 22 patients were treated with SWL. Both groups were compared in terms of demographic characteristics, clinical data, operative parameters, stone-free rate (SFR), need for re-treatment and auxiliary therapy, and complications. **Results:** Both groups were statistically comparable in terms of their demographic characteristics and stone characteristics. Postoperative SFR was 85% in the RIRS group and 77% in the SWL group. When compared in terms of the procedure time, the mean duration of RIRS was significantly longer when compared with the mean of one-session SWL duration ($p<0.001$). When compared with the RIRS group, 63.6% of the patients in the SWL group had a significant higher need for re-treatment, because they required a second session ($p<0.001$). Rates of auxiliary procedures applied were 22.7% in the SWL group and 15% in the RIRS group ($p=0.15$). The overall complication rates were 10% and 9.1% in the RIRS and SWL groups, respectively. **Conclusion:** RIRS and SWL are the preferred treatment methods in the treatment of 10-20 mm lower calyceal stones with similar SFR and complication rates.

Keywords: Kidney stone; lower calyx; retrograde intrarenal surgery; shock wave lithotripsy

ÖZET Amaç: Çalışmamızda, 10-20 mm alt kaliks taşlarının tedavisinde retrograt intrarenal cerrahi [retrograde intrarenal surgery (RIRS)] ve şok dalgası litotripsi [shock wave lithotripsy (SWL)] sonuçlarını karşılaştırmayı amaçladık. **Gereç ve Yöntemler:** Ocak 2018-Eylül 2019 tarihleri arasında Erzurum Bölge Eğitim ve Araştırma Hastanesi Uroloji Kliniğinde, 10-20 mm boyutlarında soliter alt kaliks taşı nedeniyle RIRS veya SWL tedavisi uygulanan 42 hastanın verileri retrospektif olarak incelendi. Hastaların 20'sine RIRS, 22'sine ise SWL tedavisi uygulandı. İki grup; demografik özellikler, klinik veriler, operatif parametreler, taşsızlık oranı [stone-free rate (SFR)], yeniden ve yardımcı tedavi uygulanma ihtiyacı ve komplikasyonlar açısından karşılaştırıldı. **Bulgular:** Demografik karakteristikler ve taş özellikleri açısından her iki grup istatistiksel açıdan benzerdi. Postoperatif SFR, RIRS grubunda %85, SWL grubunda %77 olarak belirlendi. İşlem süresi açısından karşılaştırıldığında RIRS'nin, 1 seans SWL süresine göre anlamlı derecede yüksek olduğu izlendi ($p<0,001$). SWL grubunda hastaların %63,6'sında 2. seans gerekmesi nedeniyle yeniden tedavi ihtiyacı, RIRS'ye göre anlamlı daha yüksek izlendi ($p<0,001$). Yardımcı prosedür uygulanma oranı SWL'de %22,7; RIRS grubunda %15 olarak saptandı ($p=0,15$). Genel komplikasyon oranı, RIRS ve SWL grubunda sırasıyla %10 ve %9,1 olarak izlendi. **Sonuç:** RIRS ve SWL, benzer SFR ve komplikasyon oranı ile 10-20 mm alt kaliks taşlarının tedavisinde tercih edilebilir tedavi yöntemleridir.

Anahtar Kelimeler: Böbrek taşı; alt kaliks; retrograt intrarenal cerrahi; şok dalgası litotripsi

Prevalence of lifelong kidney stones in adults is common with a rate of 10%.[1] The choice of treatment for kidney stones is made according to the stone size, anatomy of the pelvicalyceal system of the affected kidney, the availability of equipment, and the common preference of the clinician and the patient.[2] The aim of kidney stone treatment should always be to achieve a high stone-free rate (SFR) and low com-

Correspondence: Emre ŞAM
Department of Urology, University of Health Sciences Erzurum Regional Training and Research Hospital, Erzurum, TURKEY/TÜRKİYE
E-mail: emresam@yahoo.com

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plication rate. The treatment of lower calyceal stones is more complex because of its difficult anatomy. The ideal treatment modality remains controversial and depends on several factors such as calyceal anatomy, stone size, body habitus, and comorbidities.[3]

Retrograde intrarenal surgery (RIRS) and extracorporeal shock wave lithotripsy (SWL) are the most commonly used treatment options for 10-20 mm kidney stones.[4] The current European Association of Urology guideline recommends SWL or endourological treatment alternatives [percutaneous nephrolithotomy (PNL) or RIRS] for 10-20 mm kidney stones (excluding lower calyceal stones). Both RIRS and SWL are recommended as equivalent treatment options for 10-20 mm lower calyceal stones in the absence of challenging anatomical factors known to adversely affect the success of SWL.[2]

SWL is a non-invasive treatment method with high patient compliance and low morbidity without any need for anesthesia.[5] However, the SFR of SWL appears to be lower for lower calyceal stones compared to renal stones in other locations. In addition, steep infundibulopelvic angle, long calyx, increased skin-to-stone distance, narrow infundibulum, and SWL-resistant stones negatively affect SWL success.[2] The development of semirigid and flexible ureterorenoscopes and laser technology is increasing the popularity of endourological treatment methods every day. Although RIRS requires anesthesia contrary to SWL, thanks to its higher SFR and acceptable complication rates, it has become more frequently applied by clinicians.[6,7] In this study, we aimed to compare the efficiency and safety of SWL and RIRS in patients with 10-20 mm lower calyceal stones.

MATERIAL AND METHODS

After the approval of the Atatürk University Faculty of Medicine Clinical Research Ethics Committee (date: 4/3/2021, approval number: B.30.2.ATA.0.01.00/30), the data of patients who underwent RIRS or SWL for 10-20 mm solitary lower calyceal stones in Erzurum Regional Training and Research Hospital between January 2018 and September 2019, were retrospectively analyzed. Our study have been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Non-contrast computed tomography (CT) and intravenous urography were used for primary diagnosis and treatment plan. Stone characteristics or anatomical factors such as stone size, stone density, infundibulopelvic angle, infundibular length, stone-skin distance, and infundibular width were determined using these 2 imaging methods. The infundibulopelvic angle was determined by measuring the angle between the vertical axis connecting the central axis of the ureteropelvic region and the central axis of the upper ureter, and the vertical axis of the lower calyx, where the stone is located, using the method described by Sampaio et al.[8] Infundibular width and length were determined by the method described by Elbahnasy et al. The infundibular width was determined as the narrowest diameter of the lower calyx where the stone was located. The infundibular length was determined as the distance between the most distal end of the lower calyx, where the stone is located, and the middle of the lower lip of the renal pelvis.[9] The stone-skin distance was calculated by averaging the three distances measured on CT as 0°, 45°, and 90° from the center of the stone to the skin. Stone density (Hounsfield unit) was calculated with region of interest, which covers the entire area of the stone in axial CT images showing the largest diameter of the stone.

Patients with congenital kidney anomalies, solitary kidney, calyceal diverticulum, ureteropelvic junction obstruction were excluded from the study. Additionally, patients with steep infundibulopelvic angle (90° or less), long infundibulum (3 cm and longer), increased skin-to-stone distance (10 cm and longer) and, narrow infundibulum (5 mm and shorter), which are known to negatively affect the success of SWL in the management of lower calyceal stones, were also excluded from the study. In addition, patients who had a D-J stent pre-operatively were excluded from the study. As a result, 20 patients who underwent RIRS and 22 patients who underwent SWL were included in the study.

Before the treatment, urine cultures were obtained from the patients and the patients with bacter-

ial growth in their urine cultures were given antibiotic therapy to obtain a negative urine culture. Hemogram and coagulation parameters of all patients were examined before treatment. A single dose of intravenous prophylactic antibiotic (2nd or 3rd generation cephalosporin) was administered to the patients before RIRS.

The presence of residual fragments was investigated by ultrasonography (USG) in non-opaque stones and kidney-ureter-bladder (KUB) radiography and USG in opaque stones at 3 months after treatment. CT was used in symptomatic patients and/or in patients with suspected kidney or ureteral stones on KUB/USG. Demographic characteristics, stone-related features (laterality, localization, and size of the stone), procedure time, SFR, need for re-treatment and auxiliary therapy, and complications were compared between both groups. Cases with clinically insignificant residual fragments smaller than 3 mm were accepted as stone-free.[10] Second session SWL or repeated RIRS application was defined as re-treatment. Applying a treatment modality different from the first one to ensure stone-free status was defined as the use of auxiliary therapy. Complications were classified according to the Clavien-Dindo grading system.[11]

SHOCK WAVE LITHOTRIPSY TECHNIQUE

Oral diclofenac sodium (dosage: 50 mg for <70 kg, and 100 mg for >70 kg) was administered 60 minutes before the SWL sessions. Before SWL, KUB and USG were used to determine the localization of the stone, and continuous position analysis was performed during the session. Wolf Piezolith-3000 (Richard Wolf GmbH, Knittlingen, Germany) device was used. A maximum of 3,000 shocks were delivered at a rate of 60-90 shocks/min. A maximum of 3 SWL sessions were applied. The patients were discharged after the procedure.

RETROGRADE INTRARENAL SURGERY TECHNIQUE

RIRS was performed under general or spinal anesthesia using a 7.5 Fr FLEX-X2 flexible ureterorenoscope (Karl Storz, Tuttlingen, Germany). Ureteral access sheath (9.5/11.5 Fr or 11/13 Fr) was used in all cases. Stones were placed in a more suitable place in the pelvis or upper pole using a 2.2 F nitinol stone basket to provide better focusing during lithotripsy.

If the stone could not be mobilized, it was broken into several pieces and then repositioned to be fragmented into smaller pieces. Lithotripsy was performed with 272 µ fiber holmium:yttrium-aluminum-garnet laser (Quanta System™, Varese, Italy). Lithotripsy was applied using 0.5-1.2 J energy and 8-12 Hz frequency. At the end of the operation, a 28 cm 4.8 Fr JJ stent was placed routinely. The patients were discharged on the morning of the first postoperative day. The JJ stent was removed in an average of 2-4 weeks.

STATISTICAL ANALYSIS

Continuous variables were presented as mean and standard deviation; and categorical variables as numbers and percentages. The mean of independent groups was compared by the Student t-test. Percentages of categorical variables were compared using the Pearson chi-square or Fisher's exact test. A p value of less than 0.05 was considered as statistically significant. Statistical analysis was performed using SPSS for Windows version 18.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

A significant difference was not observed between the 2 groups in terms of demographic features and stone characteristics (Table 1). When comparing

TABLE 1: Comparison of demographic features, and stone characteristics.

Variables	SWL	RIRS	p value
Patients, n	22	20	
Age (mean±SD), years	43.6±14.5	47.5±12.7	0.361
BMI (mean±SD), kg/m^2	26.8±1.43	26.9±1.48	0.857
Gender n (%)			
Male	14 (63.6)	12 (60.0)	0.808
Female	8 (36.4)	8 (40.0)	
Laterality, n (%)			
Right	10 (45.5)	8 (40.0)	0.721
Left	12 (54.5)	12 (60.0)	
Stone size (mean±SD), mm	14.7±1.66	15.2±1.96	0.404
Stone density (mean±SD), HU	976.2±248	991.9±280	0.848

SD: Standard deviation; BMI: Body mass index; HU: Hounsfield unit; SWL: Shock wave lithotripsy; RIRS: Retrograde intrarenal surgery.

RIRS with a single-session SWL, the mean procedure time (RIRS 78.2±20.6 min vs SWL 45.3±5.06 min) was significantly longer for RIRS (p<0.0001). In 63.6% of the patients who underwent SWL, the rate of re-treatment was significantly higher relative to RIRS due to the requirement of a second session (p<0.001). In addition, due to the failure of the laser device during the operation, a JJ stent was placed in 1 patient in the RIRS group; subsequently, the device malfunction was resolved and a 2nd session RIRS was applied. Although the postoperative 3rd-month SFRs were higher in the RIRS group compared to the SWL group, the difference was not significant (p=0.70). Treatment results are summarized in Table 2.

After unsuccessful SWL, PNL was performed in 3 out of 5 patients in whom auxiliary therapy modalities were applied. RIRS was performed in 1 patient because the residual fragments were too large to be suitable for spontaneous passage. Steinstrasse developed in 2 patients. While semirigid ureteroscopic lithotripsy was applied in 1 patient, the residual fragments passed spontaneously in the other patient. The procedural failure was observed in 3 patients in the RIRS group, and one of these patients underwent PNL because the flexible ureterorenoscope could not reach the calyx containing the stone. In the other two cases, SWL was applied because the residual fragments after RIRS were larger than 4 mm.

The overall complication rates were 10% and 9.1% in the RIRS and SWL groups, respectively. In a patient with high fever in the RIRS group, treatment was continued with antipyretics and prophylactic antibiotics after blood and urine cultures were obtained. One patient who developed hematuria was treated conservatively without the need for blood transfusion. After the development of Steinstrasse in 2 patients after SWL, ureteroscopic lithotripsy was performed in 1 patient, and the residual fragments passed spontaneously in the other patient. The complication rates between the groups are shown in Table 3.

TABLE 2: Comparison of procedure time, and treatment outcomes of the groups.

Variables	SWL	RIRS	p value
SFR, n (%)	17 (77.3)	17 (85)	0.700
Retreatment, n (%)	14 (63.6)	1 (5.0)	<0.001
Auxiliary treatment, n (%)	5 (22.7)	3 (15)	0.700
Procedural time (mean±SD,) minutes	45.3±5.06	78.2±20.6	<0.001

SD: Standard deviation; SFR: Stone-free rate; SWL: Shock wave lithotripsy; RIRS: Retrograde intrarenal surgery.

TABLE 3: Intergroup comparisons of complications.

Complications	SWL	RIRS
Fever (Clavien I), n (%)	0 (0)	1 (5)
Hematuria (Clavien I), n (%)	0 (0)	1 (5)
Steinstrasse (Clavien 3a), n (%)	2 (9.1)	0 (0)
Total	2 (9.1)	2 (10)

SWL: Shock wave lithotripsy; RIRS: Retrograde intrarenal surgery.

DISCUSSION

Due to its non-invasive nature, low morbidity, and potential outpatient treatment, SWL has been highly accepted by patients and physicians.[12,13] Due to these advantages, it is still one of the treatment options in the management of lower calyceal stones, despite lower SFR and higher re-treatment rates.[14] In our study, we compared SWL and RIRS in the treatment of 10-20 mm lower calyceal stones. The mean procedure time of the RIRS group was significantly longer than the single-session SWL. This result is consistent with the other studies published in the literature.[15-17]

In our study, SFR was found to be 85% in the RIRS and 77.2% in the SWL group, and this result is consistent with the studies published in the literature.[14,18] Although the RIRS group appeared to be successful in terms of 3-month SFR compared to the SWL group, the intergroup difference was not significant. This is likely due to the lack of a sufficient sample size. The re-treatment rate was significantly higher in the SWL group than the RIRS group, and also consistent with the literature.[14,15,18] These data show that RIRS may be more effective and preferable when compared with SWL considering its lower re-treatment and higher SFR.

Since RIRS is a more invasive procedure than SWL, a higher complication rate can be expected. In

our study, complication rates were analyzed in both intervention groups and although the complication rate was slightly higher in RIRS, the intergroup difference was not significant. All complications were managed with conservative therapy or endoscopic techniques. The results of our study showed that both treatment modalities are reliable as indicated in the literature.[14,15,18-20] Steinstrasse is a complication that can affect 2% to 10% of patients who are undergoing a SWL procedure. It increases the frequency of auxiliary procedures after SWL and therefore it is one of the disadvantages of SWL.[21] This complication is directly related to increased stone burden and was observed in 2 patients in the SWL group in our study. An auxiliary procedure (ureteroscopic lithotripsy) was applied to one of these cases.

In our study, there was no significant difference observed between the treatment modalities in terms of the rates of auxiliary procedures applied in both groups. These data in our study are quite consistent with the results of a previous study by El-Nahas et al.[14] Another detail we observed in our study is that SWL and RIRS complement each other as an auxiliary procedure in the treatment of significant residual fragments that cannot be removed after treatment.

There are some limitations in our study; the first is that it is a retrospective study and the sample size we described was relatively small for patients treated with 10-20 mm lower calyceal kidney stones. Additionally, since USG and KUB have limited accuracy in detecting residual fragments after treatment, this may have led to erroneous estimates of the SFR in the present study.

CONCLUSION

RIRS and SWL are the preferred treatment modalities in the treatment of 10-20 mm lower calyceal stones with similar SFR and complication rates. Both modalities were complementary for the treatment of residual fragments. Prospective randomized studies with a larger sample size comparing RIRS and SWL should be performed to determine the first-line treatment for 10-20 mm lower calyceal stones.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Fatih Kürşat Yılmazel, Emre Şam, Fatih Akkaş;* ***Design:*** *Fatih Kürşat Yılmazel, Emre Şam, Fatih Akkaş;* ***Control/Supervision:*** *Fatih Kürşat Yılmazel;* ***Data Collection and/or Processing:*** *Emre Şam, Fatih Akkaş;* ***Analysis and/or Interpretation:*** *Fatih Kürşat Yılmazel, Emre Şam, Fatih Akkaş;* ***Literature Review:*** *Fatih Kürşat Yılmazel, Emre Şam, Fatih Akkaş;* ***Writing the Article:*** *Fatih Kürşat Yılmazel, Emre Şam, Fatih Akkaş;* ***Critical Review:*** *Fatih Kürşat Yılmazel;* ***References and Fundings:*** *Fatih Kürşat Yılmazel, Emre Şam, Fatih Akkaş;* ***Materials:*** *Fatih Kürşat Yılmazel.*

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