A Prospective, Randomized Comparison of Shock Wave Lithotripsy, Retrograde Intrarenal Surgery and Miniperc for Treatment of 1 to 2 cm Radiolucent Lower Calyceal Renal Calculi: A Single Center Experience

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Abbreviations and Acronyms

CT = computerized tomography

DJ = Double-J®

EQ = efficiency quotient

PCNL = percutaneous nephrolithotomy

RIRS = retrograde intrarenal surgery

SFR = stone-free rate

SWL = shock wave lithotripsy

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Study received institutional ethical board approval.

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Purpose: A prospective, randomized comparison of shock wave lithotripsy, retrograde intrarenal surgery and miniperc for the treatment of 1 to 2 cm radiolucent lower calyceal renal calculi was done to evaluate the safety and efficacy of these procedures.

Materials and Methods: Patients with a single 1 to 2 cm radiolucent lower calyceal renal stone who underwent treatment between January 2012 and May 2013 were included in study. They were randomized to shock wave lithotripsy, retrograde intrarenal surgery and miniperc groups. Patient demographic profiles, success and re-treatment rates, auxiliary procedures and complications were analyzed.

Results: A total of 45 patients were enrolled in each of the shock wave lithotripsy, retrograde intrarenal surgery and miniperc groups. Three, 2 and 4 patients, respectively, were excluded from final analysis due to a matrix stone diagnosis. Mean procedure and fluoroscopy times were significantly greater in the miniperc group than in the other groups. Hospital stay (3.1 days vs 3.1 hours and 1.3 days, $p = 0.01$) and the blood transfusion rate (13.3% vs 0% and 0%, $p = 0.03$) were significantly higher for miniperc vs shock wave lithotripsy and retrograde intrarenal surgery, respectively. The re-treatment rate (63.4% vs 2.1% and 2.2%, $p < 0.001$) and the auxiliary procedure rate (20.2% vs 8.8% and 6.6%, $p = 0.02$) were significantly greater for shock wave lithotripsy than for retrograde intrarenal surgery and miniperc, respectively. The 3-month stone-free rate of shock wave lithotripsy, retrograde intrarenal surgery and miniperc was 73.8% (31 of 42 patients), 86.1% (37 of 43) and 95.1% (39 of 41), respectively ($p = 0.01$).

Conclusions: Miniperc and retrograde intrarenal surgery were more effective than shock wave lithotripsy to treat 1 to 2 cm radiolucent lower calyceal renal calculi in terms of a better stone-free rate, and lesser auxiliary and re-treatment rates. However, miniperc resulted in more complications, greater operative time and radiation exposure, and a longer hospital stay.

Key Words: kidney; nephrolithiasis; lithotripsy; surgical procedures, operative; nephrostomy, percutaneous

Currently SWL, RIRS and PCNL are the mainstays of renal stone management. The 2014 EAU (European Association of Urology) urolithiasis guidelines state that for radiopaque renal stones greater than 2 cm PCNL

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is the first choice and for stones less than 1 cm SWL or RIRS is the first choice. For stones between 1 and 2 cm SWL, RIRS and PCNL are options depending on favorable and unfavorable anatomical and stone factors.

SWL, the least invasive stone treatment, has a short-term and long-term SFR of 67% to 93% and 57% to 92%, respectively, with a re-treatment rate of 13.9% to 53.9% and an auxiliary procedure rate of 7% to 33%.[1] Although PCNL is more invasive, it is safe and has a higher SFR of 60% to 100%, and the higher complication rate related to access tract number and size is decreased by the availability of the miniature nephroscope and the miniperc technique.[2,3] RIRS is now accepted as an attractive treatment option for moderate sized stones with an excellent SFR while avoiding the morbid complications of PCNL.[4]

No specific guideline is available regarding the surgical management of radiolucent renal stones. Others have retrospectively compared SWL, RIRS and percutaneous nephrolithotomy for radiolucent renal stones.[5] However, to our knowledge we report the first prospective study based on a thorough review of the literature to compare the safety and efficacy of SWL, RIRS and miniperc for treating lower calyceal radiolucent calculi.

MATERIAL AND METHODS

This prospective, randomized comparative study received institutional ethical board approval. Included in study were consecutive patients who presented to the urology outpatient department with a single lower calyceal radiolucent renal stone between January 2012 and May 2013, and in whom RIRS, SWL or miniperc was planned. Inclusion criteria included age greater than 15 years and a single 1 to 2 cm radiolucent lower calyceal renal stone. Patients with coagulopathy, radiopaque stones, active urinary tract infection, severe comorbidity that would interfere with positioning during SWL or general anesthesia during RIRS and miniperc, anatomical renal anomaly, coexisting ureteral pathology or a matrix stone and those who did not provide written informed consent were excluded from analysis.

Eligible patients were randomized to SWL, RIRS or miniperc using a computer generated randomization table of equal numbers. Initial evaluation comprised medical history, physical examination, urinalysis, hemogram, serum chemistry, serum calcium, serum phosphate, serum uric acid and 24-hour urinalysis for calcium, phosphate, uric acid and citrate. Ultrasound of the kidneys, ureters and bladder, plain x-ray of the kidneys, ureters and bladder, and CT urogram (noncontrast CT if contrast medium was contraindicated) were done to assess stone characteristics and renal anatomy.

SWL Procedure

SWL was performed on an outpatient basis using the Alpha Compact electromagnetic lithotripter (Dornier MedTech, Wessling, Germany) with an integrated ultrasound system. A eutectic mixture of lidocaine and prilocaine (5 gm) was applied on an approximately 30 cm^2 area of skin corresponding to the entry site of shock waves 60 minutes before the procedure. The stone was localized and fragmentation was monitored using an integrated ultrasound device with a 3.5 to 5 MHz probe. The shock wave delivery rate was 90 pulses per minute with a maximum of 2,500 shock waves per session. Patients remained under observation for 2 hours after SWL. To assess stone fragmentation and clearance ultrasound of the kidneys, ureters and bladder was performed 3 weeks after SWL. For incomplete clearance SWL was repeated up to a maximum of 4 sessions.

RIRS Procedure

All procedures were done by 1 consultant urologist (AK) experienced with the technique and with the patient under general anesthesia. For RIRS an 8/9.8Fr dual channel flexible Cobra ureteroscope (Richard Wolf, Vernon Hills, Illinois) was used with a 12Fr ureteral access sheath. If required, the ureteral orifice was dilated with a balloon catheter. The 100 W VersaPulse® holmium laser was used for intracorporeal lithotripsy with a 200 μm fiber and a 2.2Fr nitinol stone basket for fragment removal. The holmium laser power setting was 0.5 to 1 J with the pulse rate set at 20 to 40 Hz. In patients with a large stone burden or pelvicalyceal extravasation/perforation a DJ stent remained in situ and was removed at 4 weeks. Stone clearance was confirmed on ultrasound of the kidneys, ureters and bladder done 3 weeks after RIRS. Noncontrast CT was performed to calculate SFR.

Miniperc Procedure

All procedures were performed by 1 consultant urologist (AK) experienced with the technique and with the patient under general anesthesia. A 5Fr open-ended ureteral catheter was placed in the renal pelvis with the patient in the lithotomy position. The patient was then positioned prone and all pressure points were padded. Contrast medium was infused via the ureteral catheter to assess pelvicalyceal system anatomy. Using the bull's-eye technique the selected superior or inferior calyx was punctured under fluoroscopy guidance with an 18 gauge needle and the puncture tract was dilated to 18Fr. A 15Fr miniature nephroscope (Richard Wolf) was used with a pneumatic LithoClast®. Stone fragmentation and clearance were confirmed under direct vision. A 12Fr nephrostomy tube remained in situ for drainage and was removed after urine was clear.

Failure was defined as a residual calculus greater than 4 mm at 3 months. An auxiliary procedure was considered any method other than the primary treatment to render the patient stone free. For failed SWL the auxiliary procedures were ureteroscopy/RIRS/miniperc. For failed RIRS the auxiliary procedure was SWL/DJ stenting. For failed miniperc SWL/ureteroscopy/DJ stenting were used as auxiliary procedures. Stone analysis was done in all cases in the 3 groups.

Parameters included in analysis were patient demographics (mean age, gender and body mass index), perioperative data (mean stone location and size, operative