Management of 1-2 cm renal stones

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ABSTRACT

Introduction: The preferred treatment of <1cm stone is shockwave lithotripsy (SWL), while that of stone >2 cm is percutaneous nephrolithotomy (PCNL), but treatment of 1-2 cm renal stones is a controversial issue. We searched the literature to present a comprehensive review on this group.
Material and Methods: Pubmed search of literature was done using the appropriate key words. We separately discussed the literature in lower polar and non lower polar stone groups.
Results: For non lower polar renal stones of 1-2 cm, SWL is preferred approach, while for the lower polar stones; literature favors the use of PCNL. Retrograde intrarenal surgery (RIRS) is emerging as a promising technique for these calculi.
Conclusions: Treatment of renal stone disease depends on stone and patient related, as well as on renal anatomical factors. Treatment should be individualized according to site of stone and available expertise.

Key words: 1-2 cm, percutaneous nephrolithotomy, renal stones, retrograde intrarenal surgery, shockwave lithotripsy

INTRODUCTION

The primary goal while treating renal stones is to achieve maximum clearance of stone, while causing minimal morbidity to the patient. Various minimally invasive modalities are described for this, like shockwave lithotripsy (SWL), percutaneous nephrolithotomy (PCNL), and retrograde intrarenal surgery (RIRS).[1,2] The preferred approach for stones <1 cm is SWL, whereas for stones >2 cm, it is PCNL, but the management of stones of 1-2 cm is still controversial.[3] Addition of RIRS in the armamentarium in the last two decades has enhanced the dilemma further. We therefore reviewed the literature to formulate guidelines about this controversial issue.

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METHODOLOGY OF REVIEW

A Pubmed search was performed in February 2012, using the terms renal calculi, 1-2 cm, <2 cm, PCNL, SWL, ureteroscopy, and RIRS. Articles were reviewed after determining their relevance for the management of small- to medium-sized stones. Cross-references from the articles were also viewed. We reviewed the available literature for the management of lower polar and nonlower polar stones separately because of the reported poor clearance and difficult access for stones in the lower pole.[4]

Non lower polar caliceal calculi

Shock wave lithotripsy

SWL is a traditionally favored approach for small- to moderate-sized intrarenal calculi. For small stones with a maximum diameter of 20 mm, SWL had been established as the standard procedure, as it is noninvasive, has a low rate of complications, and does not require anesthesia.[1,2]

The most important factors which affect the outcome of SWL are stone burden and stone location. Various studies have concluded that the results of SWL are satisfactory if the size of stone is <2 cm, especially in nonlower polar location.[5,6] The highest clearance is achieved with calculi in the renal pelvis and at the pelvi ureteric junction (PUJ).[7] The overall stone-free rates (SFRs) observed with SWL are 86 to 89% (renal pelvis), 71 to 83% (upper calyx), 73 to 84% (middle calyx), and 37 to 68% (lower calyx).[1] To know the more powerful predictor of the success of SWL between stone burden and stone location, Khalil studied 438 patients.[8] The SFR for stones in the renal pelvis, lower, middle, and upper calices were 72.4, 56, 55.6, and 69%, respectively, whereas that for stones 1 cm, 1.1 to 2 cm, and >2 cm were 50.2, 39.6, and 10.2% ($P < 0.05$). The author concluded that stone burden rather than stone location is a more important predictor of the outcome of SWL.

Apart from the stone location and size, other factors including pelvicaliceal anatomy, stone composition, and patient characteristics [e.g., body mass index (BMI)] may also influence the outcome of SWL.[1-3] SWL for uric acid and calcium oxalate dihydrate stones results in a better coefficient of fragmentation than those composed of calcium oxalate monohydrate and cystine. The success rates between these two groups were shown to be 38 to 81% and 60 to 63%, respectively.[9] Krishnamurthy *et al*. evaluated the results of SWL in 211 patients with solitary pelvic stones of <2 cm according to their radiodensity (RD) in computed tomography and X-ray KUB (KUB: Kidney, ureter, and bladder).[10] They found that SFRs were similar for stones between 1 and 10 mm regardless of RD, but it was affected in patients with stones of 1-2 cm. Ackermann *et al*. evaluated 210 patients who had SWL monotherapy and found that the BMI significantly influenced the outcome.[11] Complications of SWL include steinstrasse, hematoma, infection, hypertension, and diabetes mellitus.[12] Contraindications for this treatment are pregnancy, severe skeletal malformations, severe obesity, and urinary tract obstruction distal to the stone.[9]

SWL versus percutaneous nephrolithotomy

In a case control study comprising 390 patients treated with PCNL and 618 patients with SWL, Saxby *et al*. have found a greater overall rate of success in the PCNL group (odds ratio: 2.67, $P < 0.001$), but for stones <2 cm, SWL had been found to be more satisfactory, cheaper, and a less morbid procedure, making it a treatment of choice for this group of patients.[5] Rao *et al*. compared the cost effectiveness of PCNL and SWL for renal stones of <2 cm.[6] PCNL was significantly more efficient in clearing calculi (94 vs. 69%) than SWL. Whereas patients in the PCNL group required a single sitting, those in the SWL group required more readmission (average: 2.05) and more ancillary procedures (35 patients in the SWL vs. 1 in the PCNL group). This, along with the increased initial cost of lithotripter, made the SWL a costlier procedure than PCNL. Moreover, complete stone clearance is more important in developing countries where patient compliance and follow-up are low.

In a randomized study, Deem *et al*. compared the outcome of SWL and PCNL in patients with 1-2 cm upper and middle-pole renal calculi.[7] The SFR at one week was 95% for PCNL and 17% for SWL, where SFR at three months was 85% for PCNL and 33% for SWL groups, respectively. Patients who had undergone PCNL reported a better quality of life than their counterparts. The authors suggested that PCNL should be offered as a treatment option to all patients with moderate-sized renal stones in a center with an experienced urologist and if SWL is contraindicated.

The main advantage of PCNL is its higher rate of success, which is not dependent on stone burden or composition.[9,13] On the other hand, the major factors limiting the use of PCNL is its technically demanding nature and higher morbidity than SWL. There is a steep learning curve to obtain renal access. Usually the competence to perform PCNL is reached after 60 cases and excellence is obtained after >100 cases.[14]

To reduce the invasiveness of conventional PCNL, the use of miniaturized instruments [minipercutaneous (miniperc)] has been evaluated.[15-17] Various authors have found the rate of success in the range of 89-96% with this technique.[15,16,18] Mishra *et al*. prospectively compared the outcome of miniperc and standard PCNL for the treatment of 1 to 2 cm-sized renal stones and found an SFR of 96 and 100%, respectively.[18] The study demonstrated the significant advantages of miniperc in terms of reduced bleeding, analgesic requirement, and hospital stay. Due to low morbidity, some authors have suggested miniperc as an alternative to SWL for renal calculi of size 1-2 cm in the renal pelvis and calyces,[17] although this should be interpreted with caution.

Role of retrograde intrarenal surgery

In the recent years, RIRS has emerged as an alternative therapy to treat renal calculi. Advancement in ureteroscopy has now enabled unrestricted access to calculi at virtually all locations in the urinary tract.[19] Failed SWL and the inability to undergo SWL (i.e., due to pregnancy, coagulopathy, or morbid obesity) are recognized as indications for ureteroscopy.[20] For renal stones measuring less than 2 cm, the stone clearance rate for RIRS was as good as that for SWL as a primary procedure, and a good clearance rate was also achieved following the failure of SWL.[21]

While comparing the outcome of RIRS with that of PCNL, Chung *et al*. found similar operative time and complications in both the groups.[22] The SFR was higher for the PCNL than RIRS group (87 vs. 67%), but the difference was insignificant ($P = 0.36$). Ferroud *et al*. compared the results of RIRS with that of miniperc in 144 patients.[23] The SFR was 88% in the RIRS group and 93% in the miniperc group ($P = 0.17$). Whereas the required hospital stay was more for the miniperc group, the patients in the RIRS group needed more complementary treatment for residual stones. Several authors have found a good outcome of RIRS in pediatric renal calculi also.[19]

Flexible ureteroscopy is limited by the narrowness of both the irrigation and the working channels, and the limited deflection, although newer instruments are gradually overcoming these obstacles.[3] The introduction of holmium laser lithotripsy now allows for the fragmentation of all stone types, converting them to dustlike particles, negating the need for removal of fragments. Ureteroscopy offers the low morbidity of SWL along with the potential for SFRs approaching those of PCNL for small- to moderate-sized renal calculi. Other factors such as stone density, the BMI of the patient, previous SWL, and lower pole anatomy might favor ureteroscopy in certain cases. Other specific circumstances where ureteroscopy might be useful are the stones in a caliceal diverticulum or in a horseshoe kidney, where SFRs with SWL are typically low due to poor clearance of fragments.[20]

Lower pole caliceal stones

SWL

SWL is the initial treatment of choice for most of the small-to moderate-sized renal calculi, but its use for lower pole caliceal stones (LPCSs) is controversial. The reported clearance rate of SWL for LPCS is 25-85%.[2] The stone clearance decreases with increase in stone size. In a meta-analysis, Lingeman *et al*. found SFR of 74% for stones <1 cm and 56% for 1-2 cm stones after SWL.[13] Kupeli *et al*. reported an overall SFR of 53% with SWL for inferior caliceal stone, 62% for sones of <1 cm, and 48% for 1-2 cm stones.[24] May and Chandhoke reported SFR of 75% for stones <2 cm after SWL.[25]

Sampaio and Aragao and Elbahnasy *et al*. suggested that caliceal anatomy is an important factor to predict the success of SWL for LPCSs, but other authors reported no significance for either radiographic anatomy or stone bulk.[26-29] Srivastava *et al*. evaluated the effect of these two factors prospectively for LPCSs of <2 cm as the predictor for successful stone clearance.[30] At three months, 78.8% renal units were clear of stones. On intravariable analysis, various anatomical parameters like infundibulopelvic angle, infundibular diameter, and length were significant, but on multivariate analysis, stone size was the most significant predictor of stone clearance.

Although the disintegration efficacy of SWL is not limited to the lower pole compared to other locations, the fragments often remain in the calyx and lead to recurrent formation of stone.[2] Several investigators described the measures to improve the clearance of fragments from the lower pole, like the technique of percussion, dieresis, and inversion (PDI) or placing a retrograde or percutaneous catheter directly in the lower pole to flush out the stone fragments.[3] Chiong *et al*. analyzed the effect of PDI therapy after SWL in LPCSs of <2 cm.[31] The SFR at three months after SWL in the SWL group was 35.4% and in the SWL plus PDI group was 62.5% ($P = 0.006$).

SWL versus PCNL

One of the initial studies, which compared the results of PCNL with SWL for LPCSs, includes that of Mc Dougal *et al*.[4] They noted a higher SFR for PCNL than SWL (86.2 vs. 54.3%). Netto *et al*. also found similar results, but as SWL is less morbid and does not require anesthesia or hospitalization, they considered it to be the method of choice for LPCS of <2 cm.[32] In 1994, Lingeman *et al*. published a landmark meta-analysis, which included a total of 17 studies on LPCSs.[13] They found an overall SFR of 59.2% for SWL and 90% for PCNL. For stones of 1-2 cm, the SFRs were 56 and 89% for SWL and PCNL, respectively. On logistic regression analysis, they found that the SFR in PCNL was not dependent on stone size. Based on this data, the authors recommended PCNL for LPCSs >1 cm. In the review published by Cass *et al*., the success of PCNL for LPCSs was found in the range of 70.5 to 100%.[33]

The landmark study which compared the outcome of PCNL with SWL for LPCSs was done by Abala *et al*. (Lower pole study 1).[34] It was a multicentric prospective randomized trial comparing these two approaches for LPCSs of <3 cm. Randomization was done according to size <1 cm, 1-2 cm, and 2-3 cm. The SFR was significantly better for PCNL group (95 vs. 37%), but the morbidity did not differ significantly. For stones of <1 cm, 1-2 cm, and 2-3 cm, the success was 63, 23, and 14% for the SWL group and 100, 93, and 86% for the PCNL group, respectively. The SFR of SWL was only acceptable for stone size <1 cm. This study reinforced the recommendation of PCNL for the treatment of LPCSs of >1 cm. In the Cochrane review, Srisubat *et al*. calculated the overall efficacy quotient (EQ) for the Abala group, and found it as 28% for SWL and 86% for PCNL.[1] The EQ for 1-2 cm stones was reported to be 17 and 88% for SWL and PCNL, respectively.

The changing trend of management for LPCSs has been documented in some studies. Gerber *et al*. (2003) reported that two-thirds of the American urologists preferred SWL for LPCSs of 1-2 cm, whereas Bandi *et al*. (2008) reported that more urologists preferred PCNL for the same.[35,36] Recent studies also recommend PCNL for LPCSs, as it has shown an SFR as high as 93-98% with minimal morbidity.[37]

Role of RIRS

The introduction of modern flexible ureteroscopes with a high quality of fiber optics has opened a new dimension in the management of lower pole renal calculi.[21] The outcome of RIRS in moderate-sized LPCSs was found to be satisfactory in various studies.[21,22,38] In the series of Chung *et al*., 7 out of 15 patients in the PCNL group and 4 out of 12 patients in the RIRS group had LPCSs of 1-2 cm.[22] The treatment was technically successful in all the 27 patients, and no patient in either group required a retreatment or ancillary procedure. Bozkurt *et al*. compared the outcome of RIRS ($n = 37$) versus PCNL ($n = 42$) for LPCSs of 15-20 mm and found the SFRs, after a single session, as 89.2 and 92.8%, respectively.[38] After the second intervention, the

SFR was 94.6% in the RIRS group and 97.6% in the PCNL group. Three patients in the PCNL group required blood transfusion. The overall SFRs and complications were higher in the PCNL group, but were not significant. Whereas the operative time was significantly more for the RIRS group, the postoperative hospital stay was significantly more for the PCNL group.

Ho *et al*. retrospectively reviewed the data of 46 patients, who underwent RIRS for LPCSs of <2 cm.[21] Among them 60% (n = 30) stones were located in the lower pole. They divided the patients into two groups, as patients undergoing RIRS as a primary procedure (group I) and those having RIRS as an adjunct after failure of SWL (group II). The SFR was significantly better in group I (75 vs. 56%). Other studies have also shown similar results.[39] The lower success rate of RIRS as a second-line therapy after a failed SWL was attributed to the unfavorable caliceal anatomy, which contributes to the failure of SWL.[21] The difficulty which is usually encountered while utilizing holmium laser fiber for LPCS is trouble in angulations of the fiber and scope in the lower calyx.[4] Several authors have tried to displace the calculus from the lower calyx to a more favorable calyx or pelvis, using a nitinol basket and grasper before the fragmentation.[40] They found an SFR of 29% in patients treated *in situ* versus 100% in patients treated after stone displacement (P = 0.005).

In the present economic circumstances, the cost impact of any treatment should be taken into account while counseling the patient to choose any modality. Koo *et al*. compared the efficiency and cost of RIRS and SWL for LPCSs <2 cm.[41] The SFR (64.9 vs. 58.8%), retreatment rate (16.2 vs. 21.6%), and auxillary procedure rate (21.6 vs. 7.8%) were not significantly different between the two groups. The mean perceived cost (the cost of procedure alone) of RIRS and SWL was almost similar (£249 vs. £292, respectively); however, when the overall costs (cost of additional procedures and overhead cost of treatment) were compared, the RIRS group was significantly more costly (£2602 vs. £426, P = 0.000; Mann-Whitney U test). The authors concluded that SWL is more cost effective than RIRS for LPCSs <2 cm.

Recent guidelines

The recent guidelines of the European Association of Urology (EAU) recommend SWL for stones upto 2 cm in all intrarenal locations, except for the lower pole.[2] For the LPCSs, PCNL is recommended especially if the stone size is >1.5 cm. For smaller LPCSs, SWL is recommended, if unfavorable factors like SWL-resistant stones (i.e., brushite, cystine), long lower pole (>10 mm), or narrow infundibulum (<5 mm) are not present; otherwise, PCNL is considered as a reasonable alternative. The EAU do not recommend RIRS as a first-line therapy, especially for stones >1.5 cm, for which stone free rate is usually found to be low, often requiring staged procedures.

CONCLUSIONS

There are various minimally invasive modalities like SWL, PCNL, and RIRS for the treatment of 1-2 cm renal stones. Selection of the treatment depends upon various stone-related, patient–related, and renal anatomical factors. Patients should be informed about various modalities, their chances of stone clearance, and morbidity of the procedure. Treatment should be individualized according to site of stone and available expertise. We suggest the following algorithm for the management of these calculi.

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