LOWER POLE CALYCEAL STONE AND LITHOTRIPSY - ARE ISSUES WITH CLEARANCE FACT OR REALITY?

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ABSTRACT

The lower pole calyceal (LPC) stone continues to be an enigma. The complex anatomy of the lower pole collecting system, along with other factors like acute pelvi calyceal angle and narrow and long infundibulum, are some of the complicating factors affecting stone clearance. There have been many studies assessing the impact of collecting system anatomy and most conclude that the complex anatomy of the lower pole collecting system does impact the overall stone-free rate.

Keywords: kidney stones, lower pole calyceal (LPC), percutaneous nephrolithotomy (PNL), urolithiasis

INTRODUCTION

In the last decade, there has been significant parallel progression in the skills and development of finer endourological implements in performing safe and effective percutaneous nephrolithotomy (PNL) or retrograde intra renal surgery (RIRS) for LPC stones. Results in various case series and random controlled trials (RCT) have shown higher success rate and earlier stone-free status by these modalities. The endourological interventions are, however, associated with significant morbidity and is often an overkill for small LPC stone. Incidentally identified asymptomatic stones pose a unique challenge. Some of these stones could at least be managed by deferred treatment. We still do not have quality data to define a trigger for patients with small asymptomatic LPC stones managed conservatively. Stone growth, development of obstruction, infection and pain are some of the well-defined factors to indicate intervention. Proper patient selection with a favourable collecting system anatomy is important for optimal outcome with patients undergoing treatment by shock wave lithotripsy (SWL). Stone burden (>15mm), availability of equipment and expertise, and patient's desire for a single procedure are some valid indication of PNL and RIRS.

Urolithiasis is a common medical condition, with the prevalence rate ranging between 4% and 20% in economically developed countries.[1] There is a significant geographical variation in the prevalence of urolithiasis; it is particularly prevalent in the so-called 'stone belt' areas. The overall prevalence rate in the Chinese population in a recent survey was estimated to be 4.0%, 4.8% in men and 3.0% in women.[2] It is also a highly recurrent condition, with more than half of the patients with previous history of urolithiasis forming another stone in less than a decade.[3] Kidney stones can also cause serious morbidity, pain, hematuria, infection, decreased kidney function and kidney failure. Since its introduction in the 1980s, SWL has become the most minimally invasive treatment option for the renal calculi. Although in the earlier years of its introduction the number of usage was far more liberal, this enthusiasm eventually made way for rational use. There are many factors responsible for achieving optimal stone clearance with SWL. These include stone burden, multiplicity, composition, stone to skin distance and intracalyceal distribution (stone location). Lower pole calyceal (LPC) stone location is one of the most controversial parameters. The current review is focused on the review of existing literature on the controversy surrounding LPC stone clearance.

EVIDENCE SYNTHESIS

What is Wrong with the Lower Pole Calyceal Stone?

Since the time that endourology become the mainstay in the management of nephrolithiasis, LPC stones have been a controversial topic. The debate on the lower pole calyceal anatomy and its impact on stone clearance are as old as SWL itself. Sampaio and Aragao[4] in the early 1990s pointed out that there are factors other than the gravity dependent position of LPC that have an impact on the outcome following SWL. They analysed the LPC anatomy in 146, three-dimensional polyester resin corrosion endocasts of the pelvicaliceal system. They observed that the inferior pole was drained by multiple calices disposed in 2 rows in more than half of the cases and by 1 midline calyceal infundibulum in over 40% of cases. In about 60%, there was a lower infundibulum > 4mm in diameter and the rest had a lower infundibulum smaller than 4mm in diameter. In about three-quarters of cases, an angle greater than 90 degrees was formed between the lower infundibulum and the renal pelvis, with the remaining cases forming an angle of 90 degrees or smaller. Since urologists have been wary of these anatomical features when considering SWL to treat calculi in the lower calices. Subsequently, studies also demonstrated that an acute pelvic lower pole infundibular angle hinders the spontaneous discharge of fragments after SWL.[6,11,16]

Many techniques have since been proposed for describing the pelvic lower pole infundibular angle. The anatomy of the lower pole is classically studied in an intravenous urogram (IVU). However, IVU is phasing out of the clinical practice as the imaging technique of choice, after having faithfully served the urologist in defining the anatomy of calyx and excretory function of the kidney.[5] Rachid Filho and colleagues[6] recently compared the 3D CT with IVU in defining the anatomy of the pelvicalyceal system, noting that although 3D-HCT is more precise to study calculus location, tumours, and vessels, IVU was also demonstrated to be as precise as 3D-HCT for studying the lower pole spatial anatomy. They did not observe any statistically significant difference in the measurements of infundibulo pelvic angle (IPA), infundibular length and diameter obtained using 3D-HCT when compared with those obtained using IVU, concluding that 3D-HCT does not present any advantage over IVU in the evaluation of lower pole calyceal anatomy. However, since CT is more frequently used in the diagnosis of urolithiasis, additional IVU is not required to define LPC anatomy.

Management of LPC Stones

The options of management include watchful waiting, SWL, RIRS and PNL. Watchful waiting is often recommended for small (<10mm), asymptomatic LPC stones in patients with aseptic urine.[7] Active management is often recommended for stones >10mm. SWL, RIRS and PNL all are valid management options, yet careful patient selection and understanding the limitations of each modality is absolutely necessary in the clinical decision-making.

SWL is the mainstay for the treatment of the majority of small and moderate-sized renal stones in all calyces except LPC.[8] The treatment outcome following SWL depends on the type of lithotripter, patient characteristics like body mass index (BMI), skin to stone distance, stone composition, stone size and intra calyceal distribution. However, one of the most significant factor-affecting outcomes is the stone's characteristics (i.e., number, size, composition and location), renal anatomy, and function. Clearance, rather than stone disintegration of lower pole stones after SWL, is significantly inferior according to other localisations of the kidney. Treatment outcome following SWL depends on type of lithotripter, stone characteristics (i.e., number, size, composition and location), renal anatomy and function.Observations in a meta-analysis by Lingeman et al.,[9] further supported by other reports subsequently published,[10, 11] showed a lower stone-free rate of ESWL for LPC, when compared to results of stones in other calyces. In our previously reported work, we noticed that there was a trend towards more SWL sessions and shock wave requirement in patients with acute pelvicalyceal angle and narrow infundibulum but it is not statistically significant. Size (≤20mm) and BMI has no relation with stone clearance. With modern lithotripter, stones up to 20mm could primarily be treated by SWL, irrespective of an unfavourable lower pole calyceal anatomy and body habitus.

There is dearth of quality RCT comparing the efficacy of the various options of management for LPC stones. Srisubat and colleagues[12] in a Cochrane Systematic Review in 2009 noted that results from three small studies, with low methodological quality, indicated SWL is less effective for lower pole kidney stones than PCNL, but is not significantly different from RIRS. Hospital stay and duration of treatment was less with SWL. More RCTs are required to investigate the effectiveness and complications of SWL for kidney stones compared to PCNL or RIRS.

Outcome of SWL in LPC Stones in Both Adults and Children

There are conflicting reports in literature as to the efficacy of SWL in LPC stones. In the majority of adults' reports significant difference in the stone clearance in between LPC stones and stones located in the other calyces was noted. However, in children most authors have noted insignificant or no differences in outcome. Demirkesen et al.[13] noted that SWL was equally effective for stones in all locations in children. They recommend SWL as the primary treatment of choice for stones less than 2.0cm^2 in all calyceal locations. For the management of calyceal stones greater than 2.0cm^2, prospective randomised trials comparing SWL and PCNL are necessary. Onal and colleagues[14] studied the impact of pelvicalyceal anatomy in stone clearance following SWL in paediatric population and observed that calyceal pelvic anatomy in pediatric lower pole stones has no significant impact on stone clearance after SWL. They observed a highly

Investigators	Number of patients	Mean stone size / Stone burden	Stone-free rate (%)	Impact of unfavourable anatomy
Aboutaleb H[25]	24	15.6mm	62.5	Yes
Albanis S[18]	78	63mm^2	50	Yes
Sahinkanat T[26]	82	11.75mm	62	No
Juan YS[27]	59	10.5mm	57.6	Yes
Ather MH[16]	100	9.4mm	81	Yes
Keeley FX Jr.[28]	116	14.3mm^2	52	Yes
Ghoneim IA[29]	205	65.88mm^2	68	Yes

Table 1: Stone clearance and impact of unfavorable anatomy in the stone clearance rate in the management of isolated LPC renal stone

significant relation between retreatment rates and stone burden, which should be considered for determining the treatment modality. Ather and Noor[15] noted a high stone clearance rate (95%) in renal stones up to 30mm in size. They observed no relation between stone sizes in clearance, yet 3 of 5 children who failed SWL had stones in the lower pole calyx.

The outcome of SWL for isolated LPC stones is detailed in Table 1. The various unfavorable LPC collecting system factors noted in these studies include acute pelvicalyceal angle, long and narrow infundibulum. Ather et al.[16] noted that a trend towards more SWL sessions and shock wave requirement in patients with acute pelvicalyceal angle and narrow infundibulum, but the difference did not reach statistical significance. Size (≤20mm) and BMI has no relation with stone clearance. Arzoz-Fabregas et al.[17] noted that height of the infundibulum, described as the distance between the line passing through the lowest part of the calyx containing the calculus and the highest point of the lower lip of renal pelvis, was the only parameter in which there were significant differences. Various manoeuvers including the application of a vibrating device on the flank, forced diuresis, and inversion therapy are described to improve the outcome of LPC stones. Albanis et al.[18] assessed the efficacy and safety of combined forced hydration and diuresis with limited inversion during (SWL) by comparing this treatment modality with conventional SWL for lower calyceal nephrolithiasis. Clinical outcomes were available in 90 patients. Follow-up at 3 months showed that 83.3% of the patients belonging to the study group were rendered stone-free, whereas 71.5% were stone-free in the control ($p>0.05$). Complications were minimal and not statistically significant.

Natural History of Small LPC Stone

As asymptomatic stones are increasingly identified due to widespread use of imaging (particularly ultrasonography) it becomes a challenge to devise optimal management strategy for such stones. The natural history of LPC stones is not well-defined and the rate of progression is not clear. There still are no clear recommendations for the frequency, duration and trigger for intervention. The EAU guidelines suggest that although there is no final word on the optimal treatment of calyceal stones, the trigger for intervention include stone growth, de novo obstruction, associated infection and/or chronic pain.[19] Most of these stones are only monitored, however minimally invasive treatment in the form of SWL is also proposed as an alternative.[20] Inci and colleagues[21] studied the natural history of LPC stones and proposed that observation could be considered for patients with asymptomatic lower pole stones. However, patients should be counselled concerning the 33% disease progression and 11% intervention rates.

Asymptomatic renal stones can be followed safely, but long-term follow-up is necessary. Periodic follow-up and early intervention should be recommended in patients with risk factors.[22] Hubner and Propaczy[23] noted that LPC stones are associated with various complications and cannot be indefinitely observed. In their series, 4 out of 5 patients with LPC stone required intervention within five years of diagnosis.

Skolarikos et al.[24] in a meta-analysis concluded that active stone monitoring has a certain role in the treatment of patients with urinary stones. The success is largely dependent on the stone size, location, and composition, as well as the time after the diagnosis. Medical therapy is a useful adjunct to observation.

CONCLUSION

LPC stones continue to be an actively debated subject in the urological community. Optimal management of small uncomplicated, asymptomatic stones is often deferred, however, there are no set points defined to trigger intervention. Patients on deferred treatment require close surveillance, regular clinical and microbiological and imaging work-up. SWL is the most minimally invasive treatment option, however, meta-analysis and RCT have shown lower stone clearance rates. Other endourological options like RIRS and PNL are reasonable alternatives. In experienced hands and in a well-equipped endourological unit, it has a somewhat higher stone clearance rate, while PNL, in particular mini and micro PNL, are reasonable alternatives with a high stone-free rate.

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