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Treatment Options for Calyceal Diverticula

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Abstract

Purpose of Review Calyceal diverticula are rare entities that can pose a significant challenge when it comes to their management. We analyse and summarise the literature with a focus on recent advances in the management of calyceal diverticula and discuss the advantages and disadvantages of each surgical technique.

Recent Findings The identification of calyceal diverticula requires a certain level of suspicion and contrast-enhanced imaging. Conventional techniques of imaging the renal collecting system such as the classic intravenous urography are now superseded by the ease of access to contrast-enhanced CT imaging. Conventional surgical techniques for managing calyceal diverticula are not being superseded by new techniques but rather being progressively enhanced and improved through the amelioration of existing technology. Debate still exists over the best treatment approach for the management of symptomatic calyceal diverticula, the choice of which still very much depends on the location and anatomy of the diverticulum itself.

Summary The most significant advance in the management of calyceal diverticula and indeed stones, in general, seems to be the progressive miniaturisation of percutaneous nephrolithotomy (PCNL) equipment allowing effective treatment with a reduction in associated risks of conventional PCNL. The increasing accessibility of robotics has a role to play in the management of this condition but is not likely surpass flexible ureteroscopic (fURS) or percutaneous approaches.

The future of surgical management for this condition lies in striking a balance between treatment efficacy and invasiveness. More recent identification of metabolic disturbances in patients with calyceal diverticular stones may provide further insights into the underlying pathology of this condition and is likely to play a role in future research of diverticular stones.

Keywords Calyceal diverticula · Endourology · Treatment options · CT imaging

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Introduction

Calyceal diverticula (CD) are uncommon congenital cystic cavities which communicate via a narrow neck with the urinary collecting system. These non-secretory transitional cell epithelium-lined diverticula are often asymptomatic but can be complicated by symptoms of pain, recurrent infection and haematuria [1]. Nephrolithiasis is seen in up to 50% of cases, mainly due to the stasis of urine in the diverticula and can also be compounded by recurrent infections. The incidence of calyceal diverticula in adults is around 0.3% and are more commonly found in women than men [2, 3].

Currently, there is no consensus on the management of CDs, with the trend being an upward stepwise management, from less invasive to more invasive techniques. Therefore, we aim to provide an evidence-based summary for the available treatment options for calyceal diverticula in a descriptive analysis.

Imaging and Classification

CDs often mimic other pathological conditions on ultrasound scans or non-enhanced CT scans, such as cysts or even tumours, which leads to initial confusion in the diagnosis. Therefore, urographic phase contrast CT is the investigation of choice for the correct identification of calyceal diverticula [4]. Small renal stones that appear to be within the renal parenchyma on non-contrast imaging causing unexpectedly significant symptoms are often later found to be within a calyceal diverticulum.

Two classification systems have been proposed for calyceal diverticula—the first by Wulfsohn who described two types: Type 1—(more common) arises from a minor calyx, Type 2—arises directly from renal pelvis or major calyx and are more likely to be larger/symptomatic [3]. The second more anatomically descriptive system derived by Dretler proposed four types based on the length and width of the infundibular neck and suggested the best treatment option for each type [5]. Type 1 diverticula have a wide mouth and short neck and are more amenable to Shock Wave Lithotripsy (SWL); Type 2 has a closed mouth and short neck and are more suited to flexible ureteroscopic management (fURS); Type 3 has a closed mouth and long neck; Type 4 has an obliterated neck. Types 3 and 4 are be best managed by a percutaneous (PCNL) approach.

Treatment Options

The choice of treatment for symptomatic calyceal diverticula very much depends on the location and anatomy of the diverticula itself as well as the associated stone burden. Current treatment options include Shock wave lithotripsy (SWL), flexible ureterorenoscopy/retrograde intra-renal surgery (fURS/RIRS) and percutaneous nephrolithotripsy (PCNL). A recent meta-analysis by Ito et al. found stone-free rates (SFR) of 21.3% for SWL, 61.4% for FURS/RIRS and 83% for PCNL [6•].

Which minimally invasive approach to use depends on the location and anatomy of the diverticulum. Narrow-necked, shallow diverticula can be amenable to SWL. PCNL tends to be the more preferred option for CDs. Posteriorly located diverticula are the easiest to access while anteriorly located diverticula are difficult to access percutaneously. Superior anterior located diverticula are best managed ureteroscopically whereas lower/midpole anterior diverticula are best managed with a laparoscopic approach [7].

Shock Wave Lithotripsy

Shock wave lithotripsy (SWL) is the least invasive method of treating calyceal diverticular stones, however, it has the lowest SFR of 4–20%. Despite the low SFR, there is a good symptom-free rate, reported at as high as 65% [8]. Hence, SWL is considered an option in treatment in patients who want to avoid more invasive modalities, albeit at the behest of a lower SFR.

The significant limiting factor to the success of SWL is poor drainage of the diverticulum which is the primary underlying cause of stone formation. It therefore should be reserved for symptomatic patients with favourable calyceal anatomy who are not fit enough to undergo a more invasive general anaesthetic procedure with the goal of treatment being symptomatic relief rather than complete stone clearance.

Flexible Ureterorenoscopy

Flexible (retrograde) ureterorenoscopy tends to be the first port of call for many endourologists for stones < 2 cm. It is associated with high stone-free rates of 73–95% and has the advantage of being less invasive with lower complication rates than PCNL [9].

The location of the calyceal ostium during flexible ureterorenoscopy (fURS) can prove difficult to identify in some cases. However, using intraoperative ultrasound to facilitate the identification of calyceal diverticula during fURS has led to an improvement in SFR [10]. Another technique to help identify the ostium is the "Blue Spritz" technique, which involves the installation of methylene blue into the collecting system and then aspirating it out before commencing saline irrigation whereupon residual dye would escape from the calyceal diverticulum aiding the identification of the ostium [9].

Percutaneous Nephrolithotomy

Widely accepted to be the most effective method of treating calyceal diverticular stones in terms of stone clearance, percutaneous nephrolithotomy (PCNL) remains one of the mainstays of managing the condition.

A recent series reported a 96% success rate for percutaneous treatment of stones and has consistently been found to have high success rates with higher SFR than both SWL and fURS [11•]. However, PCNL is associated with a higher complication rate than its two counterparts [12•].

PCNL access generally relies on using a wire coiled within the diverticulum as it is difficult to advance it through the calyceal ostium making tract dilatation for CD more of a risk. Once accessed however, calyceal diverticula tend to contain multiple small stones which are amenable to mini-PCNL extraction using the vortex effect.

The miniaturisation of percutaneous nephroscope allows for direct access to CD stones with a reduction in the risks. Day case and even outpatient PCNLs are now being described facilitated by the significant reduction in size of scopes and hence decrease the associated risks, making this technique a more attractive treatment choice [13•, 14].

Laparoscopy/Robotic-Assisted Approach

A laparoscopic approach is more often described in the management of calyceal diverticula in children. The diverticula can often be identified by an area of thin overlying parenchyma allowing direct incision, fulguration and marsupialisation of the diverticula. The use of laparoscopic ultrasound probes has also been described to facilitate the identification of the diverticula when not immediately obvious [15].

A laparoscopic approach has the advantage of being able to access more anterior diverticula not amenable to a percutaneous approach. This approach is more suited for large diverticula with thin overlying renal parenchyma [16].

There are recent reports in the literature of robotic-assisted diverticulectomy. These reports seem to be more common in children with large diverticula [17].

Fulguration/Ablation and Infundibular Neck Dilatation

Fulguration of the lining of the calyceal diverticulum using laser or diathermy previously formed a standard part of surgical treatment after either ureteroscopic or percutaneous stone extraction. The theory of doing so is that any secretory lining of the diverticulum is obliterated so that urine is no longer secreted into the diverticulum. The process however can be time-consuming and debate exists as to the value of fulguration or ablation. The authors could not find any available evidence to prove that it reduces the risk of stone recurrence. A comparative study on the matter might be useful to compare these approaches.

Debate also exists as to whether infundibular neck dilatation has an effect on outcome or not [11•]. The idea behind this technique is to improve drainage from the diverticulum and prevent urinary stasis and hence reduce the risk of stone formation or infection.

Tumours within Calyceal Diverticula

Transitional cell and squamous cell tumours can uncommonly arise from calyceal diverticula and in such cases prove difficult to diagnose and treat [18, 19]. These cases are more often than not also associated with stones within the diverticula suggesting that chronic inflammation and/or infection may play a role in the development of tumours within diverticula.

Metabolic Considerations

Multiple studies have found that that a high proportion of patients with calyceal diverticula have metabolic disturbances such as hypercalciuria or hyperuricosuria [11•, 20, 21]. One series found that all patients treated for stones within a calyceal diverticulum had at least one metabolic derangement [11•].

This highlights the importance of an adequate metabolic work-up in these patients in particular as they may be at higher risk of developing renal stones in general even after successful treatment of their diverticula.

Conclusion

Calyceal diverticula are uncommon and often asymptomatic. The majority of symptomatic calyceal diverticula are those which are complicated by stones. Multiple surgical approaches are used to treat symptomatic calyceal diverticula, the choice of which very much depends on the location, anatomy and stone burden thereof. PCNL remains the most effective method of treatment with the highest stone-free rates reported at the cost of a higher complication rate. However, the progressive reduction in size of percutaneous nephroscopes is likely to make this a more attractive technique of choice. With day case and even outpatient PCNLs now being described, it is more likely to be the preferred treatment choice of surgeons for the treatment of calyceal diverticular stones. Similarly, fURS are now being offered for complex stones and as the skill, expertise and technology improve, it might well be offered as the first line diagnostic and/or therapeutic option given that it is less invasive than PCNL.

The heterogeneity of calyceal diverticular anatomy, location and stone burden makes comparative studies difficult to interpret as the choice of treatment will generally depend on these factors making comparison of techniques difficult. There is a lack of high-quality studies comparing different surgical techniques with a general lack of long-term follow-up in many, making the optimum choice of modality difficult.

Compliance with Ethical Standards

Conflict of Interest Niamh Smyth, Bhavan Rai and Omar M. Aboumarzouk each declare no potential conflicts of interest.

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