Kidney Stone Disease – Clinical Perspectives

JIE TANG, MD, MPH
GYAN PAREEK, MD
GUEST EDITORS

Kidney stone disease poses a growing public health challenge worldwide. In the United States, its prevalence has been steadily rising from 3.8% in the 1970s to 8.8% in the late 2000s,[1] and up to 13% of men and 7% of women will develop a kidney stone in their lifetime.[2,3] More concerning is that kidney stone formers have a recurrence rate up to 50% by five years.[4] Kidney stone disease is now considered a complex systemic illness strongly associated with metabolic syndrome, hypertension, diabetes, cardiovascular disease, chronic kidney disease, and bone loss, leading to significant morbidity.[5] Although the disease by itself does not appear to portend a higher mortality compared to the general non-stone forming population with similar comorbidity,[5] disability-adjusted life years and deaths attributed to kidney stone have increased globally over the last two decades.[6] Equally, the economic impact associated with kidney stones has been huge. In the United States alone, it has been estimated to cost upwards of 5 billion US dollars annually.[7]

Most kidney stones are composed of calcium and oxalate, which account for about 80% of all kidney stones identified.[8,9] As a result, both hypercalciuria and hyperoxaluria are key risk factors for recurrent kidney stone. Hypercalciuria can be idiopathic or secondary to a variety of medical conditions including hyperparathyroidism, sarcoidosis, and inappropriate use of medications or dietary supplements. Hyperoxaluria is also common among kidney stone formers, and can result from genetic disorders such as primary hyperoxaluria or can be secondary to conditions associated with toxic ingestion or enhanced oxalate absorption from the gut. Additionally, obesity, metabolic syndrome and diet also have strong independent associations with the risk of kidney stone disease,[10,11] and appear to be the driving force for the rising global kidney stone disease burden.

For patients suspected of kidney stone disease, early diagnosis is essential. The classic presentation is flank pain and gross or microscopic hematuria. Imaging is critical to make the diagnosis and the gold standard modality utilized is a non-contrast computed tomography scan. Pregnancy must be ruled out with a urinary test in the female patient. Other imaging studies utilized during the work-up for suspected stone disease include kidney, ureter bladder X-ray, and ultrasound. It is imperative to act quickly to make the diagnosis. A urinalysis must be done at presentation, as any signs of an infection with the possibility of an obstruction is a medical emergency and should prompt the provider to send the patient to the emergency department.

In order to prevent serious health consequences, prompt identification and control of kidney stone risk factors are key in its clinical management. For patients with calcium oxalate kidney stones, the goal is to reduce the supersaturation of calcium oxalate in urine. Supersaturation is the gold standard for assessing crystallization potential, and represents thermodynamic driving force for the process of nucleation, growth, and aggregation, ultimately the stone formation. It is defined as the ratio of the concentration of the material of interest divided by its concentration at saturation. Supersaturations of calcium oxalate, calcium phosphorus and uric acid have direct predictive values for the risks of corresponding stone formation. In addition to various medications used to reduce the crystallization potential of stone-forming minerals, dietary modification is now becoming a key component of kidney stone management for prevention. In general, an alkaline diet rich in citrate and potassium, but limiting salt and purine is highly recommended. Maintaining adequate dietary calcium intake and oral hydration are also important.

Emergent surgical interventions are often indicated in cases of obstructing ureteral stones with urinary tract infection or acute kidney injury, especially in patients with a solitary functioning kidney. Elective surgery may be indicated in patients who are passing large ureteral stones (>5 mm), or in those who have difficulty passing ureteral stones less than 5 mm after four to six weeks of medical expulsive therapy, or in those who have uncontrolled pain or recurrent UTI related to stones. The urologist's armamentarium for surgical management of stones includes shockwave lithotripsy (SWL), retrograde ureteroscopy (URS), percutaneous nephrolithotomy (PCNL) and rarely, open or robotic surgery.

The most common procedure in the United States currently is URS. The procedure is an outpatient procedure performed under general anesthesia where a small endoscope is passed through the urethra and into the ureter or kidney depending on the location of the stone. A laser fiber is passed through the endoscope to fragment and "dust" the stone. A ureteral stent is left in the majority of cases at completion and removed one week post-operatively in the office. SWL is a non-invasive technique that breaks up stones with ultrasound waves and is most commonly done with sedation in the out-patient setting and is reserved for non-acute treatment. PCNL is indicated for stones larger than 2cm and involves access to the kidney from the flank, creation of track through which large stones are pulverized with lithotrites and suctioned out through an intricate system. Robotic and open surgery are indicated in situations where the minimally invasive methods mentioned above would not be possible (complex anatomy).

This issue of the *Rhode Island Medical Journal* features a series of articles on calcium kidney stone disease. Authors will review pathophysiology, and discuss diagnostic and therapeutic approaches.

Author Contributions

Idiopathic hypercalciuria, written by **OLIVE W. TANG, MD, PhD**, and **JIE TANG, MD, MPH**, will review current literature on the topic, and discuss diagnostic and therapeutic approaches.

Hyperoxaluria – a major metabolic risk for kidney stone disease, written by **CHRISTOPHER OWINO, MD**; **ANN MUTUGI, MD**, and **JIE TANG, MD, MPH**, will review current literature on the topic and discuss pathophysiology of hyperoxaluria as well as diagnostic and therapeutic approaches.

Dietary control of calcium kidney stone disease, written by **SAIRAH SHARIF, MD**; **JIE TANG, MD, MPH**, and **MATTHEW LYNCH, MD**, will review current literature on the topic and discuss the rationale of various dietary interventions for stone prevention.

Dietary magnesium intake and the risk of kidney stone disease, written by **SANDIPAN SHRINGI, MD**; **CHRISTINA RAKER, ScD**, and **JIE TANG, MD, MPH**, will present the findings of our analyses of the National Health and Nutrition Examination Survey 2011-2018, a large US population survey.

Diagnostic imaging for kidney stone, written by **SARAH MOORE, MD**, et al, will review all the current imaging modalities available in the work-up of stone disease and the clinical scenarios where each should be ordered.

Surgical interventions for kidney stones, written by **REBECCA WALES**, et al, will review all the surgical management procedures available to treat kidney stones and the clinical scenarios where they are indicated.

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Guest Editors

Jie Tang, MD, MPH, FASN, is an academic nephrologist from Brown Physicians, Inc. He is affiliated with Lifespan Hospitals and the Veteran's Administration Medical Center of Providence. He is an associate professor of medicine at the Alpert Medical School of Brown University. His primary research interest is in chronic kidney and kidney stone diseases.

Gyan Pareek, MD, FACS, is an academic urologist from Brown Physicians, Inc. He is affiliated with Lifespan Hospitals, and is the Krishnamurthi Family Professor at the Alpert Medical School of Brown University and Chief of Urology. His primary research interest is in prostate and kidney stone diseases.

Correspondence

Jie Tang, MD
jie.tang@brownphysicians.org