RESEARCH PAPER

Association of Renal Stone Burden on Non-Contrast CT KUB with Symptoms and Complications: A Retrospective Cross-Sectional Study

Priyanka[1], Bhanu Pratap[2], Vinod Kumar Gurjar[3], Gourav Kumar[4], Prince Khandelwal[5], Singanamala Meena[6]

[1,6] M.Sc. Radiation & Imaging Technology, Department of Radiation and Imaging Technology, Nims College of Allied and Healthcare Sciences, NIMS University Rajasthan, Jaipur

[2] Assistant Professor and Head of Department, Department of Radiation and Imaging Technology, Nims College of Allied and Healthcare Sciences, NIMS University Rajasthan, Jaipur (Corresponding Author)

[3,4,5] Assistant Professor, Department of Radiation and Imaging Technology, Nims College of Allied and Healthcare Sciences, NIMS University Rajasthan, Jaipur

Corresponding Author Email: bhanupratap@nimsuniversity.org

Received: 12th Mar, 2026 | **Revised:** 24th Mar, 2026 | **Accepted:** 14th Apr, 2026 | **Available Online:** 30th Apr, 2026

ABSTRACT

Background:

Urolithiasis is a common and increasing health concern worldwide, associated with significant morbidity due to pain, recurrent episodes, and potential renal complications. The burden of renal stones, determined by their size, number, and location, may influence clinical presentation and severity of complications. Non-contrast computed tomography of the kidney, ureter, and bladder (NCCT KUB) is considered the gold standard imaging modality for the detection and evaluation of urinary calculi and associated obstructive changes.

Objective:

To evaluate renal calculi using NCCT KUB and to determine the association between renal stone burden with clinical symptoms and radiological complications.

Material and Methods:

A retrospective cross-sectional study was conducted in the Department of Radiodiagnosis and Imaging at a tertiary care teaching hospital affiliated with NIMS University, Jaipur, Rajasthan, over a period of 6 months. A total of 100 patients with renal and/or ureteric calculi confirmed on NCCT KUB were included. Demographic details, stone characteristics (size, number, and location), clinical symptoms, and radiological complications were recorded from hospital records and radiology archives. Statistical analysis was performed using SPSS software. Chi-square test and independent samples t-test were applied, with $p < 0.05$ considered statistically significant.

Results:

The mean age of the study population was 45.7 ± 17.6 years, with a male predominance (72%). Right-sided stones were most common (37%), followed by bilateral (35%) and left-sided stones (28%). Single calculi were identified in 54% of patients, and the mean maximum stone size was 10.9 ± 8.2 mm. Flank pain was the most common presenting symptom (27%), followed by abdominal/groin pain (25%), fever/chills (15%), and nausea/vomiting (15%). Radiological complications were observed in 50% of patients, with hydronephrosis/hydroureteronephrosis being the most common (29%), followed by ureteric obstruction (22%). No statistically significant association was found between stone size and complications ($p = 0.105$), stone number and complications ($p = 0.120$), or stone size and hydronephrosis ($p = 0.395$). Stone location showed a near-significant association with complications ($p = 0.073$), with right-sided stones demonstrating the highest complication rate.

Conclusion:

Renal calculi predominantly affect middle-aged males and commonly present with flank pain. Hydronephrosis is the most frequent radiological complication. Although individual parameters of stone burden, such as size and number, were not significantly associated with complications, stone location showed a trend toward significance. NCCT KUB remains an essential imaging modality for comprehensive assessment of renal calculi and associated complications, aiding in timely diagnosis and management.

Association Of Renal Stone Burden On Non-Contrast Ct Kub With Symptoms And Complications: A Retrospective Cross-Sectional Study

Keywords: Renal calculi; Urolithiasis; NCCT KUB; Stone burden; Hydronephrosis; Complications; Computed tomography

How to cite this article: Priyanka, Pratap B, Gurjar VK, Kumar G, Khandelwal P, Meena S. Association of Renal Stone Burden on Non-Contrast CT KUB with Symptoms and Complications: A Retrospective Cross-Sectional Study. Int J Drug Deliv Technol. 2026;16(36s): 922-929. DOI: 10.25258/ijddt.16.36s.106

Source of support: Nil.

Conflict of interest: None

Introduction

Urolithiasis, commonly referred to as urinary stone disease, is one of the most prevalent disorders affecting the urinary tract worldwide. Its incidence has increased steadily over the past few decades, making it a significant public health concern. This rise has been linked to changes in lifestyle, dietary habits, sedentary behaviour, metabolic disorders, and environmental factors such as high temperature and dehydration [1]. Globally, approximately 10–15% of the population is expected to experience urinary stone disease during their lifetime, and recurrence rates may reach up to 50% within five years after the first episode. In addition to causing severe pain and discomfort, renal stones contribute to repeated hospital visits, increased healthcare costs, and reduced quality of life [2].

Renal calculi vary considerably in size, number, composition, and anatomical location within the urinary tract. These characteristics collectively define the "stone burden," which is an important determinant of disease severity and treatment planning [3]. A higher stone burden is often associated with severe clinical symptoms, reduced chances of spontaneous passage, and an increased risk of complications. Patients may present with acute flank pain, haematuria, nausea, vomiting, dysuria, or fever, while some stones remain asymptomatic and are detected incidentally during imaging for unrelated conditions. The severity of symptoms is influenced not only by stone size but also by its location, degree of obstruction, and associated inflammatory response.[4]

Among available imaging modalities, non-contrast computed tomography of the kidney, ureter, and bladder (NCCT KUB) has emerged as the gold standard for evaluating urinary tract calculi. It offers excellent sensitivity and specificity for stone detection and provides rapid, accurate, and detailed information regarding stone size, number, location, and density.[5] Unlike ultrasonography or plain radiography, NCCT KUB can identify even small or radiolucent calculi and can simultaneously detect secondary signs of obstruction such as hydronephrosis, hydroureter, perinephric fat stranding, and renal enlargement. These findings are clinically important because they help in assessing the severity of obstruction and guide appropriate management.[6]

The relationship between renal stone burden and clinical presentation remains complex and is not always predictable. While larger or multiple stones are generally expected to produce more severe symptoms and complications, smaller stones located in narrow portions of the ureter may cause intense pain and acute obstruction.[4] Conversely, larger non-obstructive calyceal stones may remain clinically silent for a long period. Similarly, complications such as hydronephrosis, hydroureteronephrosis, renal atrophy, pyelonephritis, and even renal impairment may occur depending on the duration and severity of obstruction rather than stone size alone.[7]

In clinical practice, understanding the association between stone burden and patient symptoms can improve risk stratification and treatment planning [8]. Early identification of patients at higher risk of complications can help prevent irreversible renal damage and reduce morbidity. Although several studies have explored the epidemiology management of urolithiasis, limited research has specifically examined the association and between stone burden assessed on NCCT KUB and the spectrum of symptoms and radiological complications in the Indian population [9]. Therefore, the present retrospective cross-sectional study was conducted to evaluate renal calculi using NCCT KUB and to determine the association of stone burden with clinical presentation and radiological complications. The findings of this study may contribute to better diagnostic assessment, timely intervention, and improved clinical outcomes in patients with urinary stone disease.[10]

METHODS

This retrospective cross-sectional observational study was conducted in the Department of Radiodiagnosis and Imaging at a tertiary care teaching hospital affiliated with NIMS University. The study was carried out over a period of three months. A total of 100 patients who underwent NCCT KUB and were diagnosed with renal and/or ureteric calculi were included in the study. Patients of all age groups and both sexes were considered.

For the purpose of analysis, stone size, number, and location were considered independent variables, while clinical symptoms and radiological complications were considered dependent variables. The primary outcome of the study was to determine the association between renal stone burden and the presence of complications. Secondary outcomes included assessing the correlation between stone burden and clinical symptoms, as well as identifying patterns of complications according to different stone characteristics.

All collected data were entered into and analysed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics were used to summarize the data, with continuous variables expressed as mean and standard deviation and categorical variables presented as frequency and percentage. Inferential statistical tests were applied to assess associations and differences between variables. The Chi-square test was used to evaluate the relationship between categorical variables such as stone size and complications, while the independent samples t-test was used to compare mean age between groups with and without complications. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 100 patients with radiologically confirmed renal and/or ureteric calculi on non-contrast computed tomography of the kidney, ureter, and bladder (NCCT KUB) were included in this retrospective cross-sectional study. The data were collected over a 6 months of time. The findings of the study are presented below.

The age of the study population ranged from 16 to 89 years, with a mean age of 45.7 ± 17.6 years. The majority of patients belonged to the middle-age group, with the highest proportion observed in the 40–49-year age category, followed by the 30–39-year age group. This indicates that renal stone disease was more common among individuals in the productive years of life.

A clear male predominance was observed in the study population. Out of 100 patients, 72 were males and 28 were females, giving a male-to-female ratio of approximately 2.6:1.

Distribution of Stone Characteristics

Assessment of stone characteristics on NCCT KUB revealed that right-sided stones were the most common, seen in 37% of patients. Bilateral stones were present in 35% of cases, while left-sided stones accounted for 28%. Bilateral involvement was commonly associated with multiple calculi.

With respect to the number of stones, single calculi were the most frequently observed finding, present in 54% of patients. Two stones were identified in 25% of patients, whereas multiple stones (three or more) were found in 21% of cases.

Variable	Category	n (%)	Mean ± SD
Age (years)	Range: 16–89 yr	–	45.7 ± 17.6
	<20	6 (6.0%)	–
	20–29	13 (13.0%)	–
Age Groups	30–39	19 (19.0%)	–
	40–49	23 (23.0%)	–
	50–59	12 (12.0%)	–
	60–69	15 (15.0%)	–
	≥70	12 (12.0%)	–
Sex	Male	72 (72.0%)	–

Table 1: Demographic Profile of the Study Population

The maximum stone diameter ranged from 2 mm to 48 mm, with a mean stone size of 10.9 ± 8.2 mm. The most common size category was 6–10 mm, followed by stones measuring ≤5 mm and 11–20 mm. Stones larger than 20 mm were less frequently encountered.

Table 2: Distribution of Stone Characteristics

Symptom	n	Percentage (%)	
Flank / back pain	27	27.0%	
Fever / chills	15	15.0%	
Nausea / vomiting	15	15.0%	
Hematuria	12	12.0%	
Dysuria / burning micturition	7	7.0%	
Abdominal / groin pain	25*	25.0%*	

Clinical Presentation

Clinical presentation varied among patients. Flank or loin pain was the most frequently reported symptom and was present in 27% of cases. Abdominal or groin pain was the second most common complaint, reported by approximately 25% of patients, particularly among those with ureteric calculi.

Fever and chills were observed in 15% of patients, suggesting associated infection or inflammatory changes. Nausea and vomiting were also reported in 15% of cases. Haematuria was present in 12% of patients, while dysuria or burning micturition was the least common symptom, seen in 7% of cases. Some patients presented with more than one symptom.

Table 3: Frequency of Clinical Symptoms

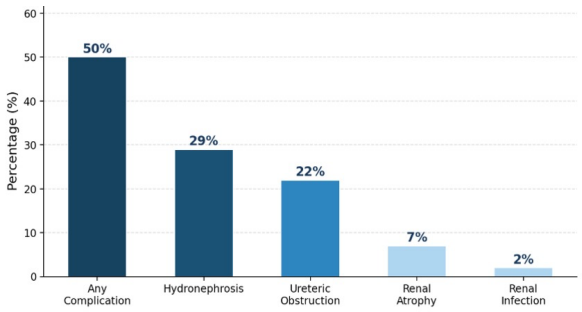
Radiological Complications

Characteristic	Category	n (%)
Stone Location	Right kidney / ureter	37 (37.0%)
	Left kidney / ureter	28 (28.0%)
	Bilateral	35 (35.0%)
Number of Stones	Single (1 stone)	54 (54.0%)
	2 stones	25 (25.0%)
	Multiple (≥3 stones)	21 (21.0%)
Maximum Stone Size	≤5 mm	28 (28.0%)
	6–10 mm	35 (35.0%)
	11–20 mm	28 (28.0%)
	>20 mm	9 (9.0%)
Mean max size	Range: 2–48 mm	10.9 ± 8.2 mm

Radiological complications were identified in 50% of the study population. Hydronephrosis or hydroureteronephrosis was the most common complication, observed in 29% of patients. Ureteric obstruction or stone impaction was seen in 22% of cases.

Renal atrophy or evidence of reduced renal parenchymal function was identified in 7% of patients. Features suggestive of acute pyelonephritis or renal infection were present in 2% of cases. Some patients demonstrated more than one complication on imaging.

Figure .1: Distribution of Radiological Complications



Association Between Stone Number and Complications

The relationship between stone number and radiological complications was analysed. Complications were more frequently observed in patients with single stones (59.3%) compared to those with two stones (36.0%) and multiple stones (42.9%). However, statistical analysis using the Chi-square test did not show a significant association between stone number and complications (p = 0.120).

Table 5: Stone Number vs Complications

Stone Number	No Complication n (%)	Complication n (%)	Total	p-value
Single (1)	22 (40.7%)	32 (59.3%)	54	
2 stones	16 (64.0%)	9 (36.0%)	25	
Multiple (≥3)	12 (57.1%)	9 (42.9%)	21	
Total	50	50	100	0.120

Max Stone Size	No Complication n (%)	Complication n (%)	Total	p-value
≤5 mm	13 (46.4%)	15 (53.6%)	28	
6–10 mm	13 (37.1%)	22 (62.9%)	35	
11–20 mm	19 (67.9%)	9 (32.1%)	28	
>20 mm	5 (55.6%)	4 (44.4%)	9	
Total	50	50	100	0.105

Association Between Stone Size and Complications

When stone size was compared with the presence of complications, the highest complication rate was observed in the 6–10 mm size group. Stones measuring ≤5 mm also showed a considerable complication rate. Interestingly, larger stones in the 11–20 mm and >20 mm categories showed comparatively lower complication rates, possibly due to their non-obstructive location in some cases.

Despite these findings, the association between stone size and complications was not statistically significant (p = 0.105).

Table 6: Stone Size vs Complications

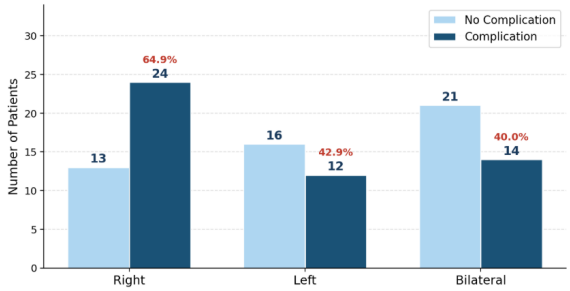
Association Between Stone Location and Complications

Stone location showed variation in complication rates. Right-sided stones demonstrated the highest complication rate, followed by left-sided and bilateral stones. Statistical analysis revealed that this association approached significance but did not reach the accepted threshold (p = 0.073), suggesting a possible trend.

Table 7: Stone Location vs Complications

Stone Location	No Complication n (%)	Complication n (%)	Total	p-value
Right	13 (35.1%)	24 (64.9%)	37	
Left	16 (57.1%)	12 (42.9%)	28	
Bilateral	21 (60.0%)	14 (40.0%)	35	
Total	50	50	100	0.073

Figure 2: Stone Location vs Complications



Association Between Stone Size and Hydronephrosis

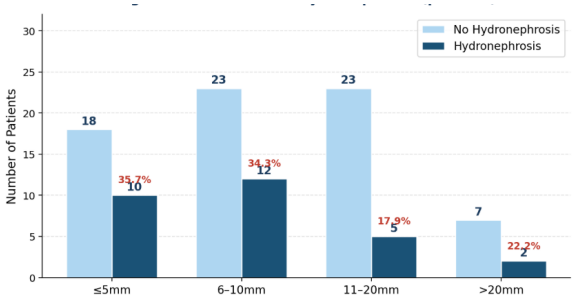
Hydronephrosis was assessed separately in relation to stone size. The highest frequency of hydronephrosis was observed in the ≤5 mm and 6–10 mm groups. Larger stones showed comparatively lower rates, likely because some were non-obstructive calyceal stones.

The association between stone size and hydronephrosis was not statistically significant (p = 0.395).

Table 8: Stone Size vs Hydronephrosis

Max Stone Size	No Hydronephrosis n (%)	Hydronephrosis n (%)	Total	p-value
≤5 mm	18 (64.3%)	10 (35.7%)	28	
6–10 mm	23 (65.7%)	12 (34.3%)	35	
11–20 mm	23 (82.1%)	5 (17.9%)	28	
>20 mm	7 (77.8%)	2 (22.2%)	9	
Total	71 (71.0%)	29 (29.0%)	100	0.395

Figure 3: Stone Size vs Hydronephrosis



Age and Sex in Relation to Complications

Patients with complications had a slightly higher mean age compared to those without complications. However, the difference was not statistically significant. Similarly, no statistically significant difference was found in complication rates between male and female patients.

Summary of Key Findings

The present study demonstrates that renal calculi were more common in middle-aged males, with right-sided and single calculi being the most frequent findings. Flank pain was the most common presenting symptom, and hydronephrosis was the most frequent radiological complication. Although stone size and number did not show statistically significant associations with complications, stone location showed a near-significant trend, suggesting that anatomical factors may influence disease severity. NCCT KUB proved to be highly effective in evaluating both stone burden and associated complications.

DISCUSSION

The present retrospective cross-sectional study evaluated the association between renal stone burden assessed on non-contrast computed tomography of the kidney, ureter, and bladder (NCCT KUB) with clinical symptoms and radiological complications in patients with renal and/or ureteric calculi. The findings demonstrated that renal stone disease was more

prevalent among middle-aged adults and showed a marked male predominance. Flank pain was the most common presenting complaint, while hydronephrosis/hydroureteronephrosis was the most frequently observed radiological complication. Although stone size and stone number were not significantly associated with complications, stone location demonstrated a near-significant association, suggesting that anatomical factors may play an important role in determining disease severity.

In the present study, the mean age of the study population was 45.7 ± 17.6 years, with the highest proportion of cases observed in the 40–49-year age group. **Scales CD Jr, et al**.[11] The higher prevalence in this age group may be attributed to occupational stress, inadequate hydration, dietary habits, sedentary lifestyle, and metabolic abnormalities that predispose to stone formation. Since this age group represents the economically productive segment of the population, the disease imposes a considerable socioeconomic burden through reduced productivity and increased healthcare expenditure.

A clear male predominance was observed in the present study, with males constituting 72% of the study population. Similar findings have been reported in previous studies, where the male-to-female ratio ranges from 2:1 to 3:1 in **Romero V, et al**.[12] Hormonal differences may partly explain this pattern, as testosterone has been implicated in increased endogenous oxalate production and crystal aggregation, whereas oestrogen may exert a protective role by inhibiting crystal retention and promoting urinary citrate excretion. Additionally, lifestyle-related factors such as increased outdoor activity, higher rates of dehydration, and greater dietary intake of animal protein and salt among males may contribute to this increased prevalence.

The analysis of stone characteristics revealed that right-sided stones were the most common, followed by bilateral and left-sided stones. Single calculi were more common than multiple calculi, and the mean maximum stone size was 10.9 ± 8.2 mm. Most stones were within the 6–10 mm size category, which is clinically relevant because calculi of this size are less likely to pass spontaneously and are more likely to cause ureteric obstruction. However, in the present study, stone size did not show a statistically significant association with complications. This finding suggests that stone size alone may not be a sufficient predictor of clinical severity. Small stones lodged in anatomically narrow regions such as the ureteropelvic junction, pelvic brim, or ureterovesical junction may cause acute obstruction and severe symptoms, whereas larger non-obstructive calyceal stones may remain asymptomatic for prolonged periods were reported in **Brisbane W, et al.**[13]

Flank or loin pain was the most common presenting symptom, followed by abdominal or groin pain. This finding is consistent with the typical presentation of renal colic, which results from acute ureteric obstruction causing increased intraluminal pressure, smooth muscle spasm, and distension of the collecting system. Fever and chills were observed in 15% of patients, indicating associated infection or inflammatory changes. Nausea and vomiting were also common and may be explained by autonomic stimulation associated with severe pain. Haematuria was present in a relatively smaller proportion of patients, which may reflect underreporting or incomplete clinical documentation in retrospective records.

Radiological complications were identified in 50% of the patients. Hydronephrosis/hydroureteronephrosis was the most common complication, followed by ureteric obstruction or stone impaction. These findings indicate the significant role of obstruction in the pathophysiology of urinary stone disease. Renal atrophy and features of pyelonephritis were observed in a smaller proportion of cases, likely reflecting chronic obstruction or superimposed infection. These observations highlight the importance of NCCT KUB not only for identifying calculi but also for detecting secondary complications that may influence urgency and mode of treatment **Brisbane W, et al**.[13]

The association between stone number and complications was not statistically significant. Interestingly, single stones showed a higher complication rate compared to multiple stones. A possible explanation is that solitary ureteric stones may cause complete or near-complete obstruction and acute symptoms, whereas multiple smaller renal calculi may remain non-obstructive and clinically silent.

Similarly, no statistically significant association was observed between stone size and hydronephrosis. The highest rates of hydronephrosis were noted among smaller stones (≤5 mm and 6–10 mm), again supporting the concept that stone location and degree of obstruction may have a greater influence on clinical outcome than stone size alone **Türk C, et al**.[14]

Stone location demonstrated a near-significant association with complications ($p = 0.073$), with right-sided stones showing the highest complication rate. Although statistical significance was not achieved, this trend suggests a potentially important clinical

relationship. Anatomical factors, delayed presentation, or differences in urinary drainage may contribute to this observation. A larger sample size may have provided sufficient statistical power to confirm this association.

The present study reinforces the role of NCCT KUB as the gold standard imaging modality in the evaluation of urinary tract calculi. It provides rapid, accurate, and comprehensive information regarding stone burden, anatomical location, and secondary signs of obstruction. Compared with ultrasonography and plain radiography, NCCT KUB offers superior sensitivity and specificity, especially in emergency settings and in patients with atypical presentations **Brisbane W, et al**. [13]

Despite its strengths, the present study has certain limitations. Being retrospective in design, it relied on the accuracy and completeness of hospital records. The study was conducted at a single centre with a relatively small sample size, which may limit the generalizability of the findings. Furthermore, metabolic evaluation, biochemical parameters, and stone composition analysis were not included, all of which may influence stone formation and recurrence. The severity and duration of symptoms and degree of obstruction could not be quantified objectively.

In conclusion, the findings of the present study suggest that stone burden should not be assessed solely on the basis of stone size or number. A comprehensive evaluation incorporating stone location and radiological evidence of obstruction is essential for accurate risk stratification and management planning. Future prospective multicentric studies with larger sample sizes and inclusion of metabolic and biochemical parameters are recommended to validate these findings and develop more robust predictive models for urinary stone disease **Worcester EM, et al.**[15]

Conclusion

The present study highlights that renal calculi are a common clinical condition predominantly affecting middle-aged adults, with a marked male predominance. Non-contrast computed tomography of the kidney, ureter, and bladder (NCCT KUB) proved to be a highly reliable and comprehensive imaging modality for evaluating renal stone burden and detecting associated complications. It provided accurate information regarding stone size, number, location, and secondary signs of obstruction, thereby playing a crucial role in diagnosis and management planning.

In this study, flank pain was the most frequent presenting complaint, while hydronephrosis was the most commonly observed radiological complication. Although individual components of stone burden, such as stone size and number, did not demonstrate statistically significant associations with complications, stone location showed a near-significant relationship, with right-sided stones being associated with a higher rate of complications. These findings suggest that anatomical factors and the degree of obstruction may influence disease severity more than stone size alone.

The results emphasize the importance of correlating radiological findings with clinical presentation for accurate risk assessment and timely intervention. A comprehensive evaluation of stone burdens rather than relying on a single parameter may improve decision-making and help identify patients at increased risk of adverse outcomes.

Further large-scale prospective studies with a larger sample size and inclusion of metabolic and biochemical parameters are recommended to better understand the relationship between stone burden and complications. Such studies may help establish stronger predictive models and improve the management of patients with urinary stone disease.

In conclusion, NCCT KUB remains an indispensable diagnostic tool in the assessment of renal calculi, enabling early detection of complications and supporting appropriate clinical and therapeutic decisions to improve patient outcomes.

REFERENCES

1. Vera-Ponce, Víctor Juan et al. Global prevalence of urolithiasis: a meta-analysis accounting for methodological heterogeneity. 2025;
2. C., Ni Ealaithe, L., Rishi, and K., Keeshan, Proceedings of the RAMI Intern Section Meeting, 18th January 2014. 2014;
3. Assimos, Dean et al. Surgical Management of Stones: American Urological Association/Endourological Society Guideline, PART I. Journal of Urology. 2016;196(4):1153-1160
4. Coll, Deirdre M., Varanelli, Michael J., and Smith, Robert C. Relationship of Spontaneous Passage of Ureteral Calculi to Stone Size and Location as Revealed by Unenhanced Helical CT. American Journal of Roentgenology. 2002;178(1):101-103.

5. Dale, Joanne et al. Imaging Advances in Urolithiasis. Journal of Endourology. 2017;31(7):623-629.

6. Eisner, Brian H. et al. Nephrolithiasis: What Surgeons Need to Know. American Journal of Roentgenology. 2011;196(6):1274-1278.

7. Dropkin, Benjamin M. et al. The Natural History of No obstructing Asymptomatic Renal Stones Managed with Active Surveillance. Journal of Urology. 2014;193(4):1265-1269.

8. Members: Authors/Task Force et al. European Guidelines on cardiovascular disease prevention in clinical practice (version 2012): The Fifth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of nine societies and by invited experts) * Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). 2012;

9. Landis, J Richard et al. The MAPP research network: design, patient characterization and operations. BMC Urology. 2014;14(1).

10. Tailly, Thomas et al. Stone Burden Measurement by 3D Reconstruction on Noncontrast Computed Tomography Is Not a More Accurate Predictor of Stone-Free Rate After Percutaneous Nephrolithotomy Than 2D Stone Burden Measurements. Journal of Endourology. 2020;34(5):550-557.

11. Scales CD Jr, Smith AC, Hanley JM, Saigal CS. Prevalence of kidney stones in the United States. European Urology. 2012;62(1):160–165.

12. Romero V, Acinar H, Assimos DG. Kidney stones: A global picture of prevalence, incidence, and associated risk factors. Reviews in Urology. 2010;12(2–3): e86–e96.

13. Brisbane W, Bailey MR, Sorensen MD. An overview of kidney stone imaging techniques. Nature Reviews Urology. 2016;13(11):654–662.

14. Türk C, Neisius A, Petrik A, et al. EAU Guidelines on Urolithiasis. European Association of Urology. 2023.

15. Worcester EM, Coe FL. Clinical practice: Calcium kidney stones. The New England Journal of Medicine. 2010;363(10):954–963.