

Role of Percutaneous Nephrolithotomy in Differentiating and Managing Nephrolithiasis in Patients with Radiological Nephrocalcinosis: A Case Series

Devashish Kaushal

All India Institute of Medical Sciences Bhopal

Ketan Mehra

All India Institute of Medical Sciences Bhopal

Shushant Shandilya

sushantmishra6916@gmail.com

All India Institute of Medical Sciences Bhopal

Nishan Gaudani

All India Institute of Medical Sciences Bhopal

Sushant Trakroo

All India Institute of Medical Sciences Bhopal

Research Article

Keywords: Nephrocalcinosis, PCNL, Endourology, Nephrolithiasis, Primary Hyperparathyroidism, Renal tubular acidosis

Posted Date: June 8th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-9870990/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Abstract

Objectives

Nephrocalcinosis (NC) refers to the deposition of calcium salts in renal tissue, often associated with metabolic disorders like primary hyperparathyroidism, distal renal tubular acidosis (dRTA), and chronic kidney disease. On imaging, NC often mimics nephrolithiasis (NL), posing a diagnostic challenge. Hence, we chose percutaneous nephrolithotomy (PCNL) as a diagnostic and therapeutic modality to evaluate its diagnostic utility in differentiating nephrolithiasis from NC and to assess its role in stone clearance.

Methods

We present a prospective case series of three patients with radiologically diagnosed NC and nephrolithiasis, in whom PCNL was performed both as a diagnostic and therapeutic modality. All three patients had varying metabolic backgrounds, including type 1 dRTA and primary hyperparathyroidism. Preoperative CT showed diffuse calcifications with no clear distinction between NC and NL. PCNL allowed direct visualization, enabling distinction of calyceal stones from parenchymal deposits, followed by stone clearance.

Results

All three patients underwent staged PCNL procedures. Intraoperatively, most calcifications were found to be minor calyceal calculi, amenable to removal. Postoperatively, stone clearance of 85–95% was achieved in each case with significant symptomatic improvement. Mean creatinine decreased from 2.59 mg/dL preoperatively to 1.37 mg/dL postoperatively. No intraoperative or postoperative complications were noted.

Conclusion

PCNL serves a dual role in patients with suspected NC and nephrolithiasis by offering both diagnostic clarity and therapeutic benefit. Our findings suggest that PCNL may have a role in selected patients with suspected NC; however, larger studies are required before changes to management paradigms can be recommended.

Introduction

Nephrocalcinosis (NC) describes the deposition of calcium salts within the renal parenchyma and has historically been linked with several metabolic and systemic disorders. The term was first introduced by Albright et al. in 1934 while studying the renal complications of primary hyperparathyroidism [1]. NC is most commonly associated with primary hyperparathyroidism, distal renal tubular acidosis (dRTA), and

medullary sponge kidney disease (MSKD) [2]. Other less common causes include vitamin D intoxication, prolonged furosemide therapy, and systemic conditions like sarcoidosis [2]. Despite the varied etiologies, a common thread among these conditions is the disturbance of calcium metabolism, leading to its deposition in renal tissues.

Traditionally, NC has been identified via radiological imaging, particularly with plain X-ray, ultrasonography, and more recently, computed tomography (CT). However, radiological assessment often fails to distinguish true parenchymal calcifications from nephrolithiasis (NL), especially when stones cluster in the calyceal system [2, 3]. This overlap complicates both diagnosis and management, frequently leading to conservative treatment approaches centered on the correction of metabolic abnormalities, while the true lithogenic burden remains unaddressed.

Recent advancements in endourological techniques, particularly percutaneous nephrolithotomy (PCNL), have significantly enhanced our ability to evaluate the renal collecting system directly. Endoscopic visualization through PCNL allows differentiation between parenchymal calcifications and intraluminal stones [2, 4]. This capability is crucial as studies have shown that a significant proportion of what appears radiologically as NC may actually be calyceal stones or calculi lodged within dilated ducts of Bellini, especially in conditions like dRTA and MSKD [2].

Moreover, PCNL not only serves as a diagnostic tool but also provides a therapeutic benefit by facilitating complete stone clearance, which may otherwise remain undetected and untreated. Miller et al. underscored this paradigm shift by demonstrating that radiographic findings suggestive of NC were frequently resolved after surgical stone removal via PCNL, indicating that the calcifications were indeed nephrolithiasis rather than NC [2]. We intended to reduce stone burden, enhancing kidney function (drop in serum creatinine) by opening block calyces with stones.

Thus, this dual role of PCNL in both diagnosing and treating patients with presumed NC necessitates a reevaluation of the current management protocols. Our case series aims to reinforce the growing evidence that PCNL should be considered in selected symptomatic patients with suspected NC, particularly those with persistent symptoms or declining renal function despite optimal metabolic control.

This study highlights the potential role of PCNL as both a diagnostic and therapeutic modality in cases where radiological distinction between nephrocalcinosis and nephrolithiasis is unclear.

Materials and Methods

We prospectively analyzed three patients with radiologically diagnosed NC and NL, treated at AIIMS Bhopal over the past 2 years. Inclusion criteria included patients with radiological features suggestive of NC with concurrent suspicion of nephrolithiasis and clinical symptoms warranting intervention.

All patients underwent detailed metabolic evaluation, preoperative imaging (CT Urography), and staged PCNL procedures. Operative findings, stone clearance rates, and renal function parameters were recorded. This study protocol was reviewed and approved by the Institutional Ethics Committee of AIIMS, Bhopal (**IHEC-LOP/2025/IP160**).

Written informed consent was obtained from all patients to participate in the study and for publication of the details of their medical case and any accompanying images.

This research was performed in accordance with the principles stated in the World Medical Association Declaration of Helsinki.

Case 1

A 55-year-old male, a known case of type 1 distal renal tubular acidosis, presented with bilateral NC and chronic kidney disease (eGFR 29 mL/min/1.73m²). Laboratory evaluation revealed anemia (Hb 10 g/dL), elevated creatinine (2.5 mg/dL), hypercalcemia (12.8 mg/dL), hypercalciuria, hypocitraturia, metabolic acidosis, and undetectable PTH levels (< 1 pg/mL). CT urography showed multiple calculi up to 16 mm with a density of 1300 HU in the right kidney and few calculi in left kidney, without hydronephrosis and with normal contrast excretion (Fig. 1a). Functional scan was suggestive of Right better functioning kidney. The patient underwent a two-stage right PCNL with initial 60% clearance followed by 90% clearance (Fig. 1b,c). Access was gained via an infracostal lower pole puncture and a supracostal middle pole puncture, both dilated up to 28Fr amplatz. Small stones occupying minor calyx were noted and removed. The patient had an uneventful recovery with relief of symptoms and stabilization of renal function. Postoperative serum creatinine improved to 1.2 mg/dL.

Case 2

A 56-year-old male with a history of hypertension and chronic kidney disease with eGFR of 26.8ml/min/1.73m², diagnosed with primary hyperparathyroidism, presented with bilateral flank pain and lithuria persisting over several years. Initial laboratory evaluation revealed anemia (Hb 10.4 g/dL), elevated creatinine (2.7mg/dL), hypercalcemia (13.55 mg/dL), elevated intact PTH (123.5 pg/mL), and declining renal function. Imaging revealed bilateral medullary NC with a relatively functional left kidney (Fig. 2a). After successful right inferior parathyroidectomy, serum calcium levels normalized. However, the patient continued to experience left flank pain and renal function decline. Repeat imaging continued to suggest NC. He underwent staged left PCNL, which revealed multiple small stones clustered within minor calyces rather than parenchymal deposits. Over two PCNL sessions using multiple tracts, 95% stone clearance was achieved (Fig. 2b,c). The patient had an uneventful recovery with relief of symptoms and stabilization of renal function. Postoperative serum creatinine improved to 1.8 mg/dL.

Case 3

A 70-year-old hypertensive male with chronic kidney disease (eGFR 26 mL/min/1.73m²) was incidentally diagnosed with bilateral NC, with a higher stone burden on the right side. Laboratory workup revealed Hb

13.5 g/dL, serum creatinine 2.56 mg/dL, vitamin D deficiency (17 ng/mL), mild hypercalcemia (10.7 mg/dL), and elevated PTH (171 pg/mL). CT urography showed multiple calculi ranging from 7 to 20 mm, occupying the upper, mid, and lower pole calyces of both kidneys, with densities of 1000–1800 HU, without hydronephrosis and with normal contrast excretion (Fig. 3a). He underwent a staged right PCNL. The first stage involved two infracostal inferior calyceal punctures and one supracostal superior calyceal puncture, each dilated to 28Fr Amplatz, achieving about 30% clearance. Multiple calculi were removed from various calyces, with stones noted protruding from dilated ducts of Bellini (Fig. 4a & 4b). The second stage involved utilizing the previous tracts and an additional infracostal middle calyceal puncture, achieving a total of 85% stone clearance (Fig. 3b & c). The patient had an uneventful recovery with relief of symptoms and stabilization of renal function. Postoperative serum creatinine improved to 1.1 mg/dL.

Stone analysis and intraoperative endoscopic findings were documented. Stone clearance was assessed by postoperative imaging. Renal function was monitored pre- and post-operatively.

Results

All patients demonstrated clustered calyceal calculi intraoperatively rather than diffuse parenchymal deposits.

Case 1

Achieved ~ 90% stone clearance post two-stage PCNL. Pre-op creatinine 2.5 mg/dL, post-op 1.2 mg/dL.

Case 2

Achieved ~ 95% clearance post PCNL with symptomatic relief and stabilized renal function (from 2.7 mg/dL to 1.8 mg/dL).

Case 3

Achieved ~ 85% clearance over two PCNL stages. Pre-op creatinine 2.56 mg/dL, post-op 1.1 mg/dL.

The use of staged PCNL allowed accurate differentiation between nephrolithiasis and NC, demonstrating that a proportion of radiologically suspected NC may represent calyceal calculi amenable to endoscopic removal. Stone clearance was substantial in all cases: 90%, 95%, and 85%, respectively, suggesting that PCNL can be effective in selected cases with complex renal calcifications (Table 1).

Table 1
Creatinine trends and clearance

Case	Pre-op Cr (mg/dL)	Post-op Cr (mg/dL)	Absolute Drop (mg/dL)	% Change
1	2.5	1.2	-1.3	52%
2	2.7	1.8	-0.9	33.3%
3	2.56	1.1	-1.46	57%

Importantly, all procedures were completed without intraoperative or postoperative complications, reinforcing the safety and feasibility of PCNL in patients with impaired renal function and radiologically dense kidneys. The observed improvement in renal function and symptom relief post-PCNL further supports the therapeutic role of PCNL in patients misdiagnosed with NC.

Statistical Analysis

- Mean Pre-op Creatinine: **2.59 ± 0.10 mg/dL**
- Mean Post-op Creatinine: **1.37 ± 0.38 mg/dL**
- Mean Difference: **1.22 ± 0.29 mg/dL**
- Relative Improvement: **47.5% ± 12.5%**

A paired *t*-test was used to compare pre- and post-operative creatinine levels:

- $t = 7.33$, $df = 2$, $p = 0.018$

Although an apparent improvement in serum creatinine was observed, the extremely small sample size ($n = 3$) limits the validity of statistical inference.

Discussion

The differentiation between nephrocalcinosis (NC) and nephrolithiasis (NL) remains a significant clinical challenge. Historically, NC was perceived as a radiological diagnosis of diffuse renal calcification associated with systemic metabolic derangements [2]. However, advances in imaging modalities, especially non-contrast CT, have led to the increased detection of renal calcifications, which may not always represent parenchymal deposition [2, 3].

Miller et al. demonstrated that in conditions such as primary hyperparathyroidism, distal RTA, and medullary sponge kidney, many calcifications presumed to be NC on imaging were, in fact, surgically removable calculi [2]. This revelation was facilitated by endourological techniques like PCNL, which allow direct endoscopic assessment of the renal calyceal system. The distinction is not merely academic; the presence of calculi warrants intervention to prevent complications such as infection, obstruction, and progressive renal impairment. All three patients in our series had progressive renal impairment.

Endoscopic visualization has shown that calyceal stones often occupy spaces previously assumed to harbor parenchymal calcifications. For example, in distal RTA, patients typically demonstrate hypocitraturia and hypercalciuria, creating a lithogenic milieu. These metabolic alterations are associated with both stone formation and parenchymal calcification [2]. However, Miller et al. highlighted that in many such cases, the majority of radiographic calcifications represented stones lodged within the collecting system, amenable to endoscopic removal [2].

Similarly, in MSKD, the cystic dilatation of the collecting ducts may trap stones, giving a radiological appearance suggestive of NC [2]. The diagnostic challenge is compounded by the inability of conventional imaging to differentiate between ductal calcifications and stones. PCNL, in such cases, serves as a pivotal diagnostic tool, allowing visualization, assessment, and removal of calculi, which can significantly impact patient outcomes.

The role of PCNL extends beyond diagnosis. Its therapeutic potential is underscored by the observed benefits in terms of symptomatic relief, reduction in stone burden, and stabilization or improvement of renal function, as documented in our case series. The safety profile of staged PCNL, even in patients with compromised renal function, further supports its utility in managing complex stone disease [5].

Importantly, the paradigm shift advocated by Miller et al. suggests that a proactive surgical approach in selected patients with presumed NC can mitigate the risk of chronic infections and renal deterioration [2]. Therefore, integrating PCNL into the diagnostic and therapeutic algorithm for NC represents a significant advancement in the field of endourology.

Existing literature suggests that some radiologically apparent NC may represent removable calculi, making PCNL both diagnostic and therapeutic [6].

Limitations

This study is limited by a very small sample size, lack of control group, and short follow-up. The observed improvements in renal function may be influenced by multiple confounders including relief of obstruction and perioperative optimization.

Conclusion

Our experience underscores PCNL as an effective modality for both diagnosing and managing nephrolithiasis in patients with radiological NC in selected patients. Direct endoscopic inspection facilitates differentiating nephrolithiasis from NC, precise treatment, highlighting the need for careful evaluation in selected patients. Our study suggests a potential role of PCNL in such cases since there is clinically significant improvement of renal function, with relative improvement in serum creatinine of 47.5% with a p value of 0.018. Further prospective studies are warranted to validate these findings.

Declarations

Study approval statement

This study protocol was reviewed and approved by the Institutional Ethics Committee of AIIMS, Bhopal (IHEC-LOP/2025/IP160).

Consent to participate statement

Written informed consent was obtained from all patients to participate in the study.

This research was performed in accordance with the principles stated in the World Medical Association Declaration of Helsinki.

Consent for publication statement

Written informed consent was obtained from the patient for publication of the details of their medical case and any accompanying images.

Funding source- Nil

References

1. Albright F, Baird PC, Cope O, Bloomberg E (1934) Studies on the physiology of the parathyroid glands. Renal complications of hyperparathyroidism. *Am J Med Sci* 187:49
2. Miller NL, Humphreys MR, Coe FL, Evan AP, Bledsoe SB, Handa SE, Lingeman JE (2010) Nephrocalcinosis: re-defined in the era of endourology. *Urol Res* 38(6):421–427. 10.1007/s00240-010-0328-8. Epub 2010 Nov 6. PMID: 21057942; PMCID: PMC3787841
3. Cheidde L, Ajzen SA, Tamer Langen CH, Christophalo D, Heilberg IP (2007) A critical appraisal of the radiological evaluation of nephrocalcinosis. *Nephron Clin Pract* 106(3):c119–c124. 10.1159/000102999. Epub 2007 May 22. PMID: 17522474
4. Gdor Y, Faddegon S, Krambeck AE, Roberts WW, Faerber GJ, Teichman JM, Lingeman JE, Wolf JS Jr (2011) Multi-institutional assessment of ureteroscopic laser papillotomy for chronic flank pain associated with papillary calcifications. *J Urol* 185(1):192–197 Epub 2010 Nov 13. PMID: 21074798
5. Kurt Kerbl RV, Clayman (2000) Endourologic treatment of nephrocalcinosis, *Urology*, 56. 508(3):0090–4295. [https://doi.org/10.1016/S0090-4295\(00\)00675-0](https://doi.org/10.1016/S0090-4295(00)00675-0)
6. Bhojani N, Paonessa JE, Hameed TA, Worcester EM, Evan AP, Coe FL, Borofsky MS, Lingeman JE (2015) Nephrocalcinosis in Calcium Stone Formers Who Do Not have Systemic Disease. *J Urol* 194(5):1308–1312. 10.1016/j.juro.2015.05.074. Epub 2015 May 16. PMID: 25988516; PMCID: PMC5774334

Figures

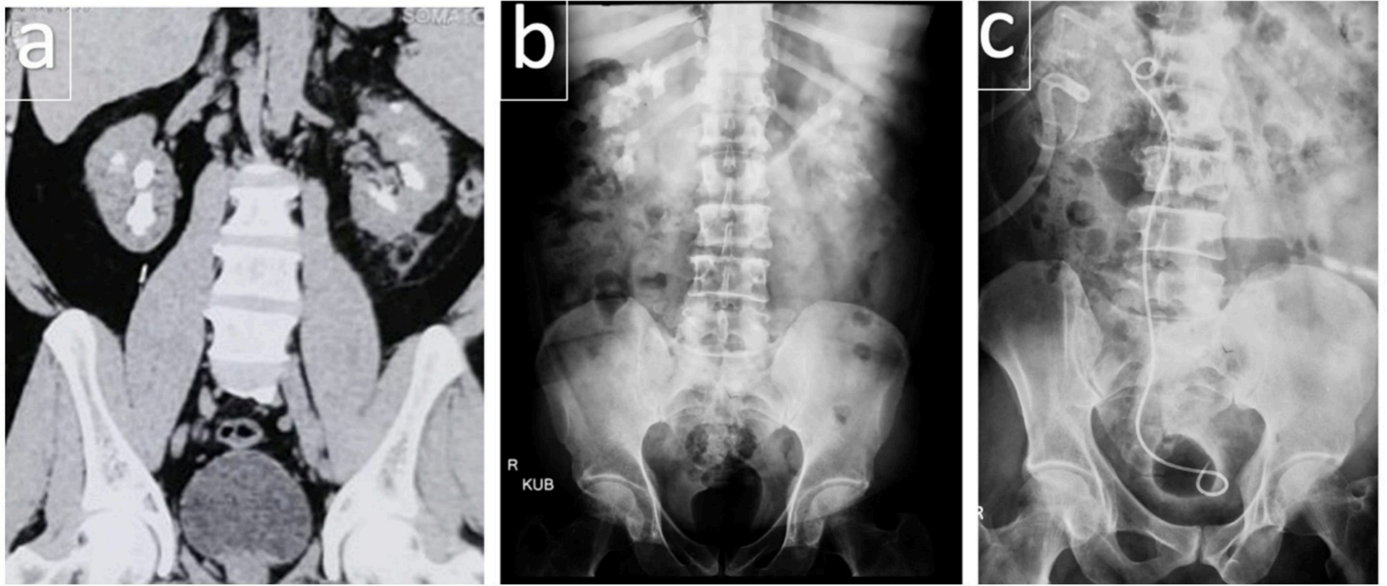


Figure 1

a shows coronal section with bilateral renal calculi, parenchymal and calyceal (a), **b** Preoperative Xray KUB and **1c** Postoperative Xray KUB showing 90% clearance.

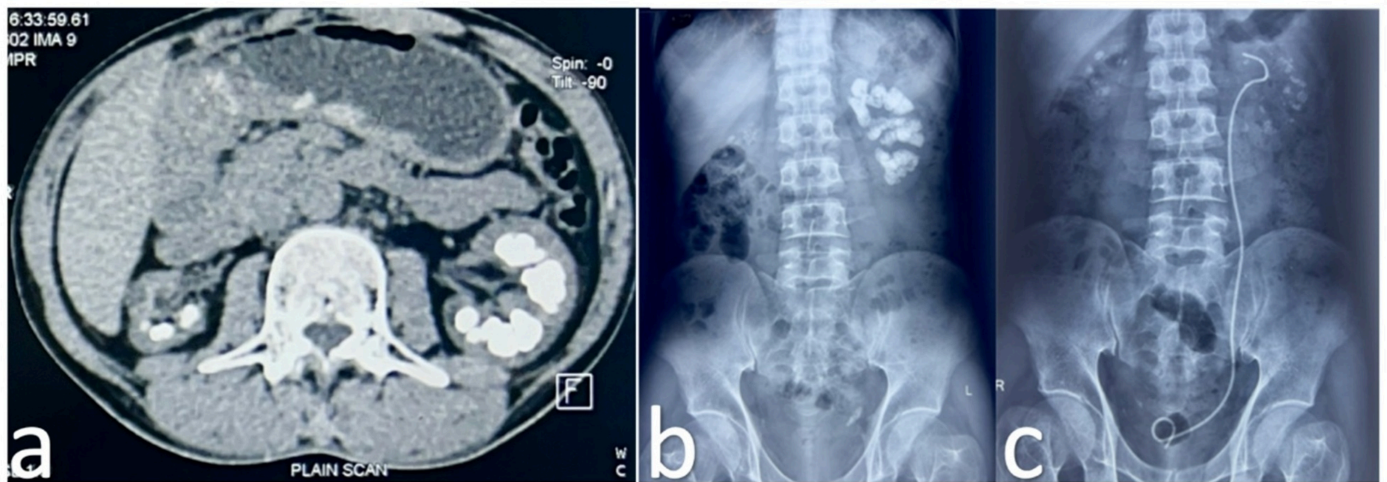


Figure 2

a Pre-operative NCCT KUB Revealing right atrophic shrunken kidney with hyper dense areas located in clusters and occupying more than half of left renal parenchyma, **b** Preoperative Xray KUB and **c** Postoperative Xray KUB showing 95% clearance.

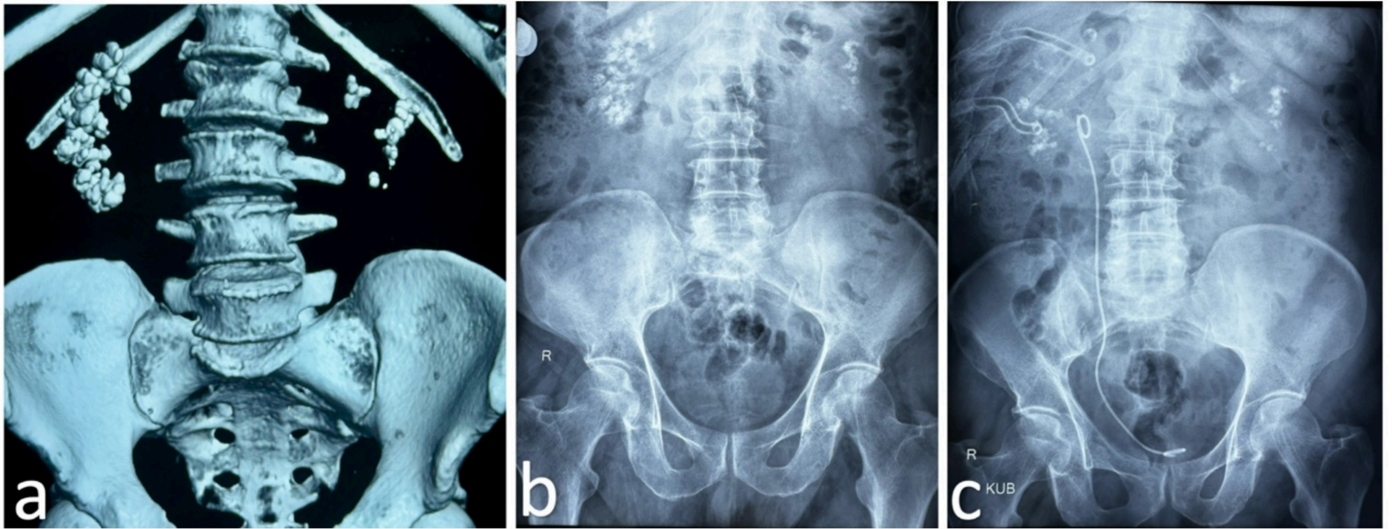


Figure 3

a shows NCCT KUB with hyperdense areas in clusters located in bilateral renal calyces and parenchyma, **b & c**-shows preoperative Xray KUB, and after Right stage 2 PCNL, achieving 85% clearance respectively.

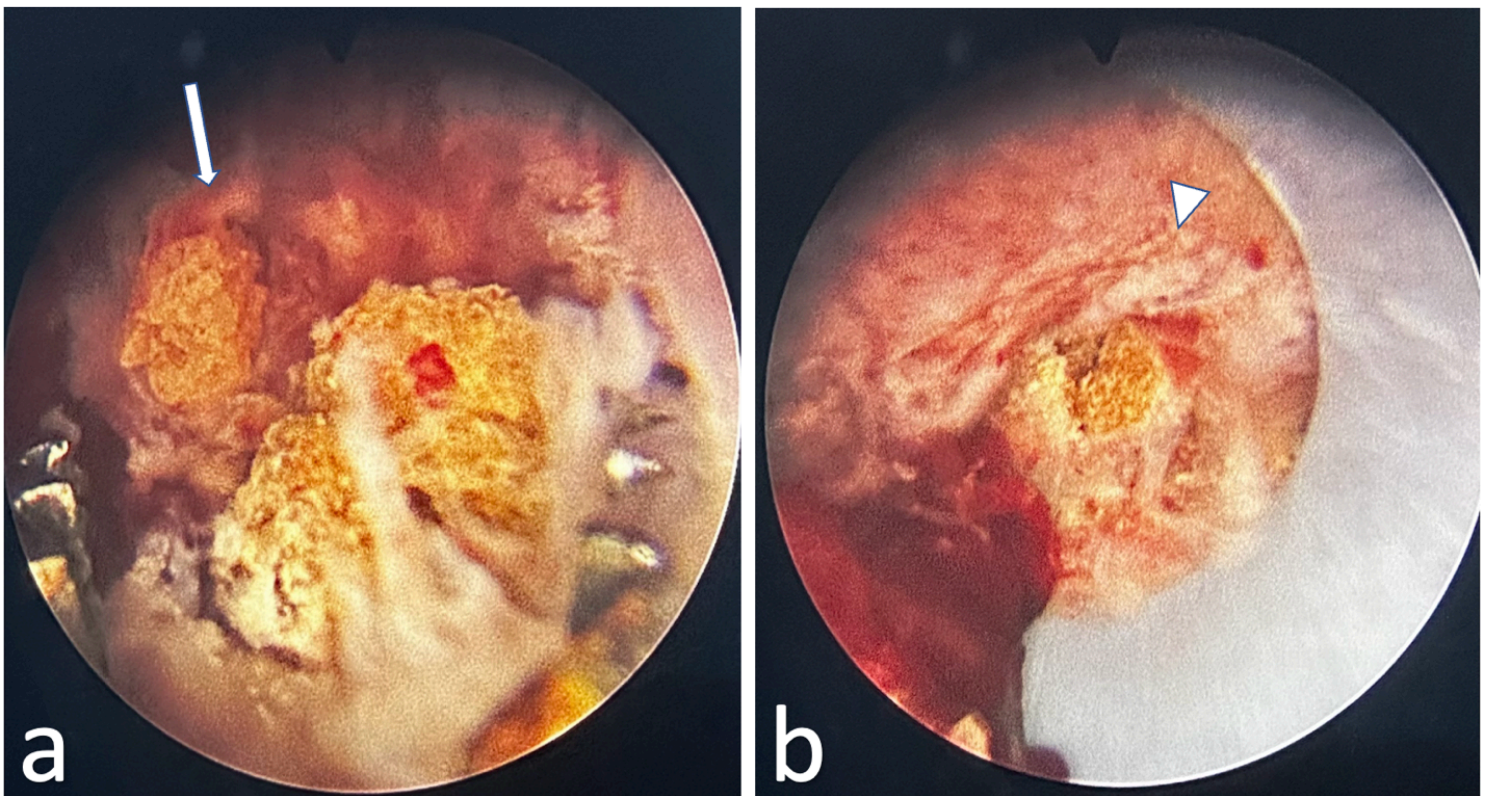


Figure 4

a suggestive of large calyceal stone being removed with PCNL forceps and smaller stone protruding from dilated duct of Bellini (white arrow). **b** shows finely stippled scattered calcifications (arrow head)