

Stone, Stuck Where?!

Pathology, Diagnosis, and Treatment of Kidney Stones

by

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Part I – Debilitating Pain

Sandeep awoke in the middle of the night with the urge to urinate and in excruciating pain. Clutching his back and taking careful steps, he made his way to the bathroom. He urinated a small amount of urine in comparison to the strong urge he was experiencing. As he walked back to bed, his wife, Kalyani, asked if he was alright. He responded in a panting whisper, “Yeah, I’m fine, it’s just the back pain is unbearable.” He took two Tylenol tablets, and they both agreed to go to the doctor’s office first thing in the morning.

Questions

1. Based on the location of the pain and the evidence provided, which organ system is most likely affected according to a referred pain map?

2. Could this reasonably have been mistaken for appendicitis?

Part II – Diagnosis and Chemistry

The next morning, Sandeep and his wife sat anxiously in the clinic examination room, waiting for Dr. Cuchelkar. A nurse entered and greeted the couple with a friendly smile. She asked Sandeep to step on the scale for his weight and height measurement. She then clipped a pulse oximeter onto Sandeep's finger and began taking his vitals: temperature, pulse rate, oxygen saturation, and blood pressure. A few minutes after her departure, the doctor entered with a warm smile that quickly faded into concern as he took in Sandeep's appearance.

"Hello Sandeep, how are you?" Dr. Cuchelkar asked.

"I'm doing okay, how about yourself?" Sandeep replied, although he was sweating and visibly struggling to avoid panting.

"Good, thank you," Dr. Cuchelkar said quickly, now focused on Sandeep's condition. "You're in pain; tell me what's happening."

Kalyani let out an exasperated and anxious sigh before stepping in to help her husband explain his symptoms. Sandeep had been struggling to urinate and was experiencing excruciating pain over the past 12 hours. He pointed to the left side of his lower back to show where the pain was centered.

"On a scale of one to ten, how would you rate your pain?" Dr. Cuchelkar asked.

"I'd say about an eight," Sandeep replied. "I took two Tylenol last night so I could rest."

"Okay," Dr. Cuchelkar said. "What you're describing sounds very similar to kidney stones. We'll do a 24-hour urine collection to help confirm that. To assist with the pain and fever, I recommend ibuprofen 600mg every six to eight hours and rest. Do you know how to do the urine collection?"

Sandeep nodded. "Your nurse walked us through the urine collection process when we arrived. No bloodwork yet; she said we'd wait to see if you recommended it."

Dr. Cuchelkar then proceeded with a physical examination. He measured Sandeep's breathing rate and palpated the abdominopelvic and lumbar regions. Sandeep gasped in pain when pressure was applied to the lower left area of his back. With the physical examination complete and a reminder of what to do, Sandeep got dressed, and the couple departed.

Thirty hours later the couple was once again seated in the doctor's office.

"Let me check to see if your urine test confirms the presence of stones," Dr. Cuchelkar said, sitting down at the computer. After a brief pause while reviewing the chart, he turned back to them. "Based on the urine results, it appears you may have kidney stones along with a urinary tract infection (UTI), indicated by the presence of *E. coli* and positive nitrite and leukocyte esterase tests (see Table 1, next page). Your blood test is consistent with this result (see Table 2, next page). This likely explains the slight elevation in your temperature. The infection is most likely caused by stones. I'm going to order a CT scan of your urinary system so we can further confirm the diagnosis and locate the stones."

"I had a feeling it would be kidney stones," Sandeep said with a sigh. "My father had this condition, and I remember how much pain he was in. He had to wait for days until the stones passed, and he would check every time he urinated using a strainer."

"Yes, I see the family history noted in your chart," Dr. Cuchelkar replied. "I'll have the nurse take you over to Imaging for the CT scan. I've already sent over your lab results, so you should be able to have the scan done shortly. I'll contact you as soon as I have the results. Please don't hesitate to call if you have any questions or if your condition worsens."

Table 1. Urine testing values for Sandeep compared with normal values (Denker et al., 2024; Leslie et al., 2024).

<i>Urine Testing Values</i>	<i>Sandeep's levels</i>	<i>Normal</i>
Urine volume	400 ml/ day	2000 ml/ day
Dipstick Urinalysis		
pH	4	4.5-8
Blood	Positive (gross hematuria)	Negative
Leukocyte esterase	High positive (3+)	Negative (0)
Nitrites	Positive (2+)	Negative (0)
Urine Culture		
Bacteria	<i>E. coli</i> present	Negative
Observation & Microscopic Analysis		
Color	Pink and turbid	Pale yellow and clear
Crystal	Present	Minimal
Colorimetric or Enzymatic Assays		
Calcium	350 mg / day	< 250 mg /day
Oxalate	58 mg / day	< 40 mg /day
Citrate	378 mg/day	≥ 450 mg/day
Uric acid	725 mg / day	600-750 mg /day
Sodium	271 mEq/day	100–260 mEq/day
Potassium	87 mg/day	25–100 mEq/day
Phosphorus	1166 mg/day	400–1,300 mg/day

Table 2. Blood testing values for Sandeep compared with normal values (Bhargava et al., 2024; Deluque et al., 2025).

<i>Blood Testing Values</i>	<i>Sandeep's levels</i>	<i>Normal</i>
Hemoglobin	15.8 g/dL	13.5–18.0 g/dL
RBC count	5.07 million/ μ L	4.7–6.0 million/ μ L
Calcium	13.9 mg/dL	8.8–10.4 mg/dL
Sodium	150 mEq/L	135–145 mEq/L
MCH (mean corpuscular hemoglobin)	31.1 pg / cell	27–33 pg / cell
WBC count	5,650 cells / μ L	4,000–10,000 cells / μ L
Lymphocytes	46%	20–40%

Questions

1. Did Sandeep's test results confirm that the urinary system was affected? Did the blood analysis support the symptoms that Sandeep was experiencing?

Part III – Exit Route

Sandeep and Kalyani followed nurse Mary to the CT scan room. As they walked slowly to accommodate Sandeep's pace, Mary chatted with the couple about the drive over. Kalyani was curious about how this had happened to her husband. Sandeep walked every day, drank a lot of water, and since she prepared the meals, mostly vegetarian, she wondered how this could have occurred. She had adjusted their diet based on her primary care recommendation, lowering salt levels. Mary explained to Kalyani that in individuals with genetic predispositions and with changes in hormonal regulations, certain foods are linked with kidney stone formation. Kalyani nodded and acknowledged that this made sense as Sandeep's father had had multiple kidney stones throughout his lifetime.

Thirty minutes later, Sandeep and Kalyani were back in their car heading home. The scan was completed, and they awaited Dr. Cuchelkar's call. Table 3 below shows the result from the CT scan.

Table 3. Computed tomography (CT) scan for Sandeep compared with normal values.

<i>Test</i>	<i>Sandeep's</i>	<i>Normal</i>
CT Scan	Stone located in left ureter at the ureterovesical junction (UVJ)	Absent

Questions

1. What are possible causes of increased calcium (Ca^{2+}) levels in the urine?
2. How is calcium regulated by the kidneys? Complete Figure 1 (see next page) by filling in the grey boxes using the key provided. (Hint: one of the boxes has two answers.)
 - (A) Ca^{2+} reabsorption in kidneys decreases
 - (B) Ca^{2+} absorption increases in the small intestine
 - (C) Ca^{2+} level in blood decreases
 - (D) Thyroid gland releases calcitonin
 - (E) Ca^{2+} reabsorbed from filtrate in the kidneys
 - (F) Parathyroid glands release PTH
 - (G) Ca^{2+} level in blood increases
 - (H) Vitamin D3 converted to calcitriol
 - (I) Osteoclast activity is inhibited
 - (J) Osteoclasts release Ca^{2+} from bones
3. What hormones are involved in the regulation of calcium (Ca^{2+}) levels?
4. Review the section "Calcium Reabsorption Along the Renal Tubule" in the following article and then answer questions (a)–(f) below.

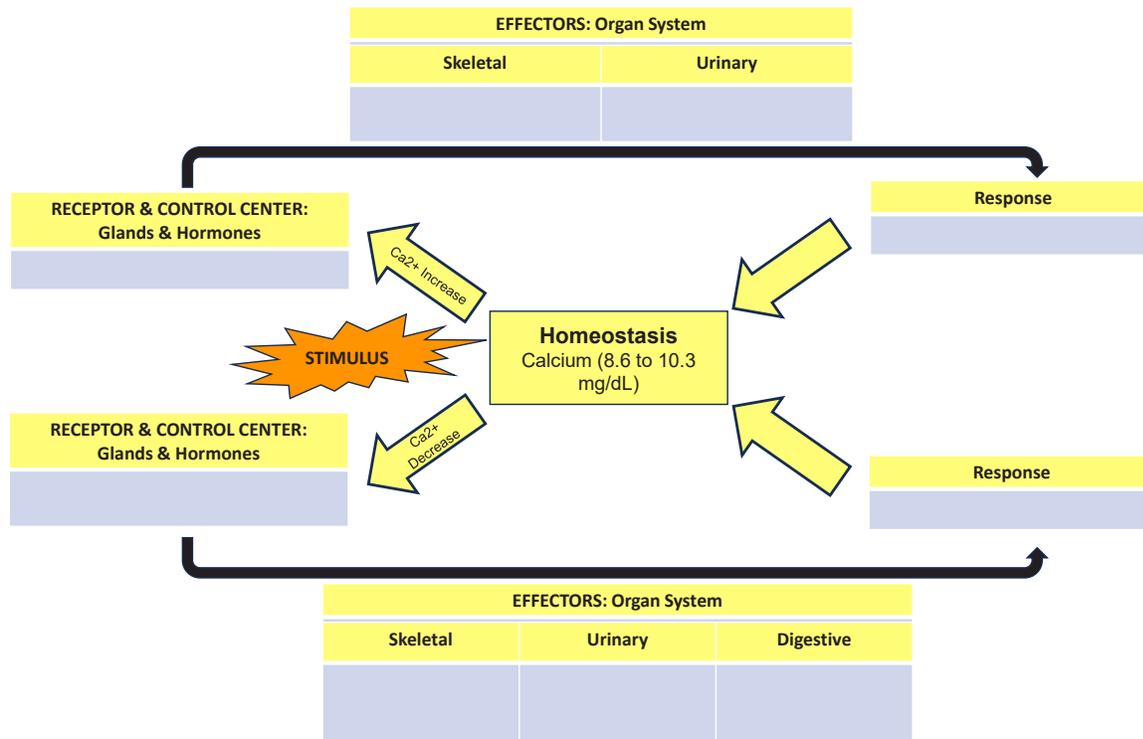


Figure 1. Calcium homeostasis.

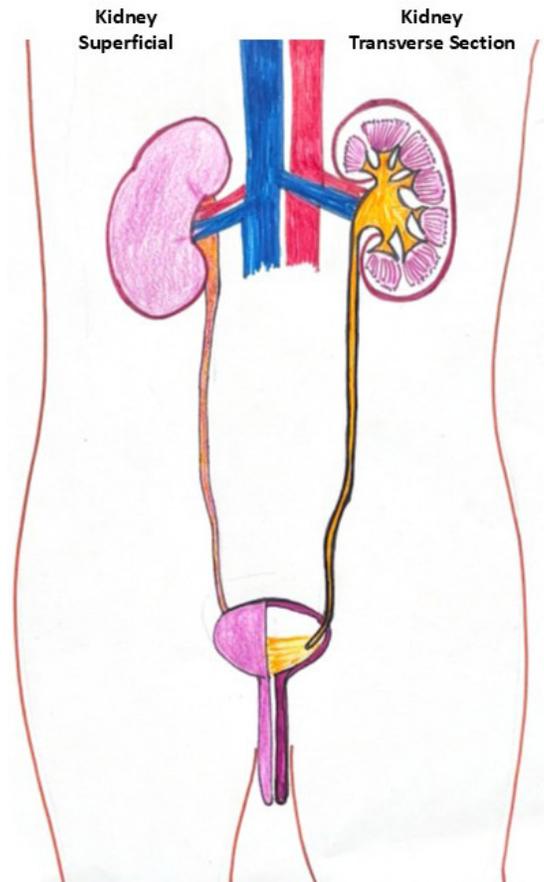
- Deluque, A.L., H. Dimke, & R.T. Alexander. (2025). Biology of calcium homeostasis regulation in intestine and kidney. *Nephrology Dialysis Transplantation* 40(3): 435–45. <<https://doi.org/10.1093/ndt/gfae204>>

- What percent of filtered Ca²⁺ is reabsorbed by the renal tubules?
 - How much calcium is reabsorbed in the proximal convoluted tubule (PCT), and by what mechanism?
 - How much calcium is reabsorbed in the thin descending limb (TDL)?
 - How much calcium is reabsorbed in the thick ascending limb (TAL), and by what mechanism?
 - How much calcium is reabsorbed in the distal convoluted tubule (DCT) and collecting tubules, and by what mechanism?
 - What percentage of filtered calcium is normally lost in the urine?
5. Given that Sandeep is experiencing hypercalcemia (see Table 2), what could be the likely cause? How would this be confirmed?

6. Where does the formation of kidney stones typically take place within the kidneys?

7. Refer to Figure 2 to answer questions (a)–(c).

- (a) Starting at the renal papilla, number and label the structures on Figure 2 in anatomical order that the stones will take to exit the body. Use the following terms: *urinary bladder*, *urethra*, *renal pelvis*, *minor calyx*, *renal papilla*, *major calyx*, *ureters*.
- (b) Circle exactly where the stone was stuck in Sandeep.
- (c) Why did the stone get stuck there?



8. What happens when a stone is stuck in the ureter?

9. Does this correlate with Sandeep’s symptoms?

Figure 2. Urinary system, with the left side shown in a coronal (frontal) section.

10. While some symptoms may overlap, the location of a kidney stone can produce additional, location-specific signs as noted in Table 4 below. Complete the table to indicate where stones may also become lodged.

Table 4. Locations of kidney stones.

<i>Location of Stone</i>	<i>Description</i>	<i>Typical Symptoms</i>
Ureterovesical junction (UVJ)	Where the ureter meets the bladder	Lower abdominal or pelvic pain, urinary urgency, frequency
	Where the renal pelvis meets the ureter	Severe flank or lower back pain, nausea, possible hematuria
	In the urinary storage organ	Lower abdominal discomfort, urinary urgency, pain during urination
	Passage from bladder to outside the body	Difficulty urinating, urinary retention, sharp pain during urination

Part IV – Holistic or Medical Intervention

After lunch, Sandeep and Kalyani received a video call from Dr. Cuchelkar regarding the CT scan results. “The CT scan shows a kidney stone in your left ureter, consistent with your labs results and symptoms,” Dr. Cuchelkar said.

Sandeep responded, “Doctor, obviously kidney stones is a family legacy, but is there anything I can do to prevent more kidney stones in the future?”

“Yes, the main thing is reducing the intake of high-sodium foods and oxalate-rich foods, such as chocolate and peanuts. I’ll email you an information sheet containing more information about a better diet to follow for kidney stone prevention. However, your family history suggests a genetic predisposition to kidney stone formation,” said Dr. Cuchelkar. Sandeep and Kalyani nodded in response to show their understanding. “For treatment, I’ll prescribe you Flomax® and ciprofloxacin. Flomax will help you relax the ureteral muscles to pass any stones into the bladder. Ciprofloxacin is an antibiotic that will help you with UTI. These medications do have multiple side effects, which will be described on the prescription when you pick them up at your local drugstore. If you have any questions about the treatment, please do not hesitate to call me,” Dr. Cuchelkar concluded.

“Thank you so much Doctor. My father used Neeri, which is an ayurvedic combination used for urinary conditions. Neeri helped him greatly to pass his kidney stones, and I prefer to use it because of its natural ingredients and minimal side effects. Would it be okay to use this instead of the medications which you prescribed?” Sandeep asked.

“Yes, absolutely. Feel free to use Neeri if that makes you feel better, but after passing the stone and taking care of the UTI with the medications I recommended.” Sandeep and Kalyani nodded in response and thanked the doctor.

Questions

1. Sandeep prefers to use Neeri. Why did Dr. Cuchelkar agree to its use after his prescribed medicine of Flomax and ciprofloxacin? (Hint: review Neeri; see Goyal et al., 2017, https://doi.org/10.4103/pm.pm_551_16; Singh et al., 2024, <https://doi.org/10.3390/biomedicines11061654>; Upadhyay & Pandey, 2024, https://doi.org/10.4103/jras.jras_70_24.)
2. Sandeep’s sodium levels were elevated (refer back to Table 1 and 2). It was recommended that he reduce high sodium foods. Why is this important, and what other dietary measures could be prescribed to prevent recurrence? (Hint: review transport mechanisms; see Deluque et al., 2025, <https://doi.org/10.1093/ndt/gfae204>.)

3. Based on the information shown in Table 5 below, which approach would you choose? Holistic (natural) or medical?

Table 5. Comparison of holistic and medical interventions for kidney stone treatment.

Condition	Holistic (Natural) Interventions	Medical Interventions
Effectiveness	Best for small stones (<5 mm)	Effective for all sizes, especially >6 mm
Speed of relief	Slow, may take days to weeks	Fast, immediate relief via procedures or medications
Invasiveness	Non-invasive	Can be minimally to highly invasive
Cost	Generally low (home remedies, lifestyle changes)	High (ER visits, imaging, surgery, hospital stay)
Side effects	Minimal (if remedies are well-researched)	Possible side effects (from anesthesia, medication, infection, etc.)
Pain management	Limited (herbs, hydration, natural anti-inflammatories)	Strong pain control (NSAIDs, opioids if needed)
Risk of complications	Higher if stone does not pass or infection develops	Lower if promptly treated
Diagnostics	None (rely on symptoms, guesswork)	CT scans, ultrasounds, blood/urine tests for accurate diagnosis
Preventive potential	Strong, focuses on hydration, diet, supplements	Limited unless paired with lifestyle changes

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