

**RENAL COLIC**



*Samuel Pepys, oil on canvas, Sir Godfrey Kneller 1664.*

*“In this great and dangerous Operation, life and death doe so wrestle together, that no man can tell which will have the victory”*

*English translation of a Dutch Medical text, Lithotomia Vesicae, 1640*

*“Up, full of pain, I believe by cold got yesterday. So to the office, where we sat, and after office home to dinner, being in extraordinary pain. After dinner my pain increasing I was forced to go to bed, and by and by my pain rose to be as great for an hour or two as ever I remember it was in any fit of the stone, both in the lower part of my belly and in my back also. No wind could I break. I took a glyster, but it brought away but a little, and my height of pain followed it. At last after two hours lying thus in most extraordinary anguish, crying and roaring, I know not what, whether it was my great sweating that may do it, but upon getting by chance, among my other tumblings, upon my knees, in bed, my pain began to grow less and less, till in an hour after I was in very little pain...”*

*Samuel Pepys, Diary Entry for Saturday 14 May 1664.*

*On the 26th of March 1658, the great diarist Samuel Pepys knocked on the door of his sister, Jane Turner’s house. He was greeted by an assortment of concerned and fussing relatives and friends as well as his sister. He had decided to undergo the operation of lithotomy for a bladder stone that had been making his life a sheer hell on Earth. Although he had chosen one of the best lithotomist surgeons in the nation, Thomas Hollyer, whose last 40 out of 44 patients had survived the operation, it was not a decision he had taken lightly. A well known English translation of a Dutch medical text gave a fearsome description of the lithotomy operation. “In this great and dangerous Operation, life and death doe so wrestle together, that no man can tell which will have the victory”, it noted. It went on to recommended that patients who were to undergo the procedure, “should make their peace with God”*

*But Pepys’ life had become so unbearable, that anything, perhaps even death itself, would be preferable than to continue any longer with the torment he had been enduring. He had been well prepared for the operation on the advice of his doctor. He had been liberally bled, and had received a “goodly purging” as well. Pepys’ father had arranged for prayers to be said for the success of the coming operation. He was allowed one egg before the operation and a brief consultation with his priest. He was given his specially prescribed pre-medication which consisted of a concoction made of liquorice, marshmallow, cinnamon, milk, rosewater, various herbs and the whites of fifteen eggs. Opium was also given, but alcohol was strictly forbidden. After this he was asked by his surgeon to take his place on a specially constructed lithotomy table that had been placed in the middle of the dining room. His surgeon uttered quiet reassurances, at the moment he had placed himself on the table when a half dozen burly assistants abruptly grabbed him and held him vice like to the table. His arms and his legs were firmly bound to the device and a bite was placed between his teeth. Hollyer soaked his surgical instruments in a solution of warm water and “milk of almonds” and with a deep breath quickly and efficiently set to work.*

*He inserted a thin silver instrument, the “itinerarium” through the penis into the bladder in order to feel for and then position the bladder stone. The scrotum was then lifted by an assistant to leave one side of the perineum exposed. A deep incision was then made with a razor sharp scalpel blade that reached all the way into the bladder. Amidst the muffled screams of the patient an assistant kept sponging the sweat off both the surgeon’s and the patient’s faces. The crows-beak forceps were then passed through the incision and Hollyer desperately sought out the stone amidst the flow of blood. After much difficult maneuvering, he managed to extract a colossal stone, the size of tennis ball. In the Seventeenth century tennis balls were a good deal smaller than they are today, nonetheless the object measured 2 cm in*

*diameter! Following the extraction the wound was packed and Pepys was unbound and led to his sister's bed in state of shock and almost fainting with pain. He would be confined to bed for a full week. Recovery for those who did not die of blood loss or horrific secondary infection, was expected to take 30 or 40 days. By the sheer grace of god Pepys recovered fully by 35 days.*

*Later on, ever the enquiring scientist, and after having given profuse thanks to the almightily for surviving his operation, he requested from Dr Hollyer his stone. He placed it in a specially constructed urn which he placed on his fireplace mantelpiece and would ever more discuss the "fascinating" object to anyone who would listen, and more often than not even to those who much preferred not to listen! So grateful was he that he celebrated the anniversary of his stone removal with a magnificent feast and gave thanks to God on his knees every year thereafter for the rest of his life!*

*In the 21st century, in an age of antibiotics, general anesthesia, powerful drugs and miraculous technology, it is difficult for us to fully appreciate what it meant to decide on a surgical procedure in the Seventeenth century. In the modern age we are excited by a renal stone of 5 mm diameter. We attack it aggressively with such marvels as extracorporeal lithotripsy and lasers and complain that these expensive procedures are not granted to us immediately! It is easy to feel smug, bemused and "superior" when we read of the desperate accounts of our Seventeenth century predecessors in their attempts to alleviate immense human suffering. Yet one should retain a great admiration for what they were able to achieve with the knowledge and technology they had. The priest was an important part of the surgical team. Both surgeon and patient would routinely spend some minutes in quiet prayer before the procedure was undertaken. The priest gave comfort and reassuring words of God's will. Although the procedures were barbaric by 21st century standards, they were nonetheless undertaken with great skill and supreme courage on both the part of the surgeon and the patient - their courage a most admirable feature of their spirit. It is interesting to contemplate if physicians of future centuries will hold anywhere near the same admiration, in relative terms, of this human quality, for ourselves when compared to our predecessors of the Seventeenth century - one suspects perhaps not!*

## RENAL COLIC

### Introduction

**Renal colic** (or **nephrolithiasis**) is an extremely common presenting problem to the Emergency Department.

The immediate priority will be pain relief.

The majority of stones (about 90%) will pass spontaneously within one month.

Larger stones (> **5 mm**) will have increased difficulty in passing spontaneously.

The majority of patients can be treated in the Emergency Department then discharged for Urologist follow-up.

Admission will be necessary for those with:

1. Associated fever/ sepsis (true urological emergency).
2. Intractable pain
3. Severe hydronephrosis
4. Impaired renal function
5. Single functioning kidney
6. Bilateral obstructions
7. Patients with a transplanted kidney.
8. Larger stones (5 mm or more – particularly if they are proximal in position).

- **These have high rates of re-presentation**

Urologists are increasingly using **Ureteroscopic laser lithotripsy** in preference to Extracorporeal shock wave lithotripsy (ESWL) for definitive treatment.

### Epidemiology

Renal colic is a common condition.

About 50% of patients suffer just a single episode in their life, but 50% will have recurrent episodes within 5 years.

It occurs most commonly in the age group 20 -50 years.

In the young and the elderly alternative diagnoses need to be more strongly considered.

### Pathophysiology

Low fluid intake, with a subsequent low volume of urine production, predisposes to high concentrations of stone-forming solutes in the urine, and so dehydration is thought to be a factor in the formation of renal tract stones.

Hereditary factors are also thought to be involved.

### Stone types:

1. Calcium based, (75%):

States of hypercalcemia (from any cause) may predispose to calcium stones.

These may take the form of:

- Calcium oxalate
- Calcium phosphate
- Calcium oxalate/ phosphate mix.

2. Uric acid stones (8%):

- These stones are associated with a urinary pH of less than 5.5, high dietary purine intake or malignancy (i.e., rapid cell turnover).

Approximately 25% of patients with uric acid stones will also have gout.

3. Struvite (magnesium ammonium phosphate) stones (15%):

- These are thought to be associated with chronic urinary tract infection with gram-negative bacilli that are capable of splitting urea into ammonium, which can then combine with phosphate and magnesium.

Usual organisms include *Proteus*, *Pseudomonas*, and *Klebsiella* species. *Escherichia coli* is *not* capable of splitting urea and, is therefore not associated with struvite stones. Urine pH is typically greater than 7.0

4. Cystine based (2%)

- They are caused by a metabolic defect resulting in failure of renal tubular reabsorption of cystine, ornithine, lysine, and arginine. Urine becomes supersaturated with cystine, with resultant crystal deposition.

5. Xanthine stones (rare):

- These are caused by an inborn defect of the enzyme xanthine oxidase.

### Complications:

The most important include:

1. Infection:
  - **This is a true Urological emergency in the setting of an obstructed renal tract.**
2. Severe hydronephrosis, leading to longer term cortical atrophy.

When severe hydronephrosis is present rupture can occur with the formation of a “uroma”

Common sites of stone obstruction include:

- Pelviureteric junction (PUJ)
- Pelvic brim, (as the ureter crosses in front of the iliac artery).
- Vesicoureteric junction (VUJ)

### Clinical Assessment

#### Important points of history:

1. Nausea and vomiting are common.
2. Pain is usually severe and colicky in nature, with loin pain radiating to the groin, testes/labia
3. If pain is constant and prolonged, this may indicate:
  - Complicating pyelonephritis.
  - Total obstruction with severe hydronephrosis
  - Pelvic calyceal rupture with uroma
4. Pain confined to the RIF/ LIF may indicate a stone in the region of the VUJ.
5. Suprapubic pain may indicate a bladder stone
6. Is the patient on warfarin or a NOAC?

- Clot retention and retroperitoneal hematoma need to be considered as a differential diagnosis.

Important points of examination:

1. Vital signs:

**Fever** in particular:

- This will indicate the serious complication of obstructive pyelonephritis.

2. The patient is usually in significant distress and is unable to remain still.

- If the patient remains still and is reluctant to move, this is more suggestive of “peritonism” and pyelonephritis.

3. It is important to check for testicular tenderness/swelling/ inflammation (as testicular pain may radiate towards the groin and thus “mimic” renal colic).

4. Hematuria:

- This can be microscopic or macroscopic.

Differential Diagnosis:

The clinical diagnosis of renal colic is usually straight forward.

Important differential diagnoses, however include:

1. Expanding or ruptured **abdominal aortic aneurysms in the elderly.**

- In fact renal colic is relatively uncommon in the elderly and abdominal aortic aneurysms must always be considered in any elderly patient presenting with back or loin pain.

2. Lower lobe lung pathology, such as pneumonia or pulmonary embolism.

3. Bleeding conditions:

- Retroperitoneal hematoma, (especially if the patient is on warfarin)
- Clot within the renal tract.

4. PUJ obstruction may result in pain similar to renal colic.

5. Testicular pathology.

6. Drug seeking behavior:

## Investigations

### Blood tests:

- 1 FBE:
  - WCC may be mildly elevated, however a count above 15000/ mm<sup>3</sup> suggests complicating infection.
2. CRP
  - If complicating infection is suspected.
- 3 U&Es and glucose
4. Beta HCG in women of child bearing age, should always be considered.

The following should be done for first episodes of renal colic, (or if not previously done):

4. Calcium phosphate.
5. Uric acid level

### FWT:

Most cases will show positive for blood, *however, its absence does not rule out renal colic.*

The incidence of hematuria increases with the acuity of the attack.<sup>1</sup>

- Acute renal colic requiring opioids has an incidence of hematuria of 90 %.
- Subsiding colic has an incidence of hematuria of 85 %.
- Post colic (pain resolved) has an incidence of hematuria of 80 %
- Quiescent calculus has an incidence of hematuria of 50 %

### Stone analysis:

If a stone or “gravel” is seen in the urine, it can be sent to the pathology laboratory for analysis.

### KUB:

This is a plain abdominal x-ray that is focused on the region of the kidney, ureter and bladder, (hence “KUB”).

It need only be done if the CT scan is positive for a renal stone.

The majority of stones are radio opaque, however KUB alone is not sufficient to diagnose nephrolithiasis as it has poor sensitivity (around 60% only).

It is primarily used to document the position of the stone for future follow-up by the urologist.

It is also done to assess whether the stone is radiolucent on plain radiographs or not for subsequent follow up purposes.

- It is useful to have a plain x-ray to document that the stone is opaque - that way at follow up the Urologist only needs to do another plain x-ray to chart progress of the stone and so the patient can be spared having a repeat **CT KUB**.
- If the stone is not seen on a plain KUB, however then it is radiolucent - and so at follow-up a CT KUB will need to be done to assess progress. (because CT can pick up a lucent stone whereas plain x-ray may not)

Note that 100% of stones are seen on CT, whilst only 85% of stones are seen on plain x-ray. Whether a stone is seen on plain x-ray largely depends on its composition.

### CT KUB:

**Virtually all renal stones are visible on CT (*without contrast*).**

**CT scan is the investigation of choice.**

It is far less time consuming than IVP (traditionally performed in the past) and does not expose the patient to the risk of IV contrast and there is no requirement for bowel preps.

It is better able to visualize smaller stones and most importantly it has the ability **pick up other unsuspected conditions such as aneurysms and diverticulitis**.

CT may also distinguish complicating pyelonephritis and uroma from simple hydronephrosis.

As well as visualizing a stone CT is also valuable for assessing the degree of associated **hydronephrosis:**

Hydronephrosis refers to distension of the renal pelvis and calyces, caused by an obstructive uropathy. Untreated, it leads to progressive atrophy of the kidney. Hydroureter is defined as a dilation of the ureter.

Hydronephrosis is generally classified by radiologists somewhat arbitrarily as **mild, moderate or severe**.

By some definitions this has been defined as:

### Mild:

- Hydronephrosis as enlargement of the calices with preservation of the renal papillae.

### Moderate:

- Hydronephrosis as rounding of the calices with obliteration of the renal papillae.

### Severe:

- Hydronephrosis as calyceal ballooning, (if there is also cortical thinning then the obstruction is chronic).

**Patients should ideally have their CT scan before leaving the Department to ensure diagnosis is made and to help rule out other unsuspected conditions.**

### Ultrasound:

Ultrasound is a useful screening test for the detection of hydronephrosis; however it *cannot* reliably detect renal stones.

It is a useful screening test in particular for patients in whom radiation is best avoided.

### MRI:

This can be an option for stone detection in pregnant women, though it currently lacks sensitivity for smaller stones.

### Management

#### 1. Analgesia:

For suspected Renal Colic the immediate priority will be analgesia.

Non-selective NSAIDs and opioids provide effective analgesia for renal colic.<sup>2,6</sup>

For mild to moderate pain use:<sup>6</sup>

- *Ibuprofen 400mg orally 6 hourly prn*

*With or without:*

- *Oxycodone immediate release 5 to 10mg orally 4 to 6 hourly prn*

*Note however that NSAIDS should be used with caution, if at all, in the elderly or in the presence of renal disease or peptic ulcer disease.*

Alternative options in those *unable to tolerate oral medication* include:

- 30 mg IM or IV ketorolac
- 100 mg PR indomethacin (if tolerated by the patient).

For severe pain use: <sup>6</sup>

**Morphine:**

- *Morphine 2.5 to 5mg IV as an initial dose, then titrated to effect every 5 to 10 minutes with further incremental doses of 2.5 to 5mg IV*
- *In elderly patients or those with cardiorespiratory compromise, an initial morphine dose of less than 2.5mg IV and incremental doses of 0.5 to 1mg should be considered.*
- *Patients should be reassessed to determine if the dose has been effective or if there are any adverse effects (especially sedation).*

**Fentanyl:**

- *If morphine is contraindicated, consider fentanyl at 25 to 50 micrograms IV as initial equivalent dose.*

Note that there is **no good evidence** that the use of IM buscopan reduces the requirement for narcotic analgesia in patients with renal colic. <sup>3</sup>

2. IV fluids:

Some authorities believe that intravenous fluids hasten passage of the stone through the urogenital system. Others express concern that additional hydrostatic pressure exacerbates the pain of renal colic. The situation is unresolved, however:

- IV fluids may be necessary in patients with prolonged stays in the ED who remain “nil orally” and especially if there has been vomiting and dehydration.
- Fluids may also be necessary in case of narcotic induced hypotension.

3. Tamsulosin:

Studies have thus far failed to definitively demonstrate the ability of tamsulosin to decrease the need for further treatment to achieve stone clearance in 4 weeks for patients with expectantly managed ureteric colic.

However a recent Australian study **has** demonstrated that for larger **distal stones**, that are between **5-10 mm** in size tamsulosin **enhances stone clearance**. <sup>5</sup>

Though a reduced need for further *intervention* was not shown, the possibility remains that this may be so.

**In any case the use of tamsulosin for distal stones of 5 - 10 mm can reduce the length of time patients suffer from debilitating symptoms.**

4. Intervention:

For stones that do not pass spontaneously with conservative management or when complications arise necessitating urgent removal interventional options include:

**Extracorporeal shock wave lithotripsy (ESWL)**

This was the standard non-invasive therapy in the past, until Ureteroscopic laser therapy became available.

**It is ideally suited to smaller stones with the renal pelvis**

Shock wave lithotripsy is the least invasive method of eliminating stones, but also the least effective.

Contraindications include:

- Pregnant patients
- Anticoagulated patients.
- Stones > 1.5 cm
- Multiple stones (a relative contraindication)

**Ureteroscopic laser lithotripsy:** <sup>7</sup>

Currently, most patients with ureteric stones that require intervention will have ureteroscopic laser lithotripsy.

Laser lithotripsy has a stone free rate that is superior to ESWL

The use of pulsed lasers to break up stones has been advocated for 15 years, but such lasers have only become commonly available in Australia in the past 10 years in the private health system, and even more recently in the public health system.

Retrograde uretero pyeloscopic laser lithotripsy has gained increased popularity with the miniaturisation of flexible uretero reoscopes and the wider availability of lasers.

Latest generation instruments enable surgeons to explore the **entire collecting system** and achieve stone clearance rates of around 95% with a single operation for stones up to 1 cm, and 88% for stones 1- 2 cm in the lower pole.

The technique however requires a GA and has higher complication rates than ESWL.

*Contraindications include:*

- Urinary sepsis
- General contraindications to general anaesthesia.

Patients on antiplatelet/anticoagulant drugs can continue taking the drugs with little increased risk.

*Complications include:*

- Hematuria
  - ♥ Very common but only problematic in <1 % of patients
- Infection
- Postoperative pain
- Ureteric injury (rare, but potentially significant).

**Percutaneous nephrolithotripsy/ nephrolithotomy:**

These are now generally reserved for stones larger than 2 cm, and most commonly for staghorn calculi.

It has considerably more risks than retrograde lithotripsy, particularly bleeding and sepsis.

Patients may have delayed retrograde laser lithotripsy or SWL to “tidy up” small remaining fragments in calyces not accessible to the percutaneous approach.

**Open nephro- or pyelo-lithotomy:**

Although open surgery is performed rarely for stone disease nowadays, it remains an effective treatment for staghorn calculi with stone clearance rates of >80%.

However, it comes at the cost of a week in hospital, considerable postoperative pain from a loin incision and a 6 week recovery before return to work for most occupations.

### Disposition

Most commonly patients can be treated the ED over a period of hours.

They may be sent home if there are no other criteria for admission, once symptoms have settled with oral analgesia and a Urology outpatient referral.

Criteria for admission include:

1. **Any patient with a fever (see also pyelonephritis document)**
2. Patients with intractable pain:

Intractable pain may be due to a large stone (> **5 mm**), which will have difficulty in passing spontaneously or severe hydronephrosis or even a “uroma”(ruptured calyceal system)

*In general terms:* <sup>4</sup>

<b>Stone Size</b>	<b>Likely outcome</b>
<b>≤ 4 mm</b>	90 % will pass within a month
<b>5- 7 mm</b>	50 % will pass within a month
<b>≥ 7 mm</b>	5 % will pass within a month

*The overall passage rates for a stone within the ureter are:*

<b>Position within the Ureter</b>	<b>Overall likelihood of passage</b>
<b>Proximal ureteric stones</b>	25%
<b>Mid ureteric stones</b>	45%
<b>Distal ureteric stones</b>	75%

3. Hydronephrosis:

- Mild or moderate cases can still be discharged so long as there are no other complicating factors.

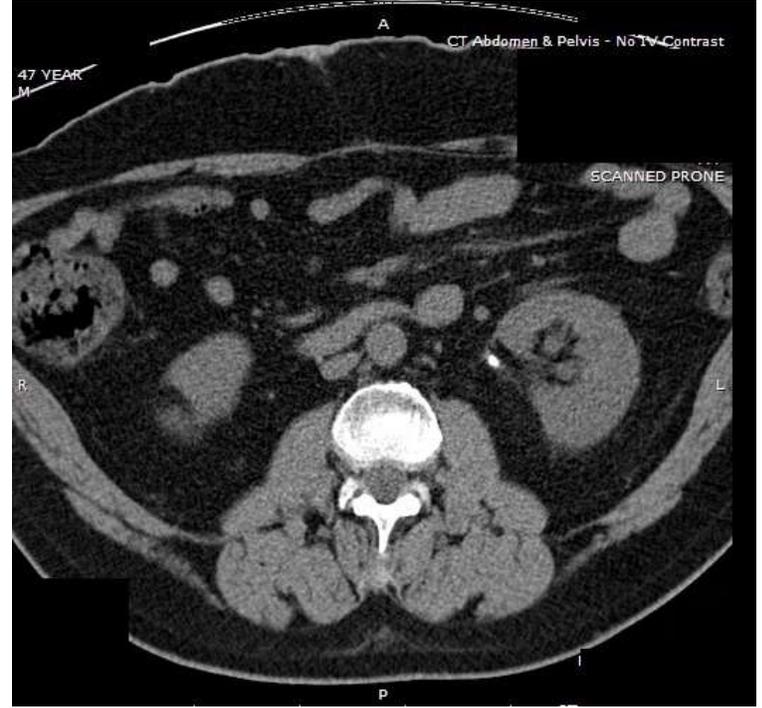
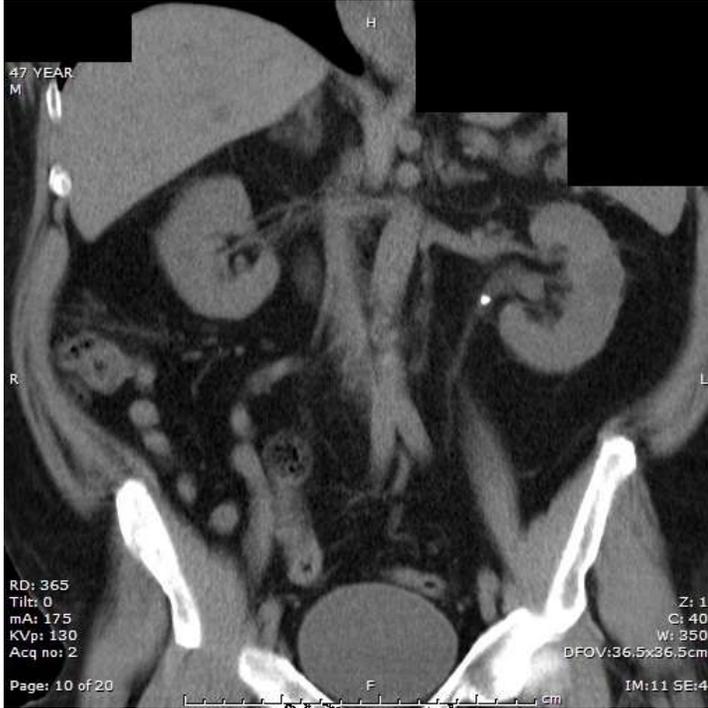
Cases of **severe hydronephrosis** usually require admission.

- 4 Deteriorating renal function.
- 5 Patients with a single functioning kidney.
6. Patients with bilateral obstructions
7. Patients with a transplanted kidney.
8. Lager stones (5 mm or more – particularly if they are proximal in position).
  - **These have high rates of re-presentation**

If uncertain, always consult with the Urologist.

**Many patients with renal colic may be suitable for a Short Stay Unit admission, until their pain is controlled.**

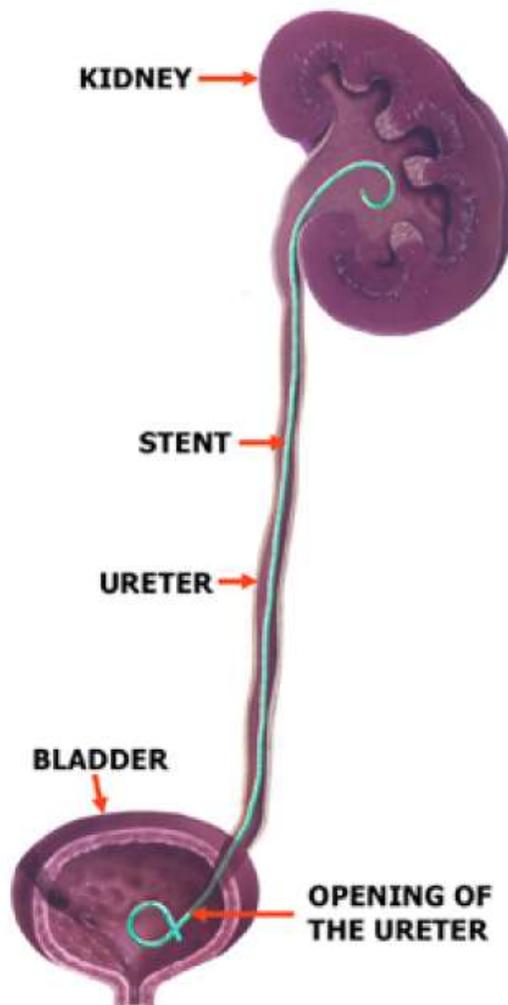
## Appendix 1



*Left: Non-contrast coronal section showing typical appearance of a renal stone, 6 mm, at the left pelvi-ureteric junction, in a 47 year old male. Right: Seen in transverse section. Stones appear to have the same density as bone on CT scan.*

## Appendix 2

### The Double J Stent:



*The double J stent is a thin, hollow stent that is often placed inside the ureter during surgery to ensure drainage of urine from the kidney into the bladder. J shaped curls are present at both ends to hold the tube in place and prevent migration, hence the description “double J stent”.*

*They allow the kidney(s) to drain urine by temporarily relieving any blockage, or to assist the kidney(s) in draining stone fragments freely into the bladder if definitive kidney stone surgery is carried out.*

*Stents are used in temporary situations and must eventually be removed from the body, within 6 months – but most are removed well before this*



*Left: Le Dejeuner d'Huitres, (The Oyster Lunch), oil on canvas, Jean-Francois de Troy, 1735, Musée Condé Chantilly. Right: Engraving from Tolet's Surgical Text, 1683, showing a patient bound down and restrained by burly assistants in preparation for the surgical removal of a bladder stone - the operation Pepys underwent in 1658.*

*The exact pathogenesis of renal stones is uncertain, but hereditary factors as well as dietary excesses have long been considered a contributory factor, especially in the case of uric acid stones caused by excessive purine production. Pepys was no stranger to the "good life" moving in the highest circles of government and royalty. Scenes such as that depicted by Jean-Francois de Troy were familiar to Samuel. Unfortunately for Samuel he did have a hereditary predisposition, with a number of close family relatives also suffering from renal stones. This, coupled with his high living, unfortunately would mean that he would be subjected to the Seventeenth century operation of "lithotomy", as depicted above right in a 1683 Surgical text.*

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