

Nephrolithiasis, Diagnosis and Management: A Review Article

Gofur NRP^{1*}, Gofur ARP², Soesilaningtyas³, Gofur RNRP⁴, Kahdina M⁴ and Putri HM⁴

¹Department of Health, Faculty of Vocational Studies, Universitas Airlangga, Surabaya, Indonesia

²Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia

³Department of Dental Nursing, Poltekkes Kemenkes, Surabaya, Indonesia

⁴Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

*Corresponding author:

Nanda Rachmad Putra Gofur,
Department of Health, Faculty of Vocational Studies,
Universitas Airlangga, Surabaya, Indonesia,
E-mail: nanda.rachmad.gofur@vokasi.unair.ac.id

Received: 01 Mar 2021

Accepted: 22 Mar 2021

Published: 27 Mar 2021

Copyright:

©2021 Gofur NRP. This is an open access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and build upon your work non-commercially.

Citation:

Gofur NRP, Nephrolithiasis, Diagnosis and Management: A Review Article. *Ame J Surg Clin Case Rep.* 2021; 2(7): 1-4.

Keywords:

Nephrolithiasis; Management; Surgery

1. Abstract

1.1 Introduction: Nephrolithiasis is a stone formed from mineral deposits in the bladder. When bladder stones clog the urinary tract, there will be complaints in the form of difficulty and pain when urinating, even bloody urine (hematuria). Nephrolithiasis can happen to anyone, including children. Symptoms associated with urinary tract stones depend on the location of the stone, the size of the stone, and any complications that have occurred. Usually stones in the kidney calyx are asymptomatic. When the stone falls off and descends into the narrow ureter, it becomes symptomatic. Stones generally get stuck in the narrowest part of the ureter, such as the ureteropelvic junction, when the ureter crosses the iliac vasa, and the ureterovesical junction. This article purpose is to review diagnosis and management of nephrolithiasis.

1.2. Discussion: The main symptom of ureteric stones is often an acute onset of pain in the back. This pain can be colicky or not. Colic pain occurs because the peristaltic activity of the smooth muscle of the calical system or ureter increases in an attempt to remove stones from the urinary tract. The increase in peristalsis causes the intraluminal pressure to increase so that there is stretching of the nerve terminals that provide a sensation of pain. The pain can radiate from the pelvis and to the ipsilateral groin. Some measures to treat urolithiasis are conservative observation (small ureteric stones can pass through the urinary tract without intervention), dissolving agents (solutions or materials to break stones), reducing obstruction (DJ stents and nephrostomy), non-invasive

extracorporeal shock wave therapy. Lithotripsy (ESWL), minimally invasive therapy: ureterorenoscopy (URS), Percutaneous Nephrolithotomy, Cystolithotripsy / ystolothopalaxy, surgical therapies such as nephrolithotomy, nephrectomy, pyelolithotomy, ureterolithotomy, systoleithotomy).

1.3. Conclusion: The goals in medical management of urolithiasis are to remove stones, determine the type of stone, prevent the destruction of nephrons, control infection, and treat possible obstruction.

2. Introduction

Nephrolithiasis is a stone formed from mineral deposits in the bladder. When bladder stones clog the urinary tract, there will be complaints in the form of difficulty and pain when urinating, even bloody urine (hematuria). Nephrolithiasis can happen to anyone, including children. However, this disease is more common in men over 52 years of age, and the risk of developing bladder stones increases if men have an enlarged prostate [1].

Stone formation is caused by saturated urine salts that can form stones or because urine lacks materials that can inhibit stone formation, lack of urine production, and other idiopathic conditions. The location of urinary tract stones is typically found in the calix or pelvis (nephrolithiasis) and when it will pass it stops in the ureter or in the bladder [2].

In the United States 5-10% of the population suffers from this disease, while worldwide there are an average of 1-2% of the population. This disease is the three most common diseases in the field of

urology besides urinary tract infections and prostate enlargement. Kidney stone disease is a significant health problem, both in Indonesia and in the world. The prevalence of stone disease is estimated to be 13% in adult men and 7% in women with adults and their ages from the third to fourth decades [3,4].

Symptoms associated with urinary tract stones depend on the location of the stone, the size of the stone, and any complications that have occurred. Usually stones in the kidney calyx are asymptomatic. When the stone falls off and descends into the narrow ureter, it becomes symptomatic. Stones generally get stuck in the narrowest part of the ureter, such as the ureteropelvic junction, when the ureter crosses the iliac vasa, and the ureterovesical junction [5]. This article purpose is to review diagnosis and management of nephrolithiasis.

3. Discussion

The main symptom of ureteric stones is often an acute onset of pain in the back. This pain can be colicky or not. Colic pain occurs because the peristaltic activity of the smooth muscle of the calical system or ureter increases in an attempt to remove stones from the urinary tract. The increase in peristalsis causes the intraluminal pressure to increase so that there is stretching of the nerve terminals that provide a sensation of pain. The pain can radiate from the pelvis and to the ipsilateral groin [6].

Other symptoms include nausea, vomiting and hematuria. Hematuria can occur macros or microscopy from urinalysis. Hematuria occurs as a result of trauma to the urinary tract mucosa caused by stones. If fever is present, urosepsis should be suspected and this is a urological emergency. In this case, it is necessary to determine the location of the anatomic abnormality in the urinary tract that underlies the onset of urosepsis and immediately carry out therapy in the form of drainage and antibiotics. On physical examination, you may find knock pain in the costovertebral area, you can feel the kidneys on the side of the pain due to hydronephrosis, you can see signs of kidney failure, urinary retention, and if accompanied by infection you get fever / chills [7,8].

Diagnosis and Supporting Examination

According literature the diagnosis of nephrolithiasis can be confirmed through several tests such as: 1) Blood chemistry and 24-hour urine tests to measure levels of calcium, uric acid, creatinine, sodium, pH and total volume. 2) Chemical analysis is carried out to determine the composition of the rock. 3) Urine culture is performed to identify the presence of bacteria in the urine (bacteriuria). 4) Plain abdominal radiograph 5) Intravenous Pyelography (IVP). IVP is the standard procedure for delineating urinary tract stones. 6) Ultrasonography (USG). Ultrasound is very limited in the diagnosis of stones and is the management of nephrolithiasis [9].

Laboratory examination for this disease is whole blood, unrinary-

sis on examination of the urine sediment showed lekosituria, hematuria, and various stone-forming crystals. Kidney physiology aims to look for the possibility of decreased kidney function and to prepare the patient for the IVU photo examination and radiology [10,11].

4. Radiological Examination

4.1. Plain Abdominal Radiograph

Aims to see the possibility of radio-opaque stones in the urinary tract. Calcium oxalate and calcium phosphate stones are radio-opaque and are the most common among other types of stones. The following is the radio-opacity sequence of several types of urinary tract stones as calcium opaque, semi-opaque MAP, non-opaque uric acid. Plain radiographs have limited sensitivity and specificity, in their ability to show multiple stones and the patient's anatomy. In addition, body habits affect the quality of the film, such as intestinal contents that interfere with stone vision [12].

4.2. Intravenous Pyelogram (IVU)

This examination aims to assess the anatomy and function of the kidneys. In addition, IVU can detect semi-opaque and non-opaque stones. If the IVU cannot explain the condition of the urinary system due to decreased renal function, a retrograde pyelographic examination is performed. Contraindicated IVU in patients allergic to contrast material, decreased renal function, and pregnant women. Pure uric acid stones are radiolucent, so on Ivu's examination, a filling defect appears [13].

4.3. Urological Ultrasound

Ultrasound is performed if the patient is unlikely to undergo an IVU examination. Ultrasound examination can assess stones in the kidney or bladder (shown as echoic shadow), hydronephrosis, pionephrosis, or contraction of the kidney. On ultrasound examination of uric acid, it gives an acoustic shadowing image. The limitations of ultrasound include the inability to visualize most ureteral stones [12].

4.4. CT Scan Stenography

CT visualizes almost all types of kidney stones and has a sensitivity and specificity of greater than 95%, which is much better than other imaging. In addition, CT has the advantage of providing three-dimensional anatomical information about the kidney and adjacent organs, consideration of relevant management strategies such as distance between the skin and stones, and stone density characteristics to help guide therapeutic choices [13].

5. Management of Nephrolithiasis

The management of nephrolithiasis depends on its size, location, and associated symptoms. The majority of stones that can enter the ureter will pass on their own, although it takes time. Stones may pass spontaneously on smaller stones and / or located in the distal ureter. When it reaches the bladder, in general, stones can be

easily removed, because the lumen of the urethra is larger than the ureter [13].

Drugs such as calcium channel blockers and α -receptor antagonists affect ureteral contractility and expulsion of stones, thereby increasing the likelihood of spontaneous passage, particularly in ureteral stones less than 5 mm in size, especially those that are distal. The therapy given aims to reduce pain, expedite urine with diuretic administration, and drink a lot to push the stones out of the urinary tract [14].

If the ureteral stone fails to pass or is too large, or the pain is intolerable, surgical intervention may be performed. The surgical interventions include [7,13].

5.1. Extracorporeal Shockwave Lithotripsy (ESWL):

Small to medium sized stones can be treated noninvasively, using shock waves focused on the stone under fluoroscopic guidance or ultrasound. The shock wave causes the rock to become fragmented, and it can be excreted in the urine. It is not uncommon for the rock fragments to come out causing colic pain and causing hematuria. This tool can break down kidney stones, proximal ureteral stones, or bladder stones.

5.2. Endourology

Minimally invasive action

5.3. Percutaneous Nephrostolithotomy

Percutaneous large endoscopy to the kidney is performed on stones that are large, and / or complex. Like a staghorn stone, a small incision is made in the pelvis, then using a large endoscope the fragmented stone and the fragments fall off.

5.4. Lithotripsy

Lithotripsy is breaking down a jar or urethral stone by inserting a stone crusher (lithotriptor) into the jar. Stone fragments were removed with the Ellik evacuator.

5.5. Ureterorenoscopy

Using a ureteroscope, which passes through the urethra, passes through the bladder and reaches the location of the stone in the ureter, the stone is then fragmented with a laser or other device that is inserted

5.6. Dormia Extraction

Dormia extraction is to remove ureteral stones by netting them through the Dormia basket

5.7. Laparoscopic Surgery

Laparoscopic surgery to remove urinary tract stones is currently being developed. This method is widely used to take ureteric stones.

5.8. Open Surgery

If you do not have adequate facilities for endourological, laparoscopic, or ESWL procedures, stone collection is still carried out

through open surgery. A pyelonolithotomy or nephrolithotomy can be performed for stones in the renal tract and ureterolithotomy for stones in the ureter. It is not uncommon for patients to undergo nephrectomy because the kidneys are no longer functioning and filled with pus (pionephrosis), the cortex is very thin, or has contracted due to urinary tract stones that cause obstruction and chronic infection.

6. Complication

6.1. Urinary Tract Obstruction

Obstruction can cause dilatation of the renal pelvis or calix, known as hydronephrosis. In general, prolonged lower urinary tract obstruction will cause upper obstruction. If not treated properly, this obstruction can lead to malfunctioning and permanent damage to kidney structures, known as obstructive nephropathy, which if you have a urinary tract infection can cause urosepsis [14].

Urinary tract obstruction will cause kidney damage, both structure and function. This damage depends on the length of the obstruction, the degree of obstruction, unilateral or bilateral, and the presence of accompanying infection. The intrapelvic increase due to obstruction is transmitted to the kidney calyces system, thereby damaging the renal papillae and calyx structures. In normal circumstances, the concave minor calix with both sharp edges, through intravenous pyelonephrography (IVU) examination can be observed the changes. The changes that occur are (1) both edges of the calix become blunt, (2) the calix becomes flat (the concavity disappears), (3) the calix becomes convex, and the longer the renal parenchyma is pressed to the periphery so that the cortex thins [14].

Obstructive anuria is a manifestation of total obstruction of urine flow in the upper urinary system, which is a reduction in urine production to less than 200 ml in 24 hours. This obstructive anuria occurs when there is bilateral urinary tract obstruction or unilateral urinary tract obstruction in a single kidney [15].

6.2. Acute Kidney Injury (AKI)

Acute kidney injury (AKI) is a sharp decrease in the filtration function of the kidneys, which can occur as a result of diseases that affect the vascularity of the kidneys, the renal parenchyma, or the urine collection system. Such a decrease is often evident by an increase in serum creatinine concentration, which may be accompanied by normal urine output, oliguria, or anuria [16,17].

AKI is categorized as caused by prerenal, intrarenal, and post renal. Prerenal AKI is the most common case (60% of cases). Mild reduction in renal performance does not affect glomerular filtration rate (GFR) due to compensatory feedback responses, such as activation of the renin-angiotensin system and release of vasodilating prostaglandins. In the regulation of decreased flow, compensatory mechanisms fail, and renal filtration decreases. However, the renal parenchyma remains intact and normal function can be restored

with intravascular fluid replacement. The main causes of prerenal AKI include excessive diuretics, diarrhea, vomiting, bleeding, burns, poor cardiac output, liver failure, hypercalcemia, and use of NSAIDs in patients with low renal perfusion. Patients with prerenal AKI show signs of volume depletion, such as tachycardia, orthostatic hypotension, and dry mucous membranes. In prerenal AKI the BUN:creatinine ratio may increase by 20; 1 reflecting increased reabsorption [18].

Intrarenal AKI occurs in about 35% of cases, reflecting direct damage to the renal parenchyma. Acute tubular necrosis (ATN) is the most common cause. ATN occurs in the presence of severe renal ischemia or direct toxic damage to the renal tubules due to extrinsic toxins (such as aminoglycosides or radiocontrast agents) or intrinsic toxins (such as myoglobin or hemoglobin). Other common causes are due to acute progressive glomerulonephritis, thrombotic microangiopathy, disseminated intravascular coagulation, malignant hypertension, acute interstitial nephritis, and post-transplant renal allograft rejection. The BUN: Creatinine ratio ranges from 10 to 15: 1. On urinalysis, results indicate glomerular or tubular damage. ATN can be found "muddy brown" pigmented granular cast or tubular epithelial cast. At GN the red blood cell casts are displayed. AIN obtained white blood cell casts. In addition, proteinuria is obtained [18,19].

Post renal AKI only occurs in about 5% of cases, reflecting obstruction of urine flow from both kidneys. The blockage can be in the urethra, bladder neck, or in the ureter. Patients sometimes have a history of weak urine output or incomplete emptying of urine. On examination, an enlarged bladder or prostate (in men) can be felt. On urinalysis, red blood cells were found in cases of nephrolithiasis [16,17].

In nephrolithiasis patients with AKI, symptoms may present with hematuria, abdominal or pelvic pain, or signs of uremia. Oligoanuria indicates total obstruction, or partial obstruction in the urine output that is adequate. Oligoanuria can diagnose urinary tract obstruction, severe ATN with cortical necrosis, or bilateral vascular occlusion. If diagnostic considerations are needed, Kidney sonography is sensitive and specific (90 to 95%) in confirming the diagnosis of hydronephrosis [19,20].

7. Conclusion

The goals in medical management of urolithiasis are to remove stones, determine the type of stone, prevent the destruction of nephrons, control infection, and treat possible obstruction.

References

- Chung MJ. Nephrolithiasis and nephrolithiasis. *JAAPA*. 2017; 30(9): 49-50.
- Caudarella R, Vescini F. Urinary citrate and renal stone disease: the preventive role of alkali citrate treatment. *Arch Ital Urol Androl*. 2009; 81(3): 182-7.
- Curhan GC, Willett WC, Rimm EB, Stampfer MJ. Family history and risk of kidney stones. *J Am Soc Nephrol*. 1997; 8(10): 1568-73.
- Scales CD, Smith AC, Hanley JM, Saigal CS., Urologic Diseases in America Project. Prevalence of kidney stones in the United States. *Eur Urol*. 2012; 62(1): 160-5.
- Espino-Grosso PM, Canales BK. Kidney Stones After Bariatric Surgery: Risk Assessment and Mitigation. *Bariatric Surg Pract Patient Care*. 2017; 12(1): 3-9.
- Hesse AT, Tiselius H-G, Siener R, Hoppe B, Cologne, et al. *Urinary Stones, Diagnosis, Treatment and Prevention of Recurrence*. 3rd edn. S. Karger. 2009.
- Izzedine H, Lescure FX, Bonnet F. HIV medication-based nephrolithiasis. *Clin Kidney J*. 2014; 7(2): 121-26.
- Purnomo BB. *Dasar-dasar Urologi*. Malang: Sagung Seto. 2016.
- Kelly C.R., Landman J. *The Netter Collection of Medical Illustrations Urinary System*. Elsevier. 2012; 5: 288.
- Wein A.J, Kavoussi L.R, Partin A.W, Peters, C.A. *Campbell-Walsh Urology*. Elsevier. 2015; 4: 4168.
- Basiri A, Shakhssalim N, Khoshdel AR, Rafdar MH, Dorraj N, et al. Familial relations and recurrence pattern in nephrolithiasis: new words about old subjects. *Urol J*. 2010; 7(2): 81-6.
- Tiselius HG, Ackermann D, Alken P, Buck C, Conort P, Gallucci M, et al. Guidelines on Nephrolithiasis. *Eur Urol*. 2001; 40(4): 362-71.
- Brisbane W, Bailey MR, Sorensen MD. An overview of kidney stone imaging techniques. *Nat Rev Urol*. 2016; 13(11): 654-662.
- Preminger GM, Tiselius HG, Assimos DG, Alken P, Buck C, Knoll T, et al. Guideline for the management of ureteral calculi. *J Urol*. 2007; 178(6): 2418-34.
- Parkhomenko E, De Fazio A, Tran T, Thai J, Blum K, Gupta M. A Multi-Institutional Study of Struvite Stones: Patterns of Infection and Colonization. *J Endourol*. 2017; 31(5): 533-537.
- Preminger GM, Tiselius HG, Assimos DG, Alken P, Buck C, Knoll T, et al; Guidelines on nephrolithiasis. *J Urol*. 2007; 178(6): 2418-34.
- Ma Q, Fang L, Su R, Ma L, Xie G, Cheng Y. Uric acid stones, clinical manifestations and therapeutic considerations. *Postgrad Med J*. 2018; 94(1114).
- Maalouf NM, Cameron MA, Moe OW, Sakhaee K. Novel insights into the pathogenesis of uric acid nephrolithiasis. *Curr Opin Nephrol Hypertens*. 2004; 13(2): 181-9.
- Sarica K. Pediatric nephrolithiasis: etiology, specific pathogenesis and medical treatment. *Urol Res*. 2006; 34: 96-101.
- Shadman A, Bastani B. Kidney Calculi: Pathophysiology and as a Systemic Disorder. *Iran J Kidney Dis*. 2017; 11(3): 180-191.
- Semins MJ, Matlaga BR. Kidney stones during pregnancy. *Nat Rev Urol*. 2014; 11(3): 163-8.