

Research Article

Percutaneous Nephrolithotomy for Staghorn Stones: A Minimally Invasive Approach in A Region with Elevated Kidney Stone Risk

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Abstract

Background: Staghorn stones are large, branched renal calculi that occupy a significant portion of the renal pelvis or calyces and are associated with serious complications if left untreated. In regions with poor water quality, such as East Nusa Tenggara, the risk of kidney stone formation is increased due to unsafe drinking water sources, including rivers and refillable bottled water.

Objective: To report the management and outcome of a staghorn renal stone using percutaneous nephrolithotomy (PCNL) in a patient treated at Prof. W. Z. Johannes Hospital, East Nusa Tenggara, Indonesia.

Method: A 41-year-old male with a 2-month history of left-sided abdominal pain and renal stones underwent clinical and radiological evaluation. Plain radiography and multislice computed tomography (MSCT) revealed a 5 cm × 3.5 cm staghorn stone in the left kidney. Percutaneous nephrolithotomy was performed in the supine position using C-arm fluoroscopic guidance. A nephroscope was introduced through a small incision to visualize and extract the stone, followed by post-procedural imaging and placement of a nephrostomy tube for drainage.

Result: The staghorn stone was successfully removed using PCNL without significant complications. Postoperative imaging confirmed adequate stone clearance. The patient had a favorable clinical outcome, demonstrating effective management of a large renal stone with a minimally invasive approach.

Conclusion: Percutaneous nephrolithotomy is an effective and safe first-line treatment for staghorn stones, offering high stone-free rates and low morbidity. Early diagnosis and timely intervention are crucial to prevent severe complications such as recurrent infections and urosepsis, particularly in areas with increased risk of kidney stone formation due to poor water quality.

Keywords: Staghorn Stone, PCNL, Renal Calculi

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Latar Belakang: Batu staghorn merupakan batu ginjal berukuran besar dan bercabang yang menempati sebagian besar pelvis renalis atau kaliks ginjal dan dapat menimbulkan komplikasi serius apabila tidak ditangani. Di daerah dengan kualitas air yang buruk, seperti Nusa Tenggara Timur, risiko pembentukan batu ginjal meningkat akibat penggunaan sumber air minum yang tidak aman, termasuk air sungai dan air minum isi ulang.

Tujuan: Untuk melaporkan penatalaksanaan dan luaran klinis batu ginjal staghorn menggunakan prosedur percutaneous nephrolithotomy (PCNL) pada seorang pasien yang dirawat di RSUP Prof. W. Z. Johannes, Nusa Tenggara Timur, Indonesia.

Metode: Seorang laki-laki berusia 41 tahun dengan riwayat nyeri perut kiri selama 2 bulan dan batu ginjal menjalani evaluasi klinis dan radiologis. Pemeriksaan radiografi polos dan multislice computed tomography (MSCT) menunjukkan adanya batu staghorn berukuran $5 \times 3,5$ cm pada ginjal kiri. Tindakan percutaneous nephrolithotomy dilakukan dalam posisi supinasi dengan panduan fluoroskopi C-arm. Nefroskop dimasukkan melalui sayatan kecil untuk memvisualisasi dan mengekstraksi batu, kemudian dilakukan pencitraan pascatindakan serta pemasangan nefrostomi untuk drainase.

Hasil: Batu staghorn berhasil dikeluarkan secara lengkap menggunakan PCNL tanpa komplikasi bermakna. Pemeriksaan pencitraan pascaoperasi menunjukkan pembersihan batu yang adekuat. Pasien menunjukkan luaran klinis yang baik, menandakan keberhasilan penatalaksanaan batu ginjal berukuran besar dengan pendekatan minimal invasif.

Kesimpulan: Percutaneous nephrolithotomy merupakan terapi lini pertama yang efektif dan aman untuk batu staghorn dengan tingkat bebas batu yang tinggi serta morbiditas yang rendah. Diagnosis dini dan intervensi yang tepat waktu sangat penting untuk mencegah komplikasi berat seperti infeksi berulang dan urosepsis, terutama di wilayah dengan risiko tinggi pembentukan batu ginjal akibat kualitas air yang buruk.

INTRODUCTION

Renal staghorn stones are a complex and potentially life-threatening urological condition characterized by the presence of large branched stones occupying a substantial portion of the renal pelvis or renal calyces. These stones are predominantly composed of magnesium ammonium phosphate (struvite) and/or calcium carbonate apatite, which are formed in an alkaline urinary environment with a high ammonia concentration and abundant phosphate and magnesium in urine. The European Association of Urology (EAU) emphasizes the importance of active treatment for all newly diagnosed staghorn calculi, as untreated staghorn calculi are prone to causing severe complications, including recurrent infections, urosepsis, and eventual destruction of

the renal parenchyma. The formation of staghorn stones is a multifactorial process. An alkaline urinary environment, often resulting from urinary tract infections (UTIs) caused by urease-producing bacteria, promotes the crystallization of magnesium ammonium phosphate. Additionally, other factors such as the formation of an exopolysaccharide biofilm and the incorporation of mucoproteins and other organic compounds into this matrix contribute to the development of these stones. The designation of "partial" or "complete" staghorn calculus does not imply any specific volume criteria; rather, it refers to the extent of the stone's branching into the renal calyces. Percutaneous nephrolithotomy (PCNL) has emerged as the preferred treatment modality for staghorn stones due to its minimally

invasive nature and high stone-free rates. PCNL involves the insertion of a nephroscope through a small incision in the skin, allowing for direct visualization and extraction of the stone. This procedure is particularly effective for stones larger than 20 mm, including staghorn and partial staghorn calculi, with stone-free rates up to 95% as recommended by the EAU. The procedure requires careful consideration of anaesthesiology and cardiorespiratory issues, as well as the appropriate percutaneous access modality to ensure optimal outcomes. Given the complexity and potential severity of staghorn stones, it is crucial to diagnose and treat these conditions promptly. This case report aims to highlight our successful experience in treating a 41-year-old patient with a staghorn renal stone using supine PCNL at Prof. W. Z. Johannes Hospital, East Nusa Tenggara, Indonesia. The patient's presentation, diagnosis, and treatment will be detailed to illustrate the efficacy and safety of PCNL in managing this challenging urological condition.

CASE REPORT

A 41-year-old-male, who worked as a farmer, brought into emergency department of Prof. W. Z. Johannes hospital with pain on the waist since 2 months ago. Patient had history of Renal Stone and had undergone surgery in Bhayangkara Hospital on June 2022. Patient had suffered fever that recurrence in the last few months, there was no pain felt when urinating, but the color was yellowish. It occurred several times over the last

few months. Main source of the patient drinking water is from river and sometimes he bought a refillable water but did not from an official store. Patient often consume analgetic to ease his pain.

On physical examination, vital signs were within normal limits and normal body mass index (19,80 kg/m²). Pain felt between ribs and waist on the left side during knocking test. There were no abnormalities in the external genitalia. Complete Blood Count of the patient is within normal limit, and the electrolyte lab result showed that the patient has a slight hypokalemia. Plain photo abdomen showed staghorn stone in the left kidney (Figure 1). MSCT of the abdomen is done to support the diagnosis and the result suggest a staghorn stone in the left kidney with a size of 5 cm x 3,5 cm (Figure 2). Therefore, PCNL is the treatment of choice. PCNL was performed on the patient with supine position. Using C-Arm in the operation theater, it showed the Staghorn Stone in the left kidney (Figure 3). The PCNL was done using routine procedure as the guideline dictate. Following the extraction, the condition of the left kidney evaluated by C-Arm in the operation theater (Figure 4). Nefrostomy is being done to the patient. Patient was advised to have a healthy lifestyle as well as cleaner water source for consumption.



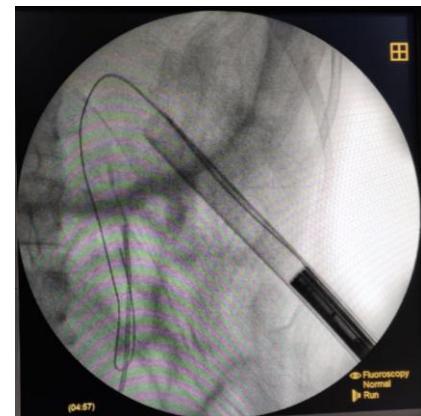
(Figure 1. Plain X-ray shows a radiopaque shadow, well defined, in the left kidney)



(Figure 2. MSCT Abdomen showed staghorn stone in the left kidney with a size of 5 cm x 3,5 cm)



(Figure 3. C-Arm showed the Staghorn Stone on the surgery)



(Figure 4. C-Arm showed the Stone successfully removed)

DISCUSSION

Staghorn stones are characterized by their branched structure, which occupies a large portion of the collecting system, typically filling the renal pelvis and branching into several or all of the calices. The term "staghorn" often refers to any branched stone occupying more than one portion of the collecting system, including renal pelvis with one or more caliceal extensions. The designation of "partial" or "complete" staghorn calculus does not imply any specific volume criteria; rather, it refers to the extent of the stone's branching into the renal calyces. The formation of staghorn stones is a multifactorial process. The alkaline urinary environment, often resulting from urinary tract infections (UTIs) caused by urease-producing bacteria, promotes the crystallization of magnesium ammonium phosphate (struvite). Additionally, other factors such as the formation of an exopolysaccharide biofilm and the incorporation of mucoproteins and other organic compounds into this matrix contribute to the development of these stones. In

our patient, the presence of a staghorn stone in the left kidney was supported by both plain X-ray and MSCT imaging. The plain X-ray showed a radiopaque shadow in the left kidney, consistent with a staghorn stone (Figure 1). The MSCT scan provided detailed information about the size and location of the stone, confirming a staghorn stone measuring 5 cm x 3.5 cm in the left kidney (Figure 2). These imaging modalities are crucial for diagnosing staghorn stones and planning the appropriate treatment. The clinical presentation of staghorn stones typically includes pain between the ribs and waist, especially during the knocking test. Recurrent fever due to infection is also a common symptom. In this patient, these symptoms were consistent with the diagnosis of a staghorn stone. The patient's history of recurrent fever and yellowish urine over the past few months further supported the diagnosis of a staghorn stone. The main source of the patient's drinking water was from rivers and sometimes from refillable bottles not from official stores. This practice is associated with a higher risk of developing kidney stones due to poor water quality and potential contamination with bacteria and minerals that promote stone formation. The geographical location of East Nusa Tenggara, with its limestone structure at an altitude of about 200 meters above sea level, contributes to poor water quality. Groundwater in this area has a higher concentration of lime compared to surface water, which increases the risk of developing kidney stones. The patient's consumption of analgetic medications to ease his pain is also

noteworthy. While these medications may provide temporary relief, they do not address the underlying issue of the staghorn stone. The patient's mild hypokalemia, as indicated by the electrolyte lab results, suggests some degree of metabolic disturbance that could have contributed to the formation of the staghorn stone. Percutaneous nephrolithotomy (PCNL) is the preferred treatment modality for staghorn stones due to its high efficacy and low morbidity rates. PCNL involves the insertion of a nephroscope through a small incision in the skin, allowing for direct visualization and extraction of the stone. This procedure is particularly effective for stones larger than 20 mm, including staghorn and partial staghorn calculi, with stone-free rates up to 95% as recommended by the EAU. The patient underwent PCNL in the supine position using a C-Arm in the operation theater to visualize the stone (Figure 3). The PCNL was conducted according to standard guidelines, with the nephroscope inserted through a small incision in the skin to directly visualize and extract the stone. Following extraction, the condition of the left kidney was evaluated using C-Arm imaging (Figure 4). A nephrostomy tube was inserted to ensure proper drainage and prevent further complications. Complete removal of the stone is an important goal in order to eradicate any causative organisms, relieve obstruction, prevent further stone growth and any associated infection, and preserve kidney function. PCNL monotherapy is the treatment of choice for treating staghorn stones. Other modalities such as

combinations of PCNL and shock-wave lithotripsy (SWL), SWL monotherapy, and open surgery can be considered but are operator-dependent. PCNL has emerged as the treatment of choice for the management of patients with staghorn calculi based on superior outcomes and acceptably low morbidity. Recent advances in instrumentation and technique have improved stone-free rates, increased treatment efficiency, and reduced morbidity thereby favoring PCNL monotherapy. In conclusion, this case highlights the successful treatment of a 41-year-old patient with a staghorn stone in the left kidney using PCNL. The procedure was performed in accordance with EAU guidelines, resulting in a high stone-free rate and minimal morbidity. The patient's age and general health, along with the size and density of the stone, were critical factors in choosing PCNL as the appropriate treatment modality. The importance of a reliable water source and healthy lifestyle was also emphasized to prevent future occurrences of kidney stones.

CONCLUSION

PCNL is a minimally invasive method with high stone-free rates, typically up to 95% as recommended by the EAU. This procedure is particularly effective for stones larger than 20 mm, including staghorn and partial staghorn calculi. Recent advances in instrumentation and technique have improved stone-free rates, increased treatment efficiency, and reduced morbidity, thereby favoring PCNL monotherapy. The patient's successful outcome underscores the

effectiveness of PCNL in managing staghorn stones, particularly in regions with high risks of kidney stone formation due to poor water quality.

ETHICS APPROVAL AND CONSENT

Written informed consent was obtained from the patient to publish this case report and accompanying images.

CONSENT FOR PUBLICATION

Each author acknowledges that he has substantively participated in the work, approve the final version of the manuscript, and take public responsibility for the paper's content.

CONFLICT OF INTERESTS

All author declare that they do not have any conflict of interest

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