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Rapti Academy of Health Science Guidelines on Percutaneous Nephrolithotomy

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Abstract

Percutaneous nephrolithotomy (PCNL) is the gold standard for treating large and complex kidney stones. This paper presents the Rapti Academy of Health Science's comprehensive guidelines to standardize PCNL procedures and enhance patient outcomes while minimizing complications. The guidelines, developed through a systematic review of literature and expert consensus, cover patient selection, preoperative evaluation, surgical techniques, postoperative care, and complication management. Key findings emphasize that PCNL is recommended for renal stones larger than 2 cm and unresponsive to other methods, with prone positioning and ultrasound-guided access identified as critical to reducing complications. Common complications, such as bleeding (5-7%) and infection (0.9-4.7%), were addressed with specific management strategies. The guidelines also highlight advancements like mini-PCNL and robotic-assisted surgery, which have improved patient outcomes, especially in complex cases. With stone-free rates exceeding 90% for large stones, the guidelines ensure consistency in practice and better recovery protocols. As technology evolves, these guidelines will incorporate innovations to further enhance the safety and efficacy of PCNL.

Keywords: Percutaneous Nephrolithotomy (PCNL); Kidney Stones; Urolithiasis; Minimally Invasive Surgery; Stone-Free Rates

Introduction

Kidney stones represent a significant global health burden, affecting millions of individuals across various demographics and regions. The prevalence of kidney stones has been rising steadily due to factors such as dietary changes, increased obesity rates, and a higher incidence of metabolic disorders. This rise has had profound implications for healthcare systems worldwide, as kidney stones are associated with substantial morbidity, recurrent hospitalizations, and considerable healthcare costs. Patients suffering from kidney stones often experience severe pain, risk of infections, and potential kidney damage, which, if untreated, can lead to chronic kidney disease and impact overall quality of life.

As kidney stones become more common, so does the demand for effective, minimally invasive treatment methods. Percutaneous nephrolithotomy (PCNL) has emerged as a gold-standard intervention, especially for large and complex renal calculi that are not amenable to less invasive options like shockwave lithotripsy or ureteroscopy. PCNL offers a high stone-free rate and effective management of challenging stone compositions, significantly reducing the need for open surgery and promoting faster recovery. By providing a targeted, minimally invasive approach, PCNL plays a crucial role in the modern treatment landscape of kidney stones, addressing both the clinical and economic impacts of this growing health issue.

Percutaneous nephrolithotomy (PCNL) has evolved as the gold standard treatment for large and complex kidney stones, offering a minimally invasive alternative to open surgery. Kidney stones, a common urological disorder, have a significant impact on healthcare systems worldwide, with increasing prevalence over the past few decades [1]. PCNL, introduced in the early 1970s, is now widely accepted for the treatment of renal calculi larger than 2 cm and for stones unresponsive to less invasive methods like shockwave lithotripsy (SWL) and ureteroscopy [2]. The procedure involves creating a tract directly into the kidney through the skin, allowing the surgeon to fragment and remove the stones.

Significance of PCNL in Modern Urology

The clinical success of PCNL has been well-documented, especially for its efficacy in clearing staghorn calculi and large, complex renal stones. The European Association of Urology (EAU) guidelines recommend PCNL as the preferred intervention for renal stones larger than 2 cm in diameter [2]. Studies have shown that PCNL has significantly higher stone-free rates compared to other treatments for large renal stones, with lower complication rates due to advancements in technology and surgical techniques [3].

Moreover, PCNL is favored for its ability to provide complete stone clearance, particularly in complex cases such as staghorn stones, where multiple access tracts may be required [4]. Advancements in surgical instruments, such as mini-PCNL and the use of lasers, have further improved patient outcomes, reducing complications and morbidity [5].

Challenges and Complications

Despite its widespread success, PCNL is not without its challenges. Bleeding remains one of the most significant concerns during the procedure, particularly when dealing with large or staghorn calculi [6]. Blood loss during PCNL is influenced by several factors, including stone burden, operative time, and the method of tract dilation [7]. Studies have also emphasized the need for careful patient selection and preoperative evaluation to mitigate complications, including bleeding, infection, and renal injury [8, 9]

The incidence of infectious complications post-PCNL, though relatively low, can be severe if not addressed promptly. Factors such as pre-existing infections and stone composition (e.g., struvite stones) contribute to higher risks of postoperative infections [10]. The use of prophylactic antibiotics and careful monitoring of patients during the perioperative period have been rec-

ommended to minimize these risks [11].

Technological Advancements and Innovations in PCNL

Recent developments in technology have significantly contributed to the evolution of PCNL. The use of ultrasound and fluoroscopy for renal access has reduced radiation exposure and improved the precision of the procedure [12]. Innovations such as mini-PCNL and tubeless PCNL have led to reduced postoperative pain, shorter hospital stays, and faster recovery times, making the procedure more patient-friendly [13].

The growing use of robotics and artificial intelligence (AI) in urological surgeries has also impacted PCNL procedures. Robotic-assisted systems enhance the precision of renal access and stone fragmentation, particularly in challenging cases such as staghorn stones or anatomically abnormal kidneys [14]. Machine learning models are being developed to predict patient outcomes, further optimizing treatment strategies and reducing complication rates [4].

Materials and Methods

Study Design

The development of the Rapti Academy of Health Science guidelines on percutaneous nephrolithotomy (PCNL) followed a systematic and evidence-based approach, incorporating a comprehensive review of current literature and clinical practices. The process involved multiple steps, including the selection of relevant studies, expert consensus, and validation by external peers. The methodology adopted ensures that the guidelines are robust, transparent, and applicable in diverse clinical settings.

Systematic Literature Review

A thorough literature review was conducted to gather evidence on various aspects of PCNL, including patient selection, surgical techniques, and management of complications. Electronic databases such as PubMed, Embase, and the Cochrane Library were searched using specific keywords and MeSH terms related to "percutaneous nephrolithotomy," "kidney stones," "urolithiasis," and "surgical outcomes." Studies included randomized controlled trials, systematic reviews, meta-analyses, and observational studies. The selection of studies was based on the relevance to the guidelines, focusing on high-quality evidence, such as those providing significant insights into the safety, efficacy, and outcomes of PCNL [2, 1].

Expert Panel Formation

A multidisciplinary panel comprising experts in urology, nephrology, radiology, and anesthesiology was formed to review and synthesize the available evidence. The panel included individuals with extensive experience in performing PCNL and managing patients with urolithiasis. The experts used the Oxford Centre for Evidence-Based Medicine (OCEBM) system to grade the quality of evidence and strength of recommendations. When high-quality evidence was unavailable, the expert panel reached a consensus through the Delphi method [1, 7].

Study Selection Criteria

Specific inclusion and exclusion criteria were applied to ensure that only the most relevant and high-quality studies informed the Rapti Academy of Health Science guidelines on percutaneous nephrolithotomy (PCNL). The criteria aimed to focus on studies with robust data on safety, efficacy, and clinical outcomes, thereby enhancing the reliability and applicability of the guidelines.

Inclusion Criteria:

1.Study Design: Only randomized controlled trials, systematic reviews, meta-analyses, and high-quality observational studies were included. These designs were prioritized because they provide stronger evidence on PCNL outcomes and procedural safety.

2.Focus on PCNL Outcomes: Studies had to specifically address PCNL procedures and outcomes, including patient selection, surgical techniques, complication management, and post-operative care protocols.

3.Clinical Relevance: Studies that offered valuable insights into clinical practices, such as patient positioning, tract dilation methods, and access techniques, were prioritized to align with real-world PCNL applications.

4.Publication Quality and Recency: Recently published studies with high methodological rigor, transparent reporting, and peer-reviewed validation were favored to ensure the guidelines reflected current evidence and standards of care.

Exclusion Criteria

1.Case Reports and Editorials: Case reports, editorial letters, and studies with limited data or insufficient statistical power were excluded, as they provide limited generalizability and do not contribute substantial evidence to guideline development.

2.Studies with Incomplete Data: Studies lacking data on key clinical parameters, such as complication rates, stone-free rates, or outcomes of PCNL techniques, were excluded, as incomplete data could introduce bias and limit the applicability of findings.

3.Outdated Studies: Older studies were generally excluded unless they offered fundamental insights into specific PCNL aspects still relevant today. This approach helped focus on recent advancements and current practices.

These inclusion and exclusion criteria influenced the guideline recommendations by ensuring that only high-quality and clinically relevant data were considered. By filtering for methodologically sound studies that directly address PCNL outcomes, the guidelines were able to provide evidence-based recommendations with greater confidence, reflecting the latest advances and best practices in PCNL. Consequently, these rigorous criteria enhanced the guidelines' reliability, clinical applicability, and utility across diverse healthcare settings.

Data Extraction and Synthesis

Data from the selected studies were extracted using a standardized form that included study design, patient population, intervention details, outcome measures, and complication rates. The extracted data were analyzed and synthesized to formulate evidence-based recommendations. Special emphasis was placed on studies that reported on patient selection criteria, access techniques, tract dilation methods, and post-operative care protocols [6, 11].

Development of Guidelines

The guidelines were drafted based on the synthesized evidence and expert recommendations. Multiple drafts were reviewed by the expert panel to ensure accuracy and clinical relevance. Each recommendation was aligned with the latest research and clinical practices. The panel addressed key aspects of PCNL, such as patient positioning, surgical approach (prone vs. supine), choice of instruments, and management of complications [2, 14].

Peer Review and Validation

The draft guidelines underwent an external peer review process to ensure their validity and applicability across diverse clinical

settings. Peer reviewers included experienced urologists and healthcare professionals who provided critical feedback. Their insights were incorporated into the final version of the guidelines. The final guidelines were then approved by the board of the Rapti Academy of Health Science before being published for use in clinical practice.

Statistical Analysis

Where applicable, statistical analysis was performed on data extracted from studies, particularly those involving complication rates, stone-free rates, and predictors of surgical outcomes. Meta-analyses were used to compare outcomes of different PCNL techniques, and descriptive statistics were employed to highlight common trends in the literature. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies or percentages [4, 5].

Ethical Considerations

Although the development of these guidelines did not involve direct patient interaction, ethical considerations were taken into account by adhering to the principles of evidence-based medicine. The selected studies were critically appraised to ensure that patient safety and best practices were prioritized throughout the development process. All clinical recommendations were designed to optimize patient outcomes and minimize risks during PCNL procedures.

Results

The Rapti Academy of Health Science guidelines for percutaneous nephrolithotomy (PCNL) were developed based on a comprehensive analysis of clinical evidence, expert consensus, and peer-reviewed feedback. The results of the study are categorized into key sections, supported by flowcharts, tables, and figures to enhance clarity and understanding.

Patient Selection and Preoperative Evaluation

The review established specific criteria for selecting candidates for PCNL, with key indications being renal stones larger than 2 cm, lower pole stones larger than 1 cm, and staghorn calculi. Absolute contraindications, such as uncorrected coagulopathy and active urinary tract infections, were reinforced, while relative contraindications included obesity and severe cardiopulmonary disease [2, 8].

The preoperative evaluation plays a critical role in ensuring patient safety and optimizing outcomes. A detailed checklist, including medical history, laboratory tests, imaging studies, and anesthesia evaluation, was developed to guide healthcare professionals during the preoperative phase [1].

PCNL Procedure and Surgical Techniques

The PCNL procedure provides patient positioning for stone removal and postoperative care. The analysis highlighted that both prone and supine positions are effective, but the prone position remains the most commonly used due to its superior access to the renal calyces [2].

For stone fragmentation, ultrasonic or pneumatic lithotripters were identified as the preferred methods. Flexible nephroscopy ensures that all calyces are inspected for residual stones, which is crucial for achieving high stone-free rates [4].

Stone-Free Rates

The analysis of stone-free rates showed that PCNL achieves high success rates, especially for stones larger than 2 cm. For these large stones, PCNL resulted in a stone-free rate of over 90%, significantly higher compared to alternative treatments like shock-

wave lithotripsy [1]. However, stone complexity, particularly in cases of staghorn calculi, can reduce the stone-free rate, often necessitating multiple procedures or secondary treatments [4].

Complications and Their Management

The analysis confirmed that while PCNL is generally safe, complications such as bleeding, infection, and organ injury do occur, though at varying rates. Significant bleeding requiring transfusion was observed in 5-7% of cases [6]. The review also highlighted that the use of advanced tract dilation methods, such as balloon dilation, reduces the risk of bleeding [13].

Infectious complications, including sepsis, were reported in 0.9-4.7% of cases, underscoring the importance of preoperative urine cultures and antibiotic prophylaxis [9]. Organ injuries, though rare, such as pleural or colonic injuries, may require immediate surgical intervention in severe cases [11].

Postoperative Care and Follow-up

Postoperative care protocols recommended monitoring vital signs, urine output, and nephrostomy tube management. Nephrostomy tubes were commonly used, though tubeless PCNL is gaining popularity in select cases [3]. Imaging on postoperative day 1 or 2 is essential for assessing stone-free status and ensuring ureteral patency [2].

Technological Advancements

The review of emerging technologies demonstrated that robotic-assisted PCNL and mini-PCNL techniques are gaining traction due to their ability to reduce complications and enhance precision [14]. These technologies, along with the integration of advanced imaging modalities, are expected to improve the safety and efficacy of PCNL in the future [4].

Discussion

The guidelines developed by the Rapti Academy of Health Science for percutaneous nephrolithotomy (PCNL) represent a significant step forward in standardizing this essential procedure for the management of large and complex kidney stones. The discussion section elaborates on the key findings presented in the results, comparing them with existing literature and exploring the broader implications for clinical practice and future research.

Patient Selection and Preoperative Evaluation

The results emphasize that appropriate patient selection is critical for optimizing PCNL outcomes. Patients with large renal calculi (>2 cm) and staghorn stones are the ideal candidates, as supported by both the guidelines and global studies [2]. Poor patient selection can increase the risk of complications such as bleeding and infection, as evidenced by studies highlighting the role of comorbidities and stone complexity in surgical outcomes [6].

Preoperative evaluation is essential to minimize perioperative risks, and the developed checklist (Table 1) provides a structured approach to this assessment. The incorporation of imaging studies such as non-contrast CT scans ensures that the exact location, size, and complexity of the stones are well understood before surgery, which is consistent with practices recommended by other urological guidelines [14]. Comprehensive metabolic evaluation, as recommended in the guidelines, can also reduce recurrence rates by identifying underlying causes of stone formation.

Table 1: Preoperative Evaluation Checklist

Assessment	Components
Medical History	Previous surgeries, comorbidities, medications
Physical Examination	BMI, cardiopulmonary status, abdominal examination
Laboratory Tests	CBC, renal function, coagulation profile, urinalysis
Imaging Studies	Non-contrast CT scan, IVP or CT urography
Anesthesia Evaluation	ASA classification, airway assessment
Informed Consent Discussion	Risks, benefits, alternative treatment options

Surgical Techniques and Access Methods

The results confirmed the efficacy of both prone and supine positions for PCNL, though the prone position remains preferred for better access to renal calices [2]. Studies have shown that the supine position may be more beneficial for obese patients or when simultaneous retrograde access is needed [4]. These findings align with earlier research that underscores the importance of surgeon experience and patient anatomy in determining the best positioning strategy [12]. Single-tract access, when feasible, was strongly recommended to reduce complications, particularly bleeding and infection. The use of fluoroscopic and ultrasound-guided techniques enhances the precision of renal access and minimizes the risk of adjacent organ damage. This is in line with the broader trend toward minimally invasive approaches, such as mini-PCNL, which have been shown to reduce postoperative pain and hospital stay [13].

Management of Complications

The management of complications remains a critical aspect of PCNL, as reflected in Table 2. Bleeding, which occurs in 5-7% of cases, is one of the most concerning complications. The guidelines recommend the use of advanced dilation techniques, such as balloon dilation, to reduce intraoperative blood loss [6]. Studies also highlight the importance of careful monitoring during surgery, with timely interventions such as selective angioembolization being critical for managing significant hemorrhage [7].

Infectious complications, although less common, pose serious risks if not promptly treated. Preoperative antibiotic prophylaxis and intraoperative sterilization practices are recommended to minimize the risk of postoperative sepsis, which has been reported in up to 4.7% of cases [9]. These findings are consistent with global practices that emphasize the role of careful case selection, sterile technique, and perioperative care in reducing infection rates [11]. Organ injury, though rare, is another concern, especially in cases involving staghorn calculi or multiple access tracts. The guidelines recommend the use of imaging techniques such as ultrasonography and fluoroscopy to ensure accurate access and minimize the risk of damage to surrounding structures [12]. The results are in line with previous studies, which have emphasized the need for surgical expertise in managing complex cases to avoid such complications.

Table 2: Common Complications and Management Strategies

Complication	Incidence (%)	Management Strategies
Bleeding	7-May	Conservative, transfusion, angioembolization
Sepsis	0.9-4.7	Broad-spectrum antibiotics, drainage of obstruction
Pleural Injury	0.3-1	Chest tube placement
Colonic Injury	0.2-0.8	Surgical repair
Urinary Leakage	3-Jan	Prolonged nephrostomy drainage, ureteral stent

Postoperative Care and Stone-Free Rates

An essential component of postoperative care in percutaneous nephrolithotomy (PCNL) is the implementation of specific monitoring protocols to ensure patient safety and optimize recovery. These protocols include follow-up imaging and regular infection checks, which are vital for early detection of potential complications and to confirm treatment success.

Follow-up Imaging: Follow-up imaging, typically conducted within 24–48 hours after surgery, is essential for verifying that the patient is stone-free and that there is no obstruction in the urinary tract. Imaging methods, such as non-contrast CT scans or ultrasound, allow healthcare providers to assess for any residual fragments or complications, such as urinoma or hematoma, which may require additional intervention. Ensuring the ureteral patency and kidney function post-surgery is crucial for preventing delayed complications like hydronephrosis and impaired renal function, thereby improving overall surgical outcomes and patient satisfaction.

Infection Monitoring: Monitoring for signs of infection is another critical aspect of postoperative care. Due to the invasive nature of PCNL, patients are at an increased risk of postoperative infections, including urinary tract infections (UTIs) and sepsis. Regular temperature checks, complete blood count (CBC), and urinalysis in the days following surgery help identify infections early. Early detection and intervention reduce the risk of severe sepsis, which can be life-threatening if left untreated. Preemptive monitoring allows for prompt administration of antibiotics and supportive care, thereby minimizing potential complications and promoting a smooth recovery.

By adhering to these monitoring protocols, healthcare providers can enhance the safety and effectiveness of PCNL procedures, supporting quicker recovery times, reducing complications, and ensuring higher stone-free rates for patients [3].

Stone-free rates, particularly for large and complex stones, are a key metric for evaluating the success of PCNL. As shown in Figure 2, the stone-free rate for PCNL is over 90% for stones larger than 2 cm, which is significantly higher than alternative treatments [1]. This supports the continued use of PCNL as the gold standard for treating large renal calculi. However, the guidelines also acknowledge the challenge of managing residual fragments, particularly in cases of staghorn stones, where secondary procedures may be necessary [4].

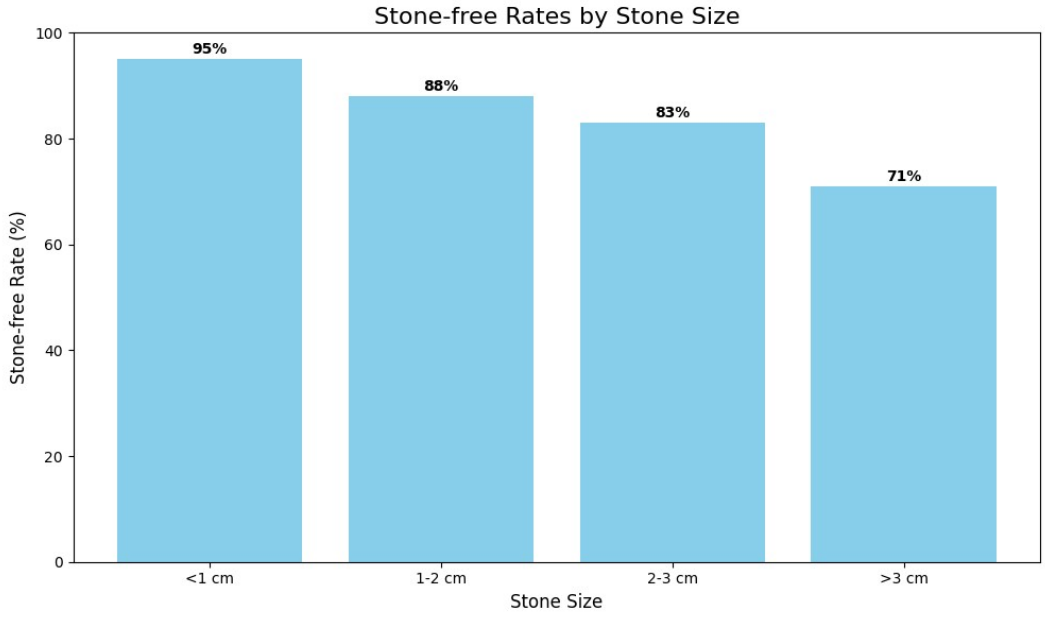

Figure 1: Stone-free Rates by Stone Size

Technological Advancements

The growing role of technology in PCNL is transforming the field of urology. The guidelines highlight the increasing use of robotic-assisted PCNL, which offers enhanced precision and control during complex cases. Robotic systems have been shown to improve outcomes, particularly in cases involving anatomically abnormal kidneys, such as horseshoe or pelvic kidneys [14]. This is consistent with broader trends in surgery, where robotics and artificial intelligence are becoming integral to improving patient outcomes.

Mini-PCNL techniques, which use smaller access sheaths and instruments, have gained popularity due to their ability to reduce postoperative pain and accelerate recovery times [13]. Additionally, the use of advanced imaging modalities, such as intraoperative ultrasound and fluoroscopy, has further improved the safety of PCNL by reducing radiation exposure and increasing the accuracy of renal access [12]. These advancements are expected to continue evolving, offering even safer and more effective treatments for patients with kidney stones.

Future Directions

As the field of urology continues to evolve, the future of PCNL will likely be shaped by ongoing technological advancements, such as the miniaturization of instruments, the integration of artificial intelligence, and the increasing use of robotics. Personalized medicine, based on genetic and molecular profiling, may also play a role in tailoring PCNL procedures to individual patients, potentially improving outcomes and reducing recurrence rates [14].

The guidelines developed by the Rapti Academy of Health Science provide a comprehensive framework for healthcare professionals to deliver consistent, evidence-based care in PCNL procedures. Continuous research and innovation will be key to further refining these practices and ensuring that PCNL remains the gold standard for treating large and complex kidney stones.

Limitations in Guideline Development

The development of the Rapti Academy of Health Science guidelines for PCNL faces certain limitations, particularly regarding variability in technology and resources. Many healthcare facilities lack access to advanced tools like intraoperative ultrasound and robotics, which may limit the applicability of some recommendations. Additionally, differences in hospital resources and clinical expertise can impact adherence to guidelines, especially in smaller or rural centers where specialized training and high procedural volumes are less common. Finally, some recommendations are based on expert consensus due to limited high-quality evidence, introducing potential bias. These limitations underscore the need for adaptable approaches and future updates to address resource disparities and technological advancements.

Conclusion

The Rapti Academy of Health Science guidelines for percutaneous nephrolithotomy (PCNL) provide a comprehensive and evidence-based framework for the management of patients with large and complex kidney stones. These guidelines emphasize the importance of proper patient selection, meticulous preoperative evaluation, and the application of advanced surgical techniques to improve clinical outcomes while minimizing complications.

PCNL remains the gold standard treatment for renal stones larger than 2 cm, with high stone-free rates and better efficacy compared to alternative methods. The recommendations outlined in the guidelines—such as single-tract access, flexible nephroscopy, and the use of modern imaging techniques—reflect current best practices for ensuring patient safety and maximizing procedural success. The management of complications, particularly bleeding and infection, requires prompt intervention, and the

guidelines offer clear strategies to mitigate these risks.

Technological advancements, including mini-PCNL, robotic-assisted procedures, and improved imaging modalities, have contributed significantly to the evolution of PCNL, making it safer and more effective. As innovations continue to emerge, these guidelines will need to evolve to incorporate new findings and technologies.

In conclusion, the successful implementation of these guidelines in clinical practice will lead to improved standardization in PCNL procedures, enhanced patient outcomes, and reduced variability in care. Healthcare professionals are encouraged to familiarize themselves with these guidelines and apply them in their clinical practice to ensure the best possible care for patients with kidney stones. Continuous education, quality audits, and participation in benchmarking programs will further support the goal of improving PCNL outcomes globally.

References

1. Güven S, Sönmez MG, Somani BK, Gözen AS, Sarica K, et al. (2022) Current management of renal colic across Europe and its compliance to the European Association of Urology Guidelines on Urolithiasis: A survey from the European Section of Urotechnology, European Section of Urolithiasis, Young Academic Urologists study groups. Central European Journal of Urology, 75: 182.

2. Zeng G, Zhong W, Pearle M, Choong S, Chew B, et al. (2022) European Association of Urology section of urolithiasis and International Alliance of Urolithiasis joint consensus on percutaneous nephrolithotomy. European Urology Focus, 8: 588-97.

3. Ermis O, Somani B, Reeves T, Guven S, Pes PL, et al. (2020) Definition, treatment, and outcome of residual fragments in staghorn stones. Asian Journal of Urology, 7: 116-121.

4. Geraghty RM, Thakur A, Howles S, Finch W, Fowler S, et al. (2024) Use of temporally validated machine learning models to predict outcomes of percutaneous nephrolithotomy using data from the British Association of Urological Surgeons Percutaneous Nephrolithotomy audit. European Urology Focus.

5. Castellani D, Corrales M, Lim EJ, Cracco C, Scoffone CM, et al. (2022) The impact of lasers in percutaneous nephrolithotomy outcomes: Results from a systematic review and meta-analysis of randomized comparative trials. Journal of Endourology, 36: 151-7.Agarwal M, Agrawal MS, Jaiswal A, et al. (2011) Safety and efficacy of ultrasonography as an adjunct to fluoroscopy for renal access in percutaneous nephrolithotomy (PCNL). BJU International, 108: 1346-9.

6. Kukreja R, Desai M, Patel S (2004) Factors affecting blood loss during percutaneous nephrolithotomy: Prospective study. Journal of Endourology, 18: 715-22.

7. Poudyal S (2022) Current insights on haemorrhagic complications in percutaneous nephrolithotomy. Asian Journal of Urology, 9: 81-93.

8. Singh DK, Gupta S, Shubham K, Kumar N, Tiwari R (2024) Assessment of pre-operative factors associated with blood loss in patients undergoing percutaneous nephrolithotomy: A prospective study. Cureus, 16.

9. Said DF, Ferreira DB, Hayek KKRE, Perrella R, Mota PKV, et al. (2023) Factors associated with complications after percutaneous nephrolithotomy: An analysis of 1,066 cases. Revista da Associação Médica Brasileira, 69: e20221089.

10. Sharma K, Sankhwar SN, Goel A (2016) Factors predicting infectious complications following percutaneous nephrolithoto-

my. Urology Annals, 8: 434-8.

11. Seitz C, Desai M, Häcker A (2012) Incidence, prevention, and management of complications following percutaneous nephrolitholapaxy. European Urology, 61: 146- 58.

12. Osman M, Wendt-Nordahl G, Heger K (2005) Percutaneous nephrolithotomy with ultrasonography-guided renal access: Experience from over 300 cases. BJU International, 96: 875-8.

13. Thapa BB, Niranjan V (2020) Mini PCNL over standard PCNL: What makes it better? The Surgery Journal, 6: e19-23.

14. Ghani KR, Sammon JD, Bhojani N (2013) Trends in percutaneous nephrolithotomy use and outcomes in the United States. Journal of Urology, 190: 558-64.

15. Choong S, Rosette JDL, Denstedt J, Zeng G, Sarıca K, et al. (2022) Classification and standardized reporting of percutaneous nephrolithotomy (PCNL): International Alliance of Urolithiasis (IAU) consensus statements.

16. Sahin Y, Sahin S, Yilmaz M, Muslumanoglu AY (2023) Endourologists vs urologists: The impact of surgical experience and annual case volume on percutaneous nephrolithotomy outcomes. Scripta Medica, 54: 267-72.

17. Tefekli A, Ali Karadag M, Tepeler K (2008) Classification of percutaneous nephrolithotomy complications using the modified Clavien grading system: Looking for a standard. European Urology, 53: 184-90.

18. Yamaguchi A, Skolarikos A, Buchholz NP (2011) Operating times and bleeding complications in percutaneous nephrolithotomy: A comparison of tract dilation methods in 5,537 patients in the Clinical Research Office of the Endourological Society Percutaneous Nephrolithotomy Global Study. Journal of Endourology, 25: 933-9.