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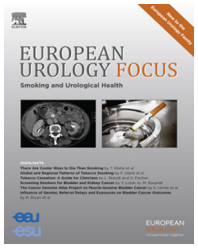

Review – Stone Disease

Safety and Efficacy of Day-case Percutaneous Nephrolithotomy: A Systematic Review from European Society of Uro-technology

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Abstract

Context: Day case or ambulatory percutaneous nephrolithotomy (PCNL) has risen over the last few years with the aim of discharging patients within 24 h.
Objective: We perform a systematic review of literature to evaluate the outcomes of day-case PCNL surgery.
Evidence acquisition: A Cochrane style search was performed and the following bibliographic databases were accessed: PubMed, Science Direct, Scopus, and Web of Science. This was carried out in accordance with the Preferred Reporting Items for Systematic reviews and Meta-analyses (PRISMA) guidelines. All studies in the English language reporting on PCNL patients discharged within 24 h were included.
Evidence synthesis: Based on the literature search of 97 articles, nine (502 patients) met the inclusion criteria (mean age: 47 yr), with a mean stone size of 20.5 mm. The mean operating time was 66 min, and over a mean hospital stay of 17.5 h, the stone-free rate was 95%. The overall complication rate was 13.5%; the vast majority of these complications were Clavien I–II complications, with a readmission rate of 3%.
Conclusions: Day-case PCNL is a safe and feasible strategy in carefully selected cases. However, for its success, detailed planning and adherence to surgical protocol are paramount with strict criteria for inpatient admission and a thorough follow-up plan.
Patient summary: Day-case percutaneous nephrolithotomy procedure seems to be a safe procedure with good outcomes, and low risk of complications and readmissions. Detailed preoperative protocol and planning are paramount, with indications for inpatient admission as well as a thorough follow-up plan.

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1. Introduction

Since its first description in 1976 by Fernstrom and colleagues [1], percutaneous nephrolithotomy (PCNL) has undergone significant development and change [2,3]. Such advancements include miniaturisation of equipment, improved optic systems, and refinement of renal access methods [4,5]. These modifications all strive to yield high stone clearance while minimising surgical morbidity. Such is this evolution in endourological practice that, while

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patients undergoing PCNL traditionally require planned inpatient admission as part of their recovery, a body of evidence is growing to support its potential feasibility as an ambulatory procedure in appropriately selected patients. Ambulatory surgery refers to patients being discharged either the same day or within 24 h after the procedure. Indeed, alternative surgeries such as ureteroscopy are now commonly performed on such a basis [6]. While an increasing number of original studies are reporting outcomes on ambulatory PCNL, also referred to as day case or outpatient PCNL, critical evaluation remains under-reported. The aim of this article was to review the current evidence in order to determine its safety and feasibility, and to consider if there are any recommendations that can be established from the literature for adoption of such a service.

2. Evidence acquisition

2.1. Criteria for considering studies for this review

Inclusion criteria:

1. Studies with the objective to discharge patients the same day or within 24 h after PCNL
2. Adult patients
3. Studies published over the past 20 yr

Exclusion criteria:

1. Animal studies
2. Case reports
3. Studies not specifically aiming to discharge patients the same day of surgery or within 24 h after it.

2.2. Search strategy and study selection

The authors performed a systematic review of the world literature to identify any original studies performed where adult patients underwent PCNL with the objective to discharge patients either the same day or within 24 h. This was carried out in a Cochrane style and in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) checklist.

Ambulatory PCNL was defined as discharge of patients either the same day or within 24 h after surgery. Bibliographic databases searched included the following: PubMed/Medline, Scopus, CINAHL, and Science Direct. No language restrictions were applied; however, case reports were excluded. Individual urological journals, conference proceedings, and citation lists were also hand searched. Search terms included (not limited to) “percutaneous nephrolithotomy,” “percutaneous,” “nephrostomy,” “tubeless,” “PCNL,” “PNL,” “day case,” “ambulatory,” and “outpatient.” Medical subject headings included [Urolithiasis], [Ambulatory Surgical Procedures], and [Urologic Surgical Procedures].

2.3. Data extraction and outcomes of interest

As for the search process, data extraction was carried out by two authors (P.J. and G.B.) and overseen by the senior author (B.K.S.). Authors were contacted directly in cases of missing data or uncertainty. Primary outcomes of interest were readmission rate and complications. Adverse events were graded according to the Clavien-Dindo classification [7]. The grading had already been assigned by each of the individual studies. Secondary outcomes of interest included stone-free rate (SFR), hospital stay, and operative time. Data were also collected on stone size, patient positioning, and tubeless status. To allow results of individual studies to be interpreted further, any additional information recorded on patient demographics or stone factors, for example, proportion of staghorn calculi or number of punctures, was also gathered where possible. Heterogeneity of study results did not allow for formal meta-analysis to be performed. Therefore, only pooled analysis of mean results and narrative descriptions have been carried out.

3. Evidence synthesis

From a total of 97 articles, nine ($n = 502$) were selected, which satisfied our predefined search criteria (Tables 1 and 2) [8–16]. Four studies ($n = 209$) discharged patients on the same day as surgery (group 1) [8–11], and five studies ($n = 293$) discharged patients after an overnight stay (group 2) [12–16]. These included three case series, five cohort studies, and one randomised trial.

3.1. Baseline characteristics

Across the nine studies, a total of 502 patients (mean age 47 yr, range 21–80 yr) underwent PCNL (Table 1). Mean stone size was 20.5 mm (range 7–60). There was no significant difference in stone size between the two groups (group 1: 18.8 vs 21.9, $p > 0.05$). All the studies performed standard PCNL with tract size between 24 and 30F, and none of the studies included patients undergoing any kind of miniaturised technique.

3.2. Outcomes of interest

Across all the studies, the mean SFR was 95.3% (range 88.8–100%). There was no significant difference in SFRs between patients discharged same day versus those discharged after an overnight stay (95.2 vs 95.4, $p > 0.05$). The overall mean operating time and hospital stay after the procedure were 65.6 min (range 38–106 min) and 17.5 h (range 0.5–96 h), respectively (Table 1). Prone patient positioning was adopted in six of nine studies. In the remainder of studies, two used the supine approach and one study did not detail how it was performed. Breakdown by approach was as follows: tubeless 48% ($n = 240$), percutaneous nephrostomy tube (PNT) 45% ($n = 226$), and totally tubeless (TT) 7% ($n = 36$). Kumar et al [16] compared tubeless PCNL versus standard PCNL with PNT. They found the number of days needed to return to normal activity to be significantly reduced in patients undergoing day-case surgery (8.05 vs

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Table 1 – Summary and outcomes of the included studies.

Author	Year	Study type	Sample size (M:F)	Average stone size (range)	Average hospital stay after procedure (range), h	Position/ tract size (F)	Tubeless/ totally tubeless	Stone-free rate (%)	Follow-up	Complications	Readmission rate (%)
Studies discharging patient on the same day as surgery											
Beiko [8]	2010	Case series	3 (3:0)	13.3 (11–17) mm	2.9 (0.5–5.8)	Prone/30	Tubeless	100	• Written and verbal instructions given to patients regarding returning to hospital • Follow-up for blood and plain AXR on average at 47 d	Nil	0
Shahrour [9]	2010	Case series	10 (6:4)	19.7 (9–29.9) mm	3.78 (1.25–5.7)	Supine/30	Tubeless	100	• CXR in recovery • Stents removed on day 3 postop • XR KUB after 7 d	Urosepsis (1), DVT (1)	10
Beiko [10]	2015	Cohort	50 (26:24)	19.6 (7–60) mm	3.5 (NR)	Prone/30	47/50 Tubeless 2/50 Totally tubeless 1/50 Nephrostomy tube	92	• Imaging at 1–8 wk postop	Extruded stent (1) Ovarian vein thrombosis (1) DVT (1) UTI (1) Wound cellulitis (1)	4
Fahmy [11]	2016	Cohort	146 (92:54)	504.5 (NR) mm^2	9 (NR)	Prone/30	NT and tubeless	88.9	• NT removed after 4–6 h • Phone call on day 1 • Clinic review at 1 and 4 wk	Fever (2) Haematuria (4) Flank pain (12)	1.3
Studies discharging patient after overnight stay											

Table 1 (*Continued*)

Author	Year	Study type	Sample size (M:F)	Average stone size (range)	Average hospital stay after procedure (range), h	Position/ tract size (F)	Tubeless/ totally tubeless	Stone-free rate (%)	Follow-up	Complications	Readmission rate (%)
Singh [12]	2005	Case series	10 (NR)	161 (100–250) mm^2	40 (NR)	Prone/NR	Tubeless	100	• Discharged on prophylactic oral antibiotics • XR KUB performed on day 1 after surgery	Nil	0
Alyami [13]	2012	Cohort	109 (58:51)	22 (9–59) mm	40.8 (NR)	NR	NT	89	• NT removed on day 1 Follow-up for 3 mo	UTI (1) Urinary retention (3) Haematuria (1) Pneumonia (1) Pulmonary oedema (1) Myocardial infarction (1) Colon injury (1)	5
Sharma [14]	2013	Cohort	34 (23:11)	21.4 (15.4–30) mm	12.5 (5.5–23.5)	Prone/NR	Totally tubeless	100	• US at 1 wk after surgery	Haematuria (2) Urine leak (1)	0
El-Tabey [15]	2013	Cohort	84 (51:33)	NR	33.4 (24–96)	Supine/30	Tubeless	91.7	• Removal of stents at 7–10 d	Fever (10) Perinephric collection (4) Leakage (2) Transfusion (4)	0
Kumar [16]	2016			Randomised trial	56 (33:23)	30.2 (NR) mm	11.5 (NR)	Prone/30	Tubeless	96.4	Follow-up at 6 wk
Fever (5) Urine leak (2) UTI (2) Tract site abscess (3) Transfusion (1)	7.1										

AXR = abdominal x-ray; CXR = chest x-ray; DVT = deep vein thrombosis; F = female; KUB = kidney, ureter, bladder; M = male; NR = not reported; NT = nephrostomy tube; US = ultrasonography; UTI = urinary tract infection; XR = x-ray.

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Table?2 – Selection criteria of the included studies.

Inclusion	Exclusion
• Normal renal function	• Active urinary infection
• ASA I or II	• Solitary kidney
• BMI <30	• Transplant kidney
• Adequate family and social support	• Congenital abnormality urinary tract
• >18 yr	• Encrusted stents
• Single stone	• BMI >30
• Live close to and have easy access to hospital	• Active cardiac disease
• Motivated to be compliant postoperatively	• Staghorn calculi
• Normal contralateral kidney	• Previous renal surgery
	• Multiple comorbidities
	• Bleeding diathesis

ASA = American Society of Anesthesiologists; BMI = body mass index.

18.4, $p < 0.05$). The average pain score and need for rescue analgesia were also significantly lower in the tubeless group ($p < 0.05$).

3.3. Complications

The majority of adverse events (>90%) were minor in nature (Clavien I–II). Breakdown by Clavien grade was as follows: Clavien I, 49%; Clavien II, 45%; Clavien III, 4.5%; and Clavien IV, 1.5% (Table 3). All the patients who developed complications such as fever and who required reassessment out of hours did so promptly and without delay. The single case of myocardial infarction was the only Clavien IV complication. The overall complication rate was 13.5%, and there was no significant difference between groups 1 and 2 (10.6% vs 12.8%, $p > 0.05$). No significant difference was found for major complications, and no fatalities were recorded across any of the studies. The overall readmission rate was 3% (range 0–10%). There was no significant difference in the readmission rates between the groups (group 1: 3.8% vs group 2: 2.4%, $p > 0.05$).

Table 3 – Complications of the included studies.

Complication	Grade	Frequency (*n*)	Management
Fever	I	17	Conservative
Haematuria	I	7	Conservative
Perinephric collection	I	4	Conservative
Urine leak	I	3	Conservative
Ovarian vein thrombosis	I	1	Conservative
Extruded stent	I	1	Conservative
Stent colic	II	12	Analgesia
Urinary retention	II	3	Catheter
Symptomatic UTI	II	4	Oral antibiotics
Wound cellulitis	II	1	Oral antibiotics
Blood transfusion	II	5	–
Deep vein thrombosis	II	1	Medical
Tract site abscess	II	3	Incision and drainage
Pneumonia	II	1	Oral antibiotics
Urosepsis	III	1	Intravenous antibiotics
Pulmonary oedema	III	1	Medical
Colonic perforation	III	1	Surgery
Myocardial infarction	IV	1	Medical
Death	V	0	–
Total	–	68	

UTI = urinary tract infection.

3.4. Discussion

3.4.1. Implications for practice

This is the first systematic review on this topic, and it shows that adoption of an ambulatory approach for PCNL is safe and feasible in carefully selected patients. The decision to proceed should be taken on a case-by-case basis with careful patient selection, done by experienced endourologists. Less than 5% of patients were readmitted, and only just over one in 10 patients suffered a complication.

3.4.2. Patient selection

Careful patient selection forms the cornerstone of setting up an ambulatory PCNL pathway. Key patient factors include good performance status and a low body mass index (BMI). From an anatomical perspective, patients should have a normal contralateral kidney and no congenital anomalies. The authors recommend selection of smaller stone size, for example, ≤2 cm, rather than those of larger or staghorn variety when a team is beginning this ambulatory practice. Social factors for consideration include easy access to hospital and satisfactory social support (Table 4).

3.4.3. Advantages of ambulatory PCNL

The studies identified in this review support practice of ambulatory PCNL in carefully selected patients. With experience, its application can even be extended to patients with more complex stone disease and higher BMI. Its use has also been described for bilateral simultaneous PCNL cases and in a renal transplant patient [10,17]. Crook et al [18] previously reported the length of stay to be significantly reduced when patients undergo TT technique compared with those receiving PNT placement (2.3 vs 3.4 d, $p < 0.05$). While TT technique has been reported in a few cases undergoing ambulatory surgery, the majority of studies that achieved successful discharge on the same day after surgery implemented a tubeless approach with subsequent removal of the stent a few days later. This appeared to be a more common approach than a TT surgery or leaving a PNT. If the use of PNT is adopted, this could be removed 4–6 h after surgery along with the urethral catheter.

Although none of the studies undertook formal cost-effective analyses, each author group concluded that substantial cost savings were anticipated to have been

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Table 4 – Recommendations for patient selection, and intra- and postoperative advice/monitoring.

Preoperative	Intraoperative	Postoperative
• Outpatient assessment by surgeon and anaesthetist	• Attempting tubeless approach	• Early contact with patient (face to face ± phone calls)
• Clear patient counselling	• Not suitable if any intraoperative problems	• Open access for patients to seek assessment
• Surgical requirements: bilateral functioning kidneys	• Monitor haematocrit level	• 24-h point of contact available for patient
• Anaesthetic requirements: low ASA grade, BMI <30, WHO performance status 0 or 1	• Shared decision between surgeon, nurses, and anaesthetist regarding going home the same day	• Explicit follow-up schedule (written and verbal instructions)
• Obtaining preoperative urine culture	Admit patient if:	
• Active engagement of patient and family	• Multiple punctures	
• Motivated multidisciplinary team	• Operative time >2 h	
• Experienced endourology team	• Occurrence of more than mild haemorrhage	
• Adequate social and family support for patient	• Febrile	
• Patient recovery location being near the hospital	• Haemodynamic instability	
	• Anaesthetic concerns	
	• Residual stones needing relook	
	• PCS perforation	
	• 2nd-look nephroscopy required	
	• Pain not controlled with oral analgesia	
	• Urinary retention	

ASA = American Society of Anesthesiologists; BMI = body mass index; WHO = World Health Organisation.

achieved. Additional advantages of an early discharge include encouragement of patient mobilisation, faster return to normal activities of daily living, and reduced risk of nosocomial infection. Preoperative counselling of patients promotes patient empowerment and taking ownership of their recovery, which are also strengths (Table 4).

3.4.4. *Disadvantages*

While ambulatory PCNL may offer advantages for appropriately selected candidates, it cannot be considered a "one size fits all" strategy at the present time. Most patients undergoing PCNL are nonindexed and typically have multiple comorbidities, which render them both a high surgical and a high anaesthetic risk. The potential benefits of early discharge are, therefore, outweighed by morbidity risk in this large cohort of patients. An ambulatory protocol removes the security of close/serial observation for serious complications such as haemorrhage and sepsis. Furthermore, even the most explicit take home instructions for patients cannot replace the expertise and experience of professionals in the hospital setting. At present, there is a lack of level 1 or 2 evidence to achieve disseminated practice.

3.4.5. *Recommendations for clinical practice*

Adoption of ambulatory PCNL should ideally be within a high-volume unit with sufficient endourological experience and lad by a motivated team of surgeons, nurses, and anaesthetists. The availability of high-power holmium YAG laser is crucial, and its use is likely to increase with minimally invasive PCNL techniques.

This group should have a shared and predefined set of stringent criteria regarding patient selection, as well as agreed intra- and postoperative indications for hospital admission. They should have a clear clinical pathway established to safely triage any unplanned readmissions in the early postoperative period. This should be disseminated both within the hospital and ideally to local primary care physicians. The follow-up schedule should include early face-to-face review, which can be complemented by telephone consultations with the option to expedite emergency assessment as required. Not only should the patients' geographic location during their recovery be such that it enables easy access to the hospital in case of emergency, but also the patient should ideally be independent and have adequate family and social support. The authors also advocate allocation of a nominated professional (surgeon or specialist nurse) to coordinate and champion the pathway similar to the enhanced recovery pathway for cystectomy or robotic prostatectomy [19,20]. Regular audit should be carried by the department to re-evaluate the service, and identify areas for improvement or any safety concerns. Table 4 gives an overview of recommendations for units embarking on such practice. It highlights the key areas for consideration in the planning phase, after the operation and during the follow-up period. These are based on the opinion of the authors and published expert experience, and not intended as an exhaustive list of recommendations. Furthermore, while strict criteria such as these should be followed in new units embarking on an ambulatory PCNL program, they could potentially be relaxed as experience is gained.

3.4.6. *Further considerations and future research*

While Beiko et al [10] recorded a lower overall SFR of 90.4% and one case of deep vein thrombosis, their patient cohort included two bilateral procedures and 21.1% of cases had staghorn calculi; 16% of their samples were also American Society of Anesthesiologists III. Similarly, Alyami and Norman [13] recorded a lower overall SFR of 89%; however, 36% of their patients had staghorn calculi. Therefore, the studies that have recorded such scores need to be interpreted in light of these additional stone and patient factors. To date, there has been only one randomised study on this topic [16]. An important limitation is the number of studies included. For true dissemination of day-case PCNL to occur

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more such studies are required. These should ideally be performed in the multicentre setting and have large sample sizes. Our search process served to identify studies that had the aim of discharging patients either the same day as surgery or within a maximum of 24 h after the procedure. It would be expected that this may have been achieved in other studies as part of a larger sample, but these were not searched for [20–22]. The first 24 h seem to be most crucial for the prevention of infective complications, and therefore patients can safely be discharged after this time [23,24].

Incorporation of cost-effective analyses would augment this and enable the presumed financial savings to be formally proved. Assessment of quality-of-life measurements would allow the perceived benefits for the patient's psychosocial status to be confirmed too [25]. With the advent of micro and ultramini techniques [21,22], which also befit a tubeless approach, it may be expected that the potential for ambulatory endourology will expand even further. Similarly, with increase in the number of endourological procedures being performed, a clear definition of SFR needs to be established for comparing outcomes [26,27]. The role of endourological techniques seems to be expanding, with good outcomes now being reported in paediatric patients, pregnancy, and patients with a solitary kidney [21,22,28,29].

4. Conclusions

Ambulatory PCNL is a safe and feasible strategy in carefully selected cases. Our review shows good outcomes with a low risk of complications and readmissions. Detailed planning is paramount in order to establish clear criteria for potential surgical candidates and indications for inpatient admission, as well as a thorough follow-up plan.

Author contributions: Bhaskar K. Somani had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Jones, Somani.
Acquisition of data: Bennett.
Analysis and interpretation of data: Dosis, Pietropaolo.
Drafting of the manuscript: Jones.
Critical revision of the manuscript for important intellectual content: Aboumarzouk, Skolarikos, Somani.
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