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Tubed Versus Tubeless Percutaneous Nephrolithotomy in Children in a Tertiary Centre

Sanjay Kumar Mahapatra [1], Sucheta Panigrahi [2], Tapan K. Nayak [2], Sarita Meena [2]

1. Urology, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Sambalpur, IND 2. General Surgery, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Sambalpur, IND

Corresponding author: Tapan K. Nayak, drtapannayak@gmail.com

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Abstract

Introduction: Tubeless percutaneous nephrolithotomy (PCNL) has emerged as an alternative to conventional tubed PCNL in selected children with renal calculi. However, evidence regarding its perioperative benefits and safety in the paediatric population remains limited. This study compared tubeless PCNL with tubed PCNL in children undergoing PCNL for renal calculi.

Materials and methods: This prospective comparative study was conducted at the Department of Urology, Veer Surendra Sai Institute of Medical Sciences and Research, Burla, Odisha, India, from July 2023 to June 2024. A total of 102 children aged <14 years with renal calculi measuring 1.5-2.5 cm were included, with 51 undergoing tubeless PCNL and 51 undergoing tubed PCNL using a 12-Fr nephrostomy tube. Operative time, postoperative analgesic requirement, hospital stay, haemoglobin decline, postoperative complications, and three-month stone-free rate were compared. Statistical analysis was performed using SPSS version 26 (IBM Corp., Armonk, NY, USA).

Results: The mean age and stone size were comparable between the tubeless and tubed groups. Mean operative time was significantly shorter in the tubeless group (97.22 ± 1.71 vs. 99.35 ± 1.72 minutes; P<0.0001). Analgesic requirement (3.80 ± 0.69 vs. 5.57 ± 0.57 doses) and hospital stay (3.63 ± 0.60 vs. 6.14 ± 0.72 days) were also significantly lower with tubeless PCNL (both P<0.0001). Fever and UTI rates did not differ significantly. No urinary leakage or perinephric collection occurred in either group. At three months, 49 (96.08%) children in each group were stone-free (P=1.000).

Conclusion: Tubeless PCNL was associated with lower postoperative analgesic requirements and shorter hospital stay in appropriately selected paediatric patients. Although operative time was statistically shorter, the absolute difference was modest. No statistically significant differences were observed in postoperative complications or three-month stone-free rates. However, these findings should be interpreted cautiously because of the non-randomized allocation and relatively small sample size. Tubeless PCNL may be considered in selected children when satisfactory stone clearance, adequate haemostasis, and absence of significant collecting-system injury are established intraoperatively.

Categories: Urology
Keywords: nephrostomy tube, paediatric urolithiasis, percutaneous nephrolithotomy, stone-free rate, tubeless pcnl

Introduction

Urolithiasis is characterized by the formation or presence of mineral deposits within the urinary tract and may involve the kidneys, ureters, or urinary bladder [1]. Although urinary stone disease is more common in adults, paediatric urolithiasis is an important clinical condition that requires careful evaluation and management. The prevalence of paediatric nephrolithiasis has increased worldwide and may be influenced by dietary patterns, climatic conditions, metabolic abnormalities, urinary tract infections (UTIs), anatomical abnormalities, and genetic predisposition [2-4]. In children, the risk of recurrence is particularly important because urinary stone formation may be associated with underlying metabolic or anatomical abnormalities that require appropriate evaluation and long-term follow-up [5,6].

The management of paediatric urolithiasis aims to achieve complete or clinically significant stone clearance while minimizing morbidity and preserving renal function [7]. Treatment options include conservative management with the choice depending on stone size, location, anatomical factors, and clinical characteristics [8]. Percutaneous nephrolithotomy (PCNL) is an established minimally invasive treatment for appropriately selected renal stones and provides high stone-clearance rates [9].

Tubeless PCNL, in which the nephrostomy tube is omitted in selected patients, has emerged as an alternative approach aimed at reducing postoperative morbidity. Avoidance of the nephrostomy tube may reduce postoperative discomfort and analgesic requirements and may facilitate earlier discharge from hospital [10]. Evidence regarding tubeless PCNL in the paediatric population remains relatively limited compared with the adult literature. In appropriately selected children, omission of the nephrostomy tube

may provide advantages in postoperative recovery without compromising stone clearance. However, comparative data evaluating tubeless PCNL against conventional tubed PCNL using small-bore nephrostomy tubes in children are still limited. Therefore, further evaluation of postoperative recovery, complications, and stone-free outcomes is warranted.

The present study aimed to compare tubeless PCNL with tubed PCNL using a 12-Fr nephrostomy tube in children undergoing PCNL for renal calculi, with respect to haemoglobin drop, operative time, postoperative analgesic requirement, duration of hospital stay, postoperative complications, and stone-free rate at three months.

Materials And Methods

Study design and setting

This prospective comparative study was conducted in the Department of Urology, Veer Surendra Sai Institute of Medical Sciences and Research (VIMSAR), Burla, Sambalpur, Odisha, India, from July 2023 to June 2024. The study population comprised children aged <14 years with renal calculi measuring 1.5-2.5 cm who underwent either tubed or tubeless PCNL. The study followed a non-randomized comparative design. Blinding was not performed because the nature of the surgical interventions made blinding of the patients and operating surgeon impractical. The study was initiated after approval from the Institutional Ethics Committee of VIMSAR, Burla (IEC No. 209-2022/I-S-T/159, dated 17 June 2023).

Sample size

The sample size was calculated using G*Power software, assuming a medium effect size (d) of 0.5, an alpha error of 0.05, a statistical power of 80%, and an allocation ratio of 1:1 between the two groups. The predetermined recruitment target was 51 children in each group, resulting in a total sample size of 102 children. Eligible participants were recruited prospectively using consecutive sampling until the planned group sizes were achieved.

Inclusion and exclusion criteria

Children aged <14 years undergoing PCNL for renal calculi measuring 1.5-2.5 cm were included. Children with stones located within the kidney were eligible for participation. Children aged ⩾14 years, those with renal or skeletal anatomical abnormalities such as horseshoe kidney, malrotated kidney, or kyphoscoliosis, those with renal stones <1.5 cm or >2.5 cm, children with a positive preoperative urine culture, and those with coagulation disorders were excluded.

Preoperative evaluation

All eligible children underwent clinical evaluation and routine preoperative investigations. Preoperative imaging included plain radiography, ultrasonography, and computed tomography of the kidneys and urinary bladder. Intravenous ceftriaxone was administered as perioperative antibiotic prophylaxis [11].

Study groups and operative technique

A total of 102 children underwent PCNL, with 51 children undergoing tubeless PCNL (Group A) and 51 undergoing tubed PCNL (Group B). All procedures were performed by a single surgeon to minimize inter-surgeon variability. The study was non-randomized, with predetermined recruitment targets of 51 patients in each group. The decision to perform tubeless PCNL was based on intraoperative findings and surgical judgement.

The decision to perform tubeless PCNL was based on satisfactory intraoperative findings, including absence of significant pelvicalyceal system disruption or contrast extravasation, absence of profuse bleeding that could compromise the procedure, satisfactory stone clearance, and absence of clinically significant residual fragments [12,13]. Residual fragments, when present, were considered acceptable if they were non-obstructive and <4 mm in size [14]. Nephrostomy drainage was retained whenever intraoperative findings did not support safe omission of the nephrostomy tube.

All procedures were performed under general anaesthesia. A ureteric catheter was initially placed, followed by positioning of the child in the prone position. A Foley catheter was inserted per urethra. The pelvicalyceal system was punctured under fluoroscopic guidance using a 22-Fr spinal needle, and a guidewire was advanced into the collecting system. The tract was dilated using serial metallic dilators over the guidewire, followed by placement of an Amplatz sheath. A 12-Fr nephroscope was used for the procedure. Stone fragmentation was performed using a Holmium laser, and an attempt was made to achieve complete stone clearance. Stone fragments were removed using irrigation and stone graspers [11].

Fluoroscopy was used to guide renal puncture and guidewire placement during the procedure. Stone fragmentation and clearance were assessed under direct endoscopic visualization using the nephroscope. Routine fluoroscopic confirmation of complete stone clearance was not performed as a separate assessment

endpoint.

In Group B, a 12-Fr percutaneous nephrostomy tube was placed at the end of the procedure and secured to the skin using 4-0 silk mattress sutures. In Group A, the nephrostomy tube was omitted after confirming satisfactory stone clearance and absence of significant collecting-system injury or bleeding. The nephroscope was removed and the access site was closed with deep mattress suturing, with manual compression applied for haemostasis [12,13]. Operative time was measured from the beginning of cystoscopic examination to completion of nephrostomy tube fixation in the tubed group or completion of skin closure in the tubeless group.

Postoperative management and follow-up

Postoperative pain was managed using analgesics, and the requirement was recorded for comparison between the two groups. Postoperative analgesia was administered according to the institutional paediatric analgesic protocol. Intravenous paracetamol (15 mg/kg/dose) was given for analgesia. The number of analgesic doses administered during the postoperative period was recorded for comparison between the groups.

The Foley catheter was removed on the first postoperative day in the absence of significant haematuria. In Group B, the nephrostomy tube was clamped and subsequently removed when there was no fever, significant pain, or leakage around the nephrostomy tract. Patients were discharged after removal of the nephrostomy tube and Foley catheter. In Group A, patients were discharged after removal of the Foley catheter and confirmation that the surgical-site dressing was dry. Ultrasonography was performed postoperatively to assess for perinephric collection [11].

Postoperative fever was defined as a body temperature of ⩾38°C. UTI was defined by compatible clinical findings supported by microbiological evidence of urinary infection on urine culture, if culture confirmation was performed. Postoperative complications, including fever, UTI, urinary leakage, and perinephric collection, were recorded. Perioperative blood transfusion requirements were also documented. No patient in either group required perioperative blood transfusion.

Assessment of stone-free status

Stone-free status was assessed using postoperative imaging. X-ray Kidneys, Ureters, and Bladder (KUB) was performed on the first postoperative day, followed by X-ray KUB and ultrasonography of the KUB region at approximately three weeks and three months after surgery. Patients were considered stone-free when no residual stone was identified or when only clinically insignificant residual fragments measuring <4 mm were present, provided they were non-obstructive and asymptomatic. Detection of a residual stone was considered treatment failure [14]. Routine CT imaging was not performed for the three-month assessment of stone-free status.

Study variables and outcome measures

The study variables included demographic parameters such as age and sex, stone size, operative time, postoperative analgesic requirement, duration of postoperative hospital stay, change in haemoglobin level, stone-free rate, and postoperative complications. Postoperative complications assessed included fever, UTI, urinary leakage, and perinephric collection.

Statistical analysis

Statistical analysis was performed using SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. The independent-samples t-test was used to compare continuous variables between the two groups. The chi-square test or Fisher's exact test was used for comparison of categorical variables, as appropriate. A two-tailed P value <0.05 was considered statistically significant.

Results

The mean age was comparable between the tubeless and tubed PCNL groups (8.29 ± 2.46 vs. 8.12 ± 2.51 years; P=0.7305). Males constituted 27 (52.94%) and 29 (56.86%) children, respectively, while the mean stone size was 20.45 ± 2.52 and 19.55 ± 2.44 mm, with no significant difference (P=0.6921 and P=0.0699, respectively) (Table *1*).

Characteristic	Category	Tubeless PCNL (Group A) (n=51)	Tubed PCNL (Group B) (n=51)	Statistical test	P value
Age (years)	Mean ± SD	8.29 ± 2.46	8.12 ± 2.51	t = 0.345	0.7305
Gender	Male	27 (52.94%)	29 (56.86%)	χ^2 = 0.157	0.6921
	Female	24 (47.06%)	22 (43.14%)		
Stone size (mm)	Mean ± SD	20.45 ± 2.52	19.55 ± 2.44	t = 1.832	0.0699

TABLE 1: Baseline characteristics of the study population

Data are presented as mean ± standard deviation (SD) or number (N) with percentage (%). Independent-samples t test was applied for continuous variables and chi-square (χ^2) test for categorical variables. A P value <0.05 was considered statistically significant. PCNL, percutaneous nephrolithotomy.

The mean hemoglobin drop was comparable between groups (0.10 ± 0.09 vs. 0.10 ± 0.12 g/dL; P=1.000). Operative time, analgesic requirement, and postoperative hospital stay were significantly lower in the tubeless group (97.22 ± 1.71 vs. 99.35 ± 1.72 minutes; 3.80 ± 0.69 vs. 5.57 ± 0.57 doses; and 3.63 ± 0.60 vs. 6.14 ± 0.72 days, respectively; all P<0.0001) All procedures were performed by a single surgeon, and no patient in either group required perioperative blood transfusion (Table *2*).

Perioperative outcome	Tubeless PCNL (Group A) (n=51)	Tubed PCNL (Group B) (n=51)	Statistical test	P value
Drop in hemoglobin (g/dL)	0.10 ± 0.09	0.10 ± 0.12	t = 0.001	1.000
Operative time (minutes)	97.22 ± 1.71	99.35 ± 1.72	t = 6.27	<0.0001
Analgesic doses	3.80 ± 0.69	5.57 ± 0.57	t = 14.15	<0.0001
Postoperative hospital stay (days)	3.63 ± 0.60	6.14 ± 0.72	t = 19.00	<0.0001

TABLE 2: Comparison of perioperative outcomes between the tubeless and tubed PCNL groups

Data are presented as mean ± standard deviation (SD). Independent-samples t test done. A P value <0.05 was considered statistically significant. PCNL, percutaneous nephrolithotomy.

Postoperative fever occurred in three (5.88%) versus one (1.96%) children, while UTI occurred in four (7.84%) versus two (3.92%) children in the tubeless and tubed groups, respectively. Neither difference was statistically significant (P = 0.6175 and P = 0.6779, respectively). No urinary leakage or perinephric collection was observed in either group (Table *3*).

Postoperative complication	Tubeless PCNL (Group A) (n=51)	Tubed PCNL (Group B) (n=51)	P value
Postoperative fever	3 (5.88%)	1 (1.96%)	0.6175
Postoperative UTI	4 (7.84%)	2 (3.92%)	0.6779
Urinary leakage	0 (0.00%)	0 (0.00%)	1.000
Perinephric collection	0 (0.00%)	0 (0.00%)	1.000

TABLE 3: Comparison of postoperative complications between the tubeless and tubed PCNL groups

Data are presented as number (N) with percentage (%). Fisher's exact test done. A P value <0.05 was considered statistically significant. PCNL, percutaneous nephrolithotomy; UTI, urinary tract infection.

At three months, 49 (96.08%) children in each group were stone-free, while two (3.92%) children in each group were not stone-free, with no statistically significant difference between the groups (P = 1.000). No additional stone-clearance intervention was performed in these four patients during the study follow-up

period (Table 4).

Stone-free status at three months	Tubeless PCNL (Group A) (n=51)	Tubed PCNL (Group B) (n=51)	P value
Stone-free	49 (96.08%)	49 (96.08%)	1.000
Not stone-free	2 (3.92%)	2 (3.92%)	

TABLE 4: Comparison of stone-free rate at three months between the tubeless and tubed PCNL groups

Data are presented as number (N) with percentage (%). Fisher's exact test done. A P value <0.05 was considered statistically significant. PCNL, percutaneous nephrolithotomy.

Discussion

The present study demonstrated that tubeless PCNL provides favourable perioperative outcomes compared with tubed PCNL in appropriately selected children undergoing PCNL for renal calculi. The baseline characteristics were comparable between the groups. The mean age was 8.29 ± 2.46 years in the tubeless group and 8.12 ± 2.51 years in the tubed group, while the mean stone size was 20.45 ± 2.52 mm and 19.55 ± 2.44 mm, respectively. Although no statistically significant baseline differences were observed, the absence of significant differences in the measured characteristics does not exclude the possibility of selection bias or differences in other unmeasured clinical factors. Iqbal et al. similarly reported comparable age and stone size between paediatric tubed and tubeless PCNL groups, supporting the feasibility of comparing these techniques in appropriately selected children [15].

A major finding of the present study was the significantly lower postoperative analgesic requirement in the tubeless group. Children undergoing tubeless PCNL required a mean of 3.80 ± 0.69 analgesic doses compared with 5.57 ± 0.57 doses in the tubed group (P < 0.0001). Avoidance of a nephrostomy tube may reduce local irritation and postoperative discomfort. Samad et al., in a comparative study of children undergoing PCNL, reported significantly lower postoperative pethidine requirements in the tubeless group [16]. Keshavamurthy et al. also reported reduced morbidity with tubeless PCNL compared with nephrostomy drainage in selected paediatric patients [13]. More recently, Fang et al., in an updated systematic review and meta-analysis involving 661 paediatric patients, demonstrated significantly shorter pain-management duration and lower postoperative pain scores with tubeless PCNL [17]. These findings are consistent with the present study and support the postoperative comfort advantage of avoiding a nephrostomy tube in appropriately selected children. However, the observed reduction in analgesic requirement should be interpreted in the context of the non-randomized allocation and potential influence of intraoperative patient selection.

Hospital stay was also significantly shorter following tubeless PCNL. The mean hospital stay was 3.63 ± 0.60 days in the tubeless group compared with 6.14 ± 0.72 days in the tubed group (P < 0.0001). Reduced postoperative discomfort, absence of nephrostomy-tube care, and earlier mobilisation may contribute to earlier discharge. Samad et al. reported significantly shorter hospitalisation with tubeless PCNL in children [16]. Goktug et al. similarly reported a substantially shorter hospital stay in children undergoing totally tubeless PCNL while maintaining comparable stone-free and complication outcomes [12]. Ozturk et al. also observed shorter hospitalisation and lower analgesic requirements following totally tubeless PCNL in preschool children [18]. Fang et al. further demonstrated a significant reduction in hospital stay with tubeless PCNL, with a weighted mean difference of -1.60 days [17]. Thus, the substantial reduction in hospital stay observed in the present study is consistent with previous paediatric evidence. Nevertheless, the difference in hospital stay may also have been influenced by the postoperative management requirements associated with nephrostomy drainage and the non-randomized selection of patients for tubeless PCNL.

The present study found no significant difference in haemoglobin decline between the two groups. Mean haemoglobin decrease was 0.10 ± 0.09 g/dL in the tubeless group and 0.10 ± 0.12 g/dL in the tubed group (P = 1.000). No patient in either group required perioperative blood transfusion. These findings indicate that no difference in the measured haemoglobin decline was detected between the two groups; however, they should not be interpreted as definitive evidence of equivalent haemostatic safety. Nouralizadeh et al., in a systematic review and meta-analysis of tubeless versus standard PCNL in children, found no significant difference in postoperative haemoglobin decrease between the two techniques [19]. Iqbal et al. likewise demonstrated comparable haemoglobin outcomes following tubeless and tubed PCNL [15]. Fang et al. also found no significant difference in haemoglobin decline between paediatric tubeless and standard PCNL [17]. These findings support the feasibility of omitting nephrostomy drainage when the procedure is uncomplicated and patients are appropriately selected.

Operative time was statistically shorter in the tubeless group, with a mean duration of 97.22 ± 1.71 minutes

compared with 99.35 ± 1.72 minutes in the tubed group (P < 0.0001). However, the absolute difference of approximately 2.13 minutes is modest and may have limited clinical significance. This difference may primarily reflect the time saved by avoiding nephrostomy tube placement and fixation at the end of the procedure rather than a substantial improvement in overall procedural efficiency. Samad et al. reported a shorter operative time with tubeless PCNL in children, although the difference was not statistically significant [16]. Goktug et al. reported significantly shorter operative times in children selected for totally tubeless PCNL [12], while Fang et al. also identified significantly shorter operative time with tubeless PCNL in paediatric patients [17]. Thus, although the present study demonstrated a statistically significant difference, operative time should be considered a secondary procedural advantage rather than a major clinical benefit of tubeless PCNL.

Postoperative complications were comparable between the two groups. Fever occurred in three (5.88%) children in the tubeless group and one (1.96%) child in the tubed group, while UTI occurred in four (7.84%) and two (3.92%) children, respectively. Neither difference was statistically significant, and no urinary leakage or perinephric collection was observed in either group. Keshavamurthy et al. reported tubeless PCNL to be a safe and less morbid alternative in uncomplicated paediatric nephrolithiasis, with urinary leakage occurring in children receiving nephrostomy drainage but not in the tubeless group [13]. Iqbal et al. similarly found no significant difference in postoperative complications between tubed and tubeless PCNL [15]. Fang et al. reported lower postoperative fever and urine leakage with tubeless PCNL, without significant differences in overall complications, UTI, or perinephric fluid collections [17]. In the present study, although no statistically significant differences were detected in the observed complications, the relatively small sample size limits the ability to detect uncommon adverse events. Therefore, the findings should not be interpreted as establishing equivalent safety between the two approaches. These observations support the feasibility of tubeless PCNL in appropriately selected children, provided that satisfactory intraoperative conditions are achieved.

Stone clearance was maintained with the tubeless approach. At three months, 49 (96.08%) children in each group were stone-free, with no significant difference between the groups (P = 1.000). The remaining two children in each group were classified as not stone-free, and no additional stone-clearance intervention was performed during the study follow-up period. Iqbal et al. found comparable stone-free rates between tubed and tubeless PCNL in children [15]. Goktug et al. reported stone-free rates of 100% in the totally tubeless group and 93.3% in the standard group [12]. Nouralizadeh et al. also found no significant difference in stone clearance between tubeless and standard PCNL in their paediatric meta-analysis [19]. Fang et al. reported higher stone clearance with tubeless PCNL than standard PCNL, although interpretation remains dependent on patient selection and procedural characteristics [17]. The identical three-month stone-free rate in the present study demonstrates comparable observed stone-clearance outcomes between the groups. However, these findings should be interpreted in the context of the non-randomized study design and the imaging methods used for postoperative assessment.

Overall, the present study supports tubeless PCNL as a feasible alternative to conventional tubed PCNL in selected children with renal calculi. The principal advantages were reduced analgesic requirement and shorter hospitalisation, while haemoglobin decline, postoperative complications, and three-month stone-free rates showed no statistically significant differences between the groups. Although operative time was statistically shorter in the tubeless group, the absolute difference was modest. Fang et al. similarly demonstrated shorter hospital stay and operative time, lower postoperative pain, and favourable stone-clearance outcomes with tubeless PCNL in children [17]. Nevertheless, tubeless PCNL should be considered in appropriately selected cases, particularly when adequate stone clearance and haemostasis have been achieved and there is no significant collecting-system injury. The findings of the present study should be interpreted as associations rather than definitive evidence of superiority or equivalent safety because of the non-randomized allocation and potential selection bias. The present findings add further prospective comparative evidence supporting this approach in children with renal stones measuring 1.5-2.5 cm.

Strengths and limitations

The strengths of the present study include its prospective comparative design, inclusion of a well-defined paediatric population, performance of all procedures by a single surgeon, comparable baseline characteristics between the tubeless and tubed PCNL groups, standardized assessment of perioperative outcomes, and follow-up assessment of stone-free status at three months. The study evaluated clinically relevant outcomes including operative time, analgesic requirement, hospital stay, haemoglobin decline, postoperative complications, and stone-free rate.

However, the study has certain limitations. It was conducted at a single tertiary-care centre with a relatively small sample size of 102 children, which may limit the generalizability of the findings. The non-randomized allocation of patients represents an important limitation. Since tubeless PCNL was performed only when satisfactory intraoperative findings were achieved, including adequate stone clearance, haemostasis, and absence of significant collecting-system injury, the tubeless group may have included patients with relatively uncomplicated procedures. This could have introduced selection bias and potentially favoured the tubeless group in terms of postoperative recovery and complication outcomes. The follow-up period was limited to three months and therefore does not provide information regarding long-term stone recurrence or

late complications. Blinding was not performed because of the nature of the surgical interventions, which may have introduced some potential for assessment bias, particularly for subjective outcomes such as analgesic requirement. Additionally, the anatomical distribution of renal calculi within the pelvicalyceal system was not separately analysed or compared between the two groups. Since stone location may influence procedural complexity, access requirements, and stone-clearance outcomes, the absence of this analysis represents a limitation and may have affected the comparability of stone characteristics between groups. Furthermore, postoperative stone-free assessment was performed using X-ray KUB and ultrasonography rather than routine CT imaging. These modalities may have lower sensitivity for detecting small residual fragments, potentially influencing the assessment of stone-free status. Finally, the relatively small sample size limits the statistical power to detect uncommon complications, and the absence of statistically significant differences should not be interpreted as proof of equivalent safety. Larger multicentre studies with randomized or otherwise more rigorous allocation methods, standardized outcome definitions, and longer follow-up are warranted to further validate these findings.

Conclusions

Tubeless PCNL was associated with favourable postoperative outcomes compared with conventional tubed PCNL in appropriately selected paediatric patients. In the present study, tubeless PCNL was associated with lower postoperative analgesic requirements and shorter hospital stay. Although operative time was statistically shorter, the absolute difference was modest and may have limited clinical significance. No statistically significant differences were observed in haemoglobin decline or postoperative complications, including fever, UTI, urinary leakage, and perinephric collection. The three-month stone-free rate was identical in both groups, demonstrating comparable observed stone-clearance outcomes. However, the absence of statistically significant differences does not establish equivalent safety or efficacy, particularly given the relatively small sample size and non-randomized patient allocation. Therefore, tubeless PCNL may be considered a feasible approach in selected children undergoing uncomplicated PCNL, provided satisfactory stone clearance, adequate haemostasis, and absence of significant collecting-system injury are established intraoperatively. Further prospective, multicentric studies with larger paediatric cohorts, more rigorous allocation methods, and longer follow-up are warranted to validate these findings and better define the patient and procedural characteristics that are most suitable for tubeless PCNL.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Tapan K. Nayak, Sanjay Kumar Mahapatra, Sarita Meena , Sucheta Panigrahi

Acquisition, analysis, or interpretation of data: Tapan K. Nayak, Sanjay Kumar Mahapatra, Sarita Meena , Sucheta Panigrahi

Drafting of the manuscript: Tapan K. Nayak, Sanjay Kumar Mahapatra, Sarita Meena , Sucheta Panigrahi

Critical review of the manuscript for important intellectual content: Tapan K. Nayak, Sanjay Kumar Mahapatra, Sarita Meena , Sucheta Panigrahi

Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Researcha and Ethics Committee, Veer Surendra Sai Institute of Medical Sciences and Research, Burla issued approval 209-2022/I-S-T/159. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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