



Comparison of outcomes of tubed versus tubeless percutaneous nephrolithotomy in children: A single center study

Çocuklarda tüplü ve tüpsüz perkütan nefrolitotomi sonuçlarının karşılaştırılması: Tek merkezli çalışma

Nadeem Iqbal¹ , Salman Assad² , Ijaz Hussain¹ , Yumna Hassan² , Hafsa Khan² , Muhammad Armaghan Farooq² , Saeed Akhter¹

Cite this article as: Iqbal N, Assad S, Hussain I, Hassan Y, Khan H, Armaghan M, et al. Comparison of outcome of tubed versus tubeless percutaneous nephrolithotomy in children: A single center study. Turk J Urol 2018; 44(1): 56-61.

ABSTRACT

Objective: To evaluate and compare the effectiveness of tubeless percutaneous nephrolithotomy (PCNL) and tubed PCNL by using small bore nephrostomy tube (12Fr) in children for the management of nephrolithiasis.

Material and methods: This study was a retrospective analysis of 35 children where tubed PCNL (Group 1) was done in 18, and tubeless PCNL (group 2) in 17 patients from January 2010 to December 2016. Charts were reviewed for age, mass, stone size, operative time, hospital stay and stone-free rates. These variables were compared between the two groups. SPSS version 21 was used for data analysis. The data were shown as mean±standard deviation for continuous variables. Categorical variables were presented in percentages.

Results: There is no difference in terms of age, stone sizes, operative times, hospital stays, stone-free rates and post-PCNL complications between the two groups ($p>0.05$). The mean drop in hemoglobin level was 0.7 ± 0.1 g/dL and 1.3 ± 0.2 g/dL in Groups 1 and 2, respectively ($p=0.01$).

Conclusion: Tubeless PCNL in children is a safe option in well selected cases.

Keywords: Pediatric renal stones; renal stones; stone- free rate; tubeless PCNL.

ÖZ

Amaç: Çocuklarda nefrolitiazisin tedavisi için tüpsüz ve tüplü (12 Fr) perkütan nefrolitotominin (PNL) etkinliğinin değerlendirilmesi ve karşılaştırılması.

Gereç ve yöntemler: Ocak 2010 ile Aralık 2016 arasında tüplü ($n=18$; Grup 1) ve tüpsüz ($n=17$; Grup 2) PNL uygulanan 35 çocuk retrospektif olarak analiz edilmiştir. Hasta tabelaları yaş, kitle, taş büyüklüğü, ameliyat süresi, hastanede kalış süresi ve taşsızlık oranları açısından gözden geçirilmiştir. Bu değişkenler iki grup arasında karşılaştırılmışı verilerin analizi için SPSS'nin 21. sürümü kullanılmıştır. Veriler, sürekli değişkenler için ortalama ± standart sapma, ve kategorik değişkenler için yüzdeler şeklinde gösterilmiştir.

Bulgular: Bu çalışmada yaş ortalaması Grup 1 ve 2 için sırasıyla $9\pm5,2$ ve $7,5\pm5,94$ yıl idi. Ortalama taş büyüklüğü Grup 1 ve 2'de sırasıyla $1,6\pm0,6$ cm ve $1,9\pm0,7$ cm idi. Ortalama ameliyat süresi Grup 1 ve 2'de sırasıyla $156\pm38,7$ dk ve $160\pm41,1$ dk idi ($p=0,7$). Hemoglobin düzeyinde düşüş Grup 1 ve 2'de sırasıyla $0,7\pm0,1$ g/dL ve $1,3\pm0,2$ g/dL idi ($p=0,01$). Ortalama hastanede kalış süresi Grup 1 ve 2'de sırasıyla $2,8\pm1,3$ gün ve $3,1\pm1,5$ gün idi ($p=0,5$). Grup 1 ve 2'de ortalama taşsızlık oranları sırasıyla %93 ve %96 idi.

Sonuç: İki grup arasında ortalama hastanede kalış süresi, ameliyat süresi, taşsızlık oranları ve PNL sonrası komplikasyonlar açısından hiçbir fark yoktur. Çocuklarda tüpsüz PNL iyi seçilmiş olgularda güvenli bir seçenektir.

Anahtar Kelimeler: Pediatrik böbrek taşları; böbrek taşları; taşsızlık oranı; tüpsüz PNL.

ORCID IDs of the authors:

N.I. 0000-0001-7154-9795;
S.A. 0000-0002-5830-9997;
I.H. 0000-0002-1037-6306;
Y.H. 0000-0002-7393-8708;
H.K. 0000-0002-2868-7735;
M.A.F. 0000-0003-3152-6761;
S.A. 0000-0001-5289-0998

¹Department of Urology and Kidney Transplant, Pakistan Kidney Institute, Shifa International Hospital, Islamabad, Pakistan

²Shifa College of Medicine, Shifa International Hospital, Islamabad, Pakistan

Submitted:
27.04.2017

Accepted:
22.09.2017

Available Online Date:
08.01.2018

Correspondence:
Nadeem Iqbal
E-mail:
dr_nadeemiqbal84@yahoo.com

©Copyright 2018 by Turkish Association of Urology

Available online at
www.turkishjournalofurology.com

Introduction

Pediatric renal stones are increasing in frequency across the world and they are more endemic in developing world. Most of the time they are due to urinary tract infection (UTI), anatomical and metabolic abnormalities.^[1] Apart from these climate and dietary factors are also important in this regard.^[2] Over the last few years there have been continuous advancement in technology which has resulted in development of less invasive techniques such as PCNL or noninvasive technique such as Extra Corporeal Shock Wave Lithotripsy (ESWL) for the treatment of the renal stones in adults.^[3] In children first PCNL procedure was reported in 1985. After that, this procedure has been adopted gradually by other surgeons as well and the experience with pediatric PCNL for treating renal stones reinforced confidence in the practice of this technique in the Western world with time.^[3,4]

Percutaneous nephrolithotomy (PCNL) is an important surgical procedure in the management of nephrolithiasis with subsequent placement of a nephrostomy tube in patients that are not treatable by extracorporeal shock wave lithotripsy. The primary objective of using nephrostomy tube and ureteric stents along with PCNL is the adequate drainage of kidneys.^[5] The other purpose of the tube placement is to allow second- time access into the collecting system, if a second look is necessary for clearing residual stones after the primary procedure.^[4,5] In some studies done in adult patients the use of nephrostomy tube and ureteral stent has been omitted with satisfactory outcomes. The concept of tubeless PCNL has been tried to achieve earlier recovery of the patients after procedure, discharge from the hospital, and less pain at wound site.^[6]

Reduced postoperative pain and shorter hospital stays are the advantages associated with this procedure.^[7] The use of large bore nephrostomy tubes had been associated with significant post-PCNL pain, as result they were replaced either by smaller nephrostomy tubes or 'tubeless PCNL' in which ureteral stents or catheters are used after PCNL.^[8] Many centers have reported their experience with tubeless PCNL in adults, which has been adopted as a safe alternative to standard tubed PCNL in selected patients without much bleeding or need for a secondary look for residual stones. In case of children such reports are very few and there is no clarity of available evidence regarding effectiveness of tubeless PCNL in the pediatric age group. So we wanted to know the differences in outcomes as stone-free rates and complications in tubed and tubeless PCNL for the treatment of renal stones in children.

Material and methods

It was a retrospective analysis where PCNL was performed in 35 children including tubed PCNL in 18 (Group 1) and tubeless

PCNL in 17 patients (Group 2). Children with mean ages of 9 ± 5.2 years and 7.5 ± 5.94 years were included in the Groups 1 (tubed PCNL) and 2 (tubeless PCNL), respectively from January 2010 to December 2016. Consent was taken from the parents of the children before undergoing PCNL. Approval of the ethical committee of Shifa International Hospital was taken before conducting this study. The patients were consecutively assigned into Groups 1 [placement of the small bore (12 F) nephrostomy tube, $n=18$] and 2 [no tube, $n=17$]. Inclusion criteria were children of age less than 12 years, location of stone in kidney and stone size greater than 2 cm, while exclusion criteria included any anatomical abnormalities such as horseshoe kidney/malrotated kidney, kyphoscoliosis, children having positive urine cultures and coagulation disorders. For the decision of doing tubeless PCNL we made it sure that there was no disruption of the pelvicalyceal system (seen as leakage of contrast on fluoroscopic images), no development of profuse bleeding during the procedure making the surgery difficult, complete removal of the renal stone would be achieved or if residual fragments were left, they would be insignificant fragments apparently less than 4 mm size.

Preoperative intravenous pyelograms (IVP X-ray), ultrasonograms of kidneys and urinary bladder and computed tomograms of the children were reviewed in the outpatient clinics. Once the decision to perform percutaneous nephrolithotomy (PCNL) was finalized, a complete blood count (CBC), serum urea, creatinine, electrolytes and PT/APTT were obtained one day before surgery. Blood cross- matching and grouping were also done before surgery to arrange one unit of blood in case of need during intra or postoperative period. Those children who had positive urine cultures were treated accordingly before surgery.

PCNL technique

Under general anesthesia, a ureteric catheter was passed up to the kidney and fluoroscopic guidance was utilized to visualize the anatomy of the pelvicalyceal system after the contrast material was infused. A Foley catheter was passed per urethra and afterwards patient was turned to prone position. Pelvicalyceal system was punctured under fluoroscopic guidance, using 23 Fr spinal needle. The guidewire was passed through spinal needle into pelvicalyceal system. The tract was dilated by using serial metallic dilators over the guidewire. We used adult size 20 French nephroscope (we didn't use the outer sheath of 24 Fr nephroscope so basically we used the inner 20 Fr sheath) for PCNL by standard technique. Pneumatic lithoclast was utilized to fragment the stones and an attempt to achieve complete clearance was made. Stone fragments were removed by using stone graspers. Operative time was calculated from the onset of cystoscopic examination to the placement, and fixation of the nephrostomy tube to the skin or in case of tubeless PCNL the last stitch of the skin wound closure. Nephrostomy tube used in

tubed PCNL group was of 12 Fr size. A 12F Foley catheter was inserted in the Group 1 (tubed PCNL) and mattress suturing with 4/0 silk was done. A deep mattress suturing of wound site was done in Group 2 (tubeless PCNL) after removal of nephroscope. Manual compression of wound was used for hemostasis. Bupivacaine 0.025% diluted equally in 2-3 mL distilled water was injected in the peritubal area to reduce immediate postoperative pain. Patients in Group 1 were discharged after removal of the Foley catheter and nephrostomy tube. The decision to remove the nephrostomy tube was implemented if there was no fever, pain or leakage from peritubal area after clamping the nephrostomy tube. The ureteric stent was removed after 3 weeks. Group 2 children were discharged after the removal of the Foley catheters, once the surgery site dressing was found to be dry. The ureteric stent in Group 2 was removed after 3 weeks.

Follow-up

Ultrasound scan was performed at postoperative 2 weeks to detect any possible perinephric collection. Patients were considered to be stone-free if there was no stone left after surgery, or when nonobstructive, asymptomatic and clinically insignificant residual fragments (CIRFs) of size less than 4 mm were observed on postoperative imaging of the urinary tract. X-ray KUB and ultrasound were used for follow up imaging. Computed tomography was not used for follow-up imaging to avoid the radiation exposure in children in our study groups.

Statistical analysis

Data on patient age, number and position of stones, operating time, change in hemoglobin level, postoperative analgesia requirement, length of hospital stay and postoperative complications were recorded and compared between the two groups. Data were analyzed by using the IBM Statistical Package for the Social Sciences (IBM SPSS Statistics; Armonk, NY, USA) version 21. The data were shown as mean \pm standard deviation for continuous variables. Categorical variables were presented in percentages. Independent t-tests were used to analyze continuous variables, while for categorical variables like stone-free rates chi-square test was used to compare two groups and a cut-off p value of 0.05 was determined as statistically significant.

Results

Demographic and clinical data of the patients were shown in Table 1. Postoperative blood transfusions were performed in 5.55% (1/18) and 11.76% (2/17) of the patients in Groups 1, and 2, respectively. There were two cases of postoperative fever, and 3 cases of urinary tract infections while urinary leakage were found in none of the any of the tubed or tubeless PCNL patients. Perinephric collection was seen in 5.8% (1/17) of the patients in the tubeless PCNL group. There were no significant differences in terms of intraoperative or postoperative compli-

cations, mean stone-free rates, mean hospital stays and use of analgesics doses between the two groups (Table 1).

Discussion

Percutaneous nephrolithotomy (PCNL) has become the ideal surgical approach for nephrolithiasis. It is a very safe procedure in children and its wide application in many clinical settings has proved it.^[9,10] Post-PCNL hospital stay and discomfort of the patient has been reduced by use of small-bore nephrostomy tubes, externalized ureteric catheters and double J stent (DJS) in uncomplicated cases. Hemostasis, reducing urinary leakage, rapid healing, reliable drainage and providing an access tract for further endoscopic procedure are the primary reasons for placement of a nephrostomy tube.^[10-12] An important issue is the presence of pain with nephrostomy tube after percutaneous nephrolithotomy. Reduced pain and decreased analgesic requirements have been observed after introduction of local anesthetic around nephrostomy tube.^[12,13] Use of small bore nephrostomy tubes following percutaneous nephrolithotomy procedures has reduced patient discomfort.^[11,13] The importance of decreasing the duration of hospital stay and post-PCNL pain encouraged the development of tubeless percutaneous nephrolithotomy. Tubeless PCNL has been a successful procedure even in advanced aged patients.^[13,14] Shah et al.^[15] documented superiority of percutaneous nephrolithotomy in terms of patient's satisfaction. They reached a conclusion that PCNL was a safe technique even in solitary kidney, past history of any ipsilateral renal surgical procedure, elevated serum creatinine levels, with an advantage of bilateral simultaneous use of PCNL or contralateral endourological removal of stones. Agrawal et al.^[16] compared tubeless percutaneous nephrolithotomy and standard PCNL procedure. He reported significant reduction in urinary leakage, postoperative pain, need of analgesia, duration of hospital stay and faster post-PCNL recovery in the tubeless group. Study results of Agrawal et al.^[16] are in contrast to our results where we reported no difference between both PCNL techniques in terms of analgesic requirements, hospital stay, and urinary leakage ($p>0.05$). Gupta et al.^[17] reported successful and cost-effective management of renal stones by applying PCNL without using ureteric stents. Karami et al.^[18] also documented that PCNL performed without nephrostomy tubes has positive impact on decreasing the duration of hospital stay. Limb et al.^[19] reported approximate 1.2 days of hospital stay after tubeless PCNL with ureteric stent insertion compared to prolonged mean hospital stay of 3.1 ± 1.5 days in tubeless PCNL with ureteric stents in our study. This prolonged time of hospital stay in our series may be due to the fact that we had initial years of experience with pediatric tubeless PCNL, so we had to make sure that the child is discharged from the hospital without any signs of pain or other post operative complications. In our study there was no difference between mean hospital stays of

Table 1. Demographic and clinical data of the patients

Variables	Group 1-Nephrostomy Tube PCNL (n=18)	Group 2- Tubeless PCNL (n=17)	p
Mean age (years)	9±5.2	7.5±5.9	0.4
Male: Female	10:8	9:8	0.6
Mean stone size (cm)	1.6±0.6	1.9±0.7	0.1
Mean operative time (minutes)	156±38.7	160±41.1	0.7
Mean drop in Hb levels (g/dL)	0.76±0.12	1.37±0.21	0.01
Mean analgesic dose (doses)	8.8±2.8	7.3±3.9	0.1
Mean hospital stay (days)	2.8±1.3	3.1±1.5	0.5
Mean stone- free rate (%)	93	96	0.7
No. of patients with post-op blood transfusion	1 (5.5%)	2 (11.7%)	0.5
Post-op fever	1 (5.5%)	0	-
Post-op ESWL	0	0	-
Ureteric stents	18/18 (100%)	17/17 (100%)	-
Duration of retaining stents (days)	19±1.2	20±0.3	0.5
Post-op UTI	1 (5.5%)	1 (5.5%)	0.9
Urinary leakage	0	0	-
Collection present	0	1/17 (5.8%)	-

PCNL: percutaneous nephrolithotomy; Hb: hemoglobin; ESWL: extracorporeal shock wave lithotripsy; UTI: urinary tract infection

3.1±1.5 days in tubeless PCNL and 2.8±1.3 days ($p=0.5$) in PCNL with nephrostomy tubes. Samad et al.^[20] was of opinion that second look through the nephrostomy tract was not needed in any patient, and a tract left behind for such purpose might not be beneficial for the patients. Bilateral simultaneous tubeless PCNL was performed in our 3 patients with adequate results. It should be kept in mind that all these variations of results may be due to individual surgeon's surgical competence, experiences and individual patient's circumstances.

Giusti et al.^[21] reported two instances of major bleeding following tubeless PCNL which demanded vital radiological involvement and embolisation. In our patients we didn't see any child needing renal arterial embolisation or nephrectomy for postoperative bleeding. Maheshwari et al.^[22] performed a prospective study on 40 patients who had undergone either 28 F nephrostomy tube or 9 Fr pigtail catheter insertions at the end of the PCNLs. They reported relatively shorter duration of the urinary leakage and hospital stay, with reduced pain and lesser need for analgesia in pigtail nephrostomy group. In a meta-analysis of randomized controlled trials, Ni et al.^[23] found that the size of the nephrostomy tube correlates with postoperative discomfort. Shen et al.^[24] has done a meta-analysis comparing the clinical benefits of tubed PCNL with nephrostomy tube (NT)-free PCNL. Patients were divided into four groups: large-sized tube group (20-24 F), middle-bore tube group (16-18 F),

small-bore tube group (8-9 F) and nephrostomy tube-free group. This meta-analysis demonstrated that there was no significant difference between the nephrostomy tube-free group and the small-bore tube group with regard to hospital stay and visual analog scale scores for postoperative pain, but there were differences between the NT-free group versus the middle-, and large-sized tube categories. No profound difference was evident with respect to blood transfusion, postoperative fever or infection, and the operative time between nephrostomy tube-free group and the other groups. Our study also showed no difference in terms of postoperative pain or use of analgesia. This might be due to use of small nephrostomy tube after completing PCNL procedure. In our study there was no difference in terms of post-PCNL complications like fever, transfusion or infection between small bore nephrostomy tube PCNL and tubeless PCNL. We achieved satisfactory results of PCNL even in small children. We have documented that there is no difference in terms of clinical outcomes between small-bore nephrostomy tube (NT) PCNL and tubeless PCNL. Our study have showed that tubeless PCNL was safe in children population as well and there was no negative impact of tubeless PCNL if patients were appropriately selected for tubeless PCNL procedure.

In our study there was a smaller drop in mean hemoglobin levels with 0.76±0.12 g/dL in small bore nephrostomy tube PCNL compared to 1.37±0.21 g/dL in tubeless PCNL ($p=0.01$). In a

study of 27 children by Goktug et al.^[25], the mean decrease in hemoglobin levels postoperatively was 1.83 mg/dL for tubeless PCNL and 5.2 mg/dL for tubed PCNL groups ($p=0.0001$). Their result was in contrast to that of our study regarding drop in hemoglobin levels, as they noted steeper drop in hemoglobin levels in tubed PCNL group. But it should be noted that they had relatively larger stone burden in their tubed PCNL group with resultant longer operative time and increased blood loss, while we had almost similar stone burden in both groups and no significant difference in the operative time, and significant blood loss was not seen in the tubed PCNL in our study. We had rather higher drop in hemoglobin levels in the tubeless PCNL which may be due to the blood loss from the tract in tubeless PCNL as the nephrostomy tube act as a tamponade effect for stopping blood ooze from the PCNL tract.^[25] However just like our study Goktug et al.^[25] too observed no major operative or postoperative complications in both PCNL groups. They had longer hospital stay in tubed PCNL while in our children there was no difference in the longevity of hospital stay between the two groups. They had mean operative time of 15.83 min. (range, 3-25 min.) in tubeless PCNL and 48.6 min. (Range, 10-80 min.) in tubed PCNL group ($p=0.0001$). While in our study there was no difference in terms of mean operative time between the two groups. We had almost similar stone sizes in the two groups. Secondly the locations and complexity of stones were also almost similar in the two groups in our study that might be the reason why there was no significant difference in mean operative time between the two groups. Operative time is experience dependent and depends on surgeons's skill level and volume of surgeries taking place at a specific center, so operative time is different in various studies.^[25] As there are only few studies that are available in children regarding tubeless PCNL, these results need to be investigated more in larger-scale multicenter studies with standardized study protocols.

Limitations of this study are that the number of patients was small in the study groups and it was a retrospective study. However, our sample size was similar to, or relatively better than the very few studies available in the literature regarding PCNL procedures. Multicenter prospective study has not been done yet and needs to be done to elaborate the differences between the tubed and tubeless PCNL in pediatric age group.

In conclusion, both small-bore nephrostomy tube (12 Fr) PCNL and tubeless PCNL are safe and effective in children. There is no difference in terms of mean hospital stay, mean operative time, stone-free rates and post-PCNL complications between small-bore nephrostomy tube (NT) PCNL and tubeless PCNL, except for relatively smaller drop in mean hemoglobin levels in tubed PCNL compared to tubeless PCNL in pediatric age group.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Shifa International Hospital.

Informed Consent: Written informed consent was obtained from patients' parents who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - N.I., S.A.; Design - N.I., S.A.; Supervision - H.K., Y.H., A.F., N.I.; Resources - Y.H., S.A., A.F.; Materials - S.A., I.H.; Data Collection and/or Processing - S.A., I.H., H.K., S.A., A.F.; Analysis and/or Interpretation - S.A., N.I., I.H.; Literature Search - N.I., S.A.; Writing Manuscript - H.K., S.A., I.H., N.I.; Critical Review - N.I., S.A., H.K., Y.H.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

Etik Komite Onayı: Bu çalışma için etik komite onayı Shifa Uluslararası Hastanesi'nden alınmıştır.

Hasta Onamı: Yazılı hasta onamı bu çalışmaya katılan hastanın ailesinden alınmıştır.

Hakem Değerlendirmesi: Dış bağımsız.

Yazar Katkıları: Fikir - N.I., S.A.; Tasarım - N.I., S.A.; Denetleme - H.K., Y.H., A.F., N.I.; Kaynaklar - Y.H., S.A., A.F.; Malzemeler - S.A., I.H.; Veri Toplanması ve/veya İşlemesi - S.A., I.H., H.K., S.A., A.F.; Analiz ve/veya Yorum - S.A., N.I., I.H.; Literatür Taraması - N.I., S.A.; Yazıyı Yazan - H.K., S.A., I.H., N.I.; Eleştirel İnceleme - N.I., S.A., H.K., Y.H.

Çıkar Çatışması: Yazarlar çıkar çatışması bildirmemişlerdir.

Finansal Destek: Yazarlar bu çalışma için finansal destek almadıklarını beyan etmişlerdir.

References

1. Smaldone MC, Docimo SG, Ost MC. Contemporary surgical management of pediatric urolithiasis. *Urol Clin North Am* 2010;37:253-67. [CrossRef]
2. Lao M, Kogan BA, White MD, Feustel PJ. High recurrence rate at 5-year followup in children after upper urinary tract stone surgery. *J Urol* 2014;191:440-4. [CrossRef]
3. Iqbal N, Shohab D, Hussain I, Sadaf R, Waqar S, Nawaz G, et al. Paediatric Percutaneous Nephrolithotomy (PCNL). *J Coll Physicians Surg Pak* 2015;25:610-2.
4. Istanbuluoğlu MO, Cicek T, Ozturk B, Gonen M, Ozkardes H. Percutaneous nephrolithotomy: nephrostomy or tubeless or totally tubeless? *Urology* 2010;75:1043-6. [CrossRef]
5. Paul EM, Marcovich R, Lee BR, Smith AD. Choosing the ideal nephrostomy tube. *BJU Int* 2003;92:672-7. [CrossRef]

6. Ozturk A, Guven S, Kilinc M, Topbaş E, Piskin M, Arslan M. Totally tubeless percutaneous nephrolithotomy: is it safe and effective in preschool children? *J Endourol* 2010;24:1935-9. [\[CrossRef\]](#)
7. Desai MR, Kukreja RA, Desai MM, Mhaskar SS, Wani KA, Patel SH, et al. A prospective randomized comparison of type of nephrostomy drainage following percutaneous nephrostolithotomy: large bore versus small bore versus tubeless. *J Urol* 2004;172:565-7. [\[CrossRef\]](#)
8. Agrawal MS, Agarwal M. Percutaneous nephrolithotomy: Large tube, small tube, tubeless, or totally tubeless? *Indian J Urol* 2013;29:219-24. [\[CrossRef\]](#)
9. Shohab D, Iqbal N, Alam MU, Butt A, Jamil MI, Hussain I, et al. Comparison of Outcome of Percutaneous Nephrolithotomy in Adult Versus Paediatric patients. *J Coll Physicians Surg Pak* 2016; 26: 371-3.
10. Gupta NP, Kesarwani P, Goel R, Aron M. Tubeless percutaneous nephrolithotomy. A comparative study with standard percutaneous nephrolithotomy. *Urol Int* 2005;74:58-61. [\[CrossRef\]](#)
11. Kim SC, Tinmouth WW, Kuo RL, Paterson RF, Lingeman JE. Using and choosing a nephrostomy tube after percutaneous nephrolithotomy for large or complex stone disease: a treatment strategy. *J Endourol* 2005;19:348-52. [\[CrossRef\]](#)
12. Jonnavithula N, Pisapati MV, Durga P, Krishnamurthy V, Chilumu R, Reddy B. Efficacy of peritubal local anesthetic infiltration in alleviating postoperative pain in percutaneous nephrolithotomy. *J Endourol* 2009;23:857-60. [\[CrossRef\]](#)
13. Garofalo M, Pultrone CV, Schiavina R, Brunocilla E, Sanguedolce F, Borghesi M, et al. Tubeless procedure reduces hospitalization and pain after percutaneous nephrolithotomy: results of a multi-variable analysis. *Urolithiasis* 2013;41:347-53. [\[CrossRef\]](#)
14. Jou YC, Lin CT, Shen CH, Cheng MC, Chen PC. Tubeless percutaneous nephrolithotomy for geriatric patients. *Urol Int* 2009;82:346-9. [\[CrossRef\]](#)
15. Shah H, Khandkar A, Sodha H, Kharodawala S, Hegde S, Bansal M. Tubless percutaneous nephrolithotomy: 3 years experience with 454 patients. *BJU Int* 2009;104:840-6. [\[CrossRef\]](#)
16. Agrawal MS, Agrawal M, Gupta A, Bansal S, Yadav A, Goyal J. A randomized comparison of tubeless and standard percutaneous nephrolithotomy. *J Endourol* 2008;22:439-42. [\[CrossRef\]](#)
17. Gupta V, Sadasukhi TC, Sharma KK, Yadav RG, Mathur R. Tubeless and stentless percutaneous nephrolithotomy. *BJU Int* 2005;95:905-6. [\[CrossRef\]](#)
18. Karami H, Gholamrezaie HR. Totally tubeless percutaneous nephrolithotomy in selected patients. *J Endourol* 2004;18:475-6. [\[CrossRef\]](#)
19. Limb J, Bellman GC. Tubeless percutaneous renal surgery: review of first 112 patients. *Urology* 2002;59:527-31. [\[CrossRef\]](#)
20. Samad L, Aquil S, Zaidi Z. Paediatric percutaneous nephrolithotomy: setting new frontiers. *BJU Int* 2006;97:359-63. [\[CrossRef\]](#)
21. Giusti G, Piccinelli A, Maugeri O, Benetti A, Taverna G, Graziotti P. Percutaneous nephrolithotomy: tubeless or not tubeless? *Urol Res* 2009;37:153-8. [\[CrossRef\]](#)
22. Maheshwari PN, Andankar MG, Bansal M. Nephrostomy tube after percutaneous nephrolithotomy: Larger bore or pigtail catheter? *J Endourol* 2000;14:735-7. [\[CrossRef\]](#)
23. Ni S, Qiyin C, Tao W, Liu L, Jiang H, Hu H, et al. Tubeless percutaneous nephrolithotomy is associated with less pain and shorter hospitalization compared with standard or small bore drainage: A meta-analysis of randomized, controlled trials. *Urology* 2011;77:1293-8. [\[CrossRef\]](#)
24. Shen P, Liu Y, Wang J. Nephrostomy tube-free versus nephrostomy tube for renal drainage after percutaneous nephrolithotomy: A systematic review and meta-analysis. *Urol Int* 2012;88:298-306. [\[CrossRef\]](#)
25. Goktug HN, Yesil S, Ozturk U, Tuygun C, Imamoglu MA. Totally tubeless percutaneous nephrolithotomy: selecting for success in children. *Adv Clin Exp Med* 2013;22:565-70.