Predictive Factors for Safe and Effictive Percutaneous Nephrolithotomy in Children

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Abstract: Purpose: This study proposed to assess the safety and efficacy of PCNL in children less than 18 years of age with renal stones. **Materials and Methods:** All children below 18 years of age with renal stones who will be undergoing PCNL at Urology, Department of Al-Hussein and Bab El-shaarya University Hospitals January 2007 to July 2015. **Results:** A total of eighty children with renal calculi was admitted for PCNL. The cases included 50 (62.5%) males and 30 (37.5%) females; Mean patient age was 13.11 ± 4.22 years (range 5 - 18 years, median 11.5 years). Mean hospitalization was 4.01±2.0 days. Intraoperative complications include bleeding (11.25%), extravasations (22.25%), colonic injury (1.25%) and pelvic injury (3.75%). Postoperative complications include early complications as fever (5%), urinary leakage (13.75%) and intolerable pain (2.5%). **Conclusion:** Percutaneous nephrolithotomy is the treatment of choice for most renal calculi in children. The proficiency is effective and safe in children, with a high success rate and a less rate of major complications.
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1. Introduction

Pediatric urolithiasis poses a technical challenge to the urologist. Percutaneousnephrolithotomy (PCNL) is an established mode of treatment for large renal calculi. The incidence of urolithiasis in the population is 12% and pediatricurolithiasis comprises nearly 2-3% of them. PCNL was first identified in 1976 and since then, efforts have been built to establish the process safer and more effective **[1]**. PCNL will play an integral part in managing renal stones. Morbidity and death rate of the disease and of the treatment itself, been reduced. Although accepted as minimally invasive, it is an operation which still presents a real danger of complications. Clavien system been qualified to grade these complications **[2, 3].**

With numerous previous studies, pre and perioperative factors such as stone burden, configuration, percutaneous accessnumber and location. Puncture performed by a radiologist or urologist. Hydronephrosis been investigated aspredictor cause for success rates and complications **(4-5).** Efforts to identify the associated variables showed variations among the results which has made it hard to separate the patients so that the stone free rate (SFR) or complications anticipated. Directing for a fast, simple and reproducible method for the outcomes of PCNL. The 'Guy's stone score 'has been discussed by **Thomas et al.** [**6**]. They have found thatthe score associated with stone free rates, but not predict complications. The grading system mainly designed according to the number of stones, stone, site and whether the renal anatomy is favorable or unfavorable.

In this grading system, calyceal diverticulum stones, and any stonesin patienthad a spine deformity or spinal injury are the exceptional circumstances **(Table1**).

Pediatric urolithiasis is knownassociated with urinary infection, anatomical and metabolic abnormalities. The plan of treatment of renal calculi in children is complete stone clearance, eradication of urinary infection and correction of underlying metabolic or anatomical abnormalities **[7]**.

Although extracorporeal shock-wave lithotripsy (ESWL) used to fragment and clear most pediatric renal calculi, PCNL is increasingly important for the patients who shock-wave lithotripsy ineffective to fragment and clear the stones **[8, 9].**

Woodside and associates reported first case series of pediatric PCNL in 1985 taking 100% stone free andinsignificant complications **[10].**

If ananatomical abnormality is absent and renal calculi more than 2 cm in diameter sh treated by PCNL and renal calculi less than 1.5 cm treated with ESWL (EAU Recommendations). PCNL is less invasive procedure and the clearance rate is in the range of 71-78% **[11, 12]**.

The purpose of this study to measure the safety and efficacy of percutaneous nephrolithotripsy in children.

Patients and Methods:

Prospective study (30 children been served from January 2014 to July 2015) and retrospective (50 children being done between January 2007 to

December 2013) taken at the Urology Department of Al-Hussein and Bab El-shaarya University Hospitals. To assess the safety and efficacy of PCNL in children below18 years of age with renal calculi. The protocol of this survey been sanctioned by Al-Azhar Medical Research Ethics Committee and informed consent obtained from all patients' relatives. A sum of eighty children out of 220 with renal calculi.

Inclusion criteria (P.N.L 80/220 36.36%, E.S.W.L 118/220 53.64% and open renal surgery 22/220 10%). Flexible ureteroscopy for retrograde intrarenal surgery (RIRS) was not available. Years (1-18) years old and stone size more than 2 cm and cases after failed ESWL included, European Association of Urology (EAU) guidelines 2016 (12).

Exclusion of children with bleeding diathesis, marked scoliosis or kyphosis, associated anatomical obstruction as pelviureteric junction obstruction (PUJO) and congenital renal anomalies.

Data collected from the medical files including: age, gender, stone burden, stone site, presence of hydronephrosis, other concomitant disease, previous shock wave lithotripsy or renal surgery history, American Society of Anesthesiologists (ASA) score, subcostal or intercostal entry, number of access tracts made during the operation, dilatation type (Amplatz dilators/orNephromax) which was depend on surgeon preferenceAmplatz in 50 (62.5%) and balloon dilator in 30(37.5%). Operative time, blood transfusion, residual stone, pre-operative and post-operative hemoglobin (Hb) and post-operative urine and blood culture results. The kidney stones diagnosed by intravenous pyelography and/or computerized tomography (CT). Stones classified according to the Guy's stone score **Table 1**.

Table 1: - Guy's stone score

Grade	Description
Grade I	A solitary stone in the mid/lower pole with simple anatomy or A Solitary stone in the pelvis with simple anatomy.
Grade II	A solitary stone in the upper pole with simple anatomy or Multiple stones in a patient with simple anatomy or any solitary stone in a patient with abnormal anatomy.
Grade III	Multiple stones in a patient with abnormal anatomy or Stones in a calyceal diverticulum or Partial staghorn calculus
Grade IV	Staghorn calculus or any stone in a patient with spina bifida or Spinal injury.

For the nephrolitometricnomogram, stone size estimated as the surface area calculated according to the EUA guidelines using the two greatest vertical and horizontal dimensions measures seen on a plain x-ray of the kidney-ureter-bladder (KUB). In patients without a KUB or intravenous pyelography but with a CT scan, the size of the stonescalculatedin the same way. The dimensions obtained from the tomogram of the non-contrast computed tomography images. Stones occupying the renal pelvis and all the calyces defined as staghorn calculi and the area of each stone part in the calyces and the pelvis calculated separately and added, Stone size is usually given in one or two dimensions, and stratified into those measuring > 20 mm in largest diameter [**12**].

Single stage PCNL performed by using Wolfnephroscope inner sheath (size 15Fr.), under general anesthesia. Under lithotomy position, ipsilateral ureter catheterized with 5fr ureteric Catheter fixed. All pressure points were well filled out. Initial puncture and tract dilatation performed up to 21 Fr under fluoroscopic control. Nephroscope (size 15 F) used. During PNL; pneumatic lithotriptors are most normally used for rigid nephroscopy. Laser lithotripsy when using miniaturized instruments associated with lower stone migration than with pneumatic lithotripsy.

Nephrostomy tubewas kept in all patients after the procedure. Blood loss estimated by Postoperative hemogram and hematocrit value in all patients 4 hours after the operation. Check X-ray KUB was done in all examples to assess stone clearance on the first postoperative day. Nephrostomy was kept open for 24 hours and clamped on the second postoperative day. If patients had no fever, abdominal pain, Nephrostomy removed on the third postoperative day. Urethral and ureteric catheter removed after complete cessation of leak from nephrostomy site.

The patients assessed using a KUB performed in the morning after the operation and a CT performed one month after the procedure for the follow-up. The residual stone status evaluated in three categories; stone free (SF), clinically insignificant residual fragments (CIRF) residual fragments smaller than 4 millimeter) and clinically significant residual fragments (CSRF, residual fragments larger than 4 millimeter). The success rate determined ascombination of SF and CIRF. The type of complication encountered and classified according to the modified Clavien System.

All children's followed post-operatively by Hb%, urinary leakage, pain, fever, stone free status, hospital stay. Four weeks after discharge, all our patients

scheduled for KUB, abdomino-pelvicultrasound, urinalysis and culture and sensitivity.

Statistical data analysis:

The gathered data organized, tabulated and statistically analyzed using statistical software for social science (SPSS) version 20 (SPSS Inc, USA), persisting on an IMB compatible computer with Microsoft® Windows 7. For qualitative data, frequency and percent distributions calculated, while quantitative data presented as mean and standard deviations. For comparison between values before surgical intervention and the same variables after intervention, the paired samples (t) test employed for quantitative information and results interpretation, p value ≤ 0.05 was considered significant.

3. Results:

PCNL was performed in the Urology Department of Al-Hussein and Bab El-Shore University Hospital, in 80 children (mean age: 13.11 years). The mean stone size was 2.3 cm (range: 1.8–3.3cm). Overall, 50 (62.5%) single stones (Grade I and II ***Guy's stone score***) 30 (37.5%) multiple stones (Grade III ***Guy's stone score***) **Table 2**. 69 (86.25%) were completely stone free following firstPCNL. Seven cases had extracorporeal shock wave lithotripsy for residual fragments. No dispute was found between retrospective and prospective data which were compiled by the same observer except the ability to get some of the Clavian grade 1 complications.

Table 2: - Patient distribution and success rates, granting to the Guy's Stone score

Guy's stone score	Patients (n/%)	Success rate (n/%)	P value (Success)	P value (Complications)
1	30/37.5%	27/ 30 (90%)	**P<0.05**	**0.03**
2	20/25%	18/ 20 (90%)	P<0.05	0.03
3	20/25%	14/ 20 (70%)	0.02	P<0.05
4	10/12.5%	5/10(50%)	0.01	P<0.05

Table (3): Intraoperative complications of the study group

Clavian Grade	**Complications**	**No.**	**%**
2	Bleeding Yes No	 9 71	 11.25 88.75
2	Extravasation Yes No	 18 62	 22.5 77.5
3b	Colonic injury Yes No	 1 79	 1.25 98.75
3b	Pelvic perforation &DJ fixation. Yes No	 3 77	 3.75 96.25

Intra-operative complications was in 37 (46.25%) children, include, blood loss necessitating packed RBCs encountered in 9 (11.25%) children five of them needed further postoperative packed RBCs, the extravasation in 18 (22.86%) children was retroperitoneal extravasation which diagnosed intraoperative and no need for intervention, the colonic injury in 1 (1.25%) child which late recognition, was needed exploration and colostomy was done and nephrostomy tube for drainage the kidney then repair of colostomy was done one month later. The pelvic perforation in 7 (8.75%) children necessitatesDouble **J stent (**DJ) fixation. All of the complicated cases mentioned above occurred in large stones (staghorn stones) which takes more operative time with Amplatzditation (Table 3).

Operative time ranged from 50 to 180 minutes, (Mean ±SD 98.6±41.6) and Mean hospital stay, was 5 ± 1.6 (range was found 3 – 7 days).

There was no statistical difference in the operative time (97.9±45.3 minutes in balloon group versus 98.5±43.4 minutes in the Amplatz group; p=0. 43), preoperative hematocrit value (39.04±4.21 vs. 38.94±4.49; p=0. 87), postoperative hematocrit value (32.74±4.86 vs. 32.48±5.43; p=0. 73). Blood transfusion rate (15.6% versus 16.7%; p=0. 84). Treatment success rate (78.9% versus. 79.2%; p=0. 96) between the balloon and Amplatz groups. The conflicts are significant reductions in X-ray exposure in a balloon because it can be done ultrasound guided instead of fluoroscopy. Nevertheless, the price of the balloon dilator is higher than that of the Amplatz dilator.

Early post-operative complications were 18 (22.85%) children, described in 4 (5 %) children who developed fever and done with antibiotics and antipyretics, 11 (13.75%) children who developed prolonged urinary leakage from nephrostomy site which managed conservatively, 2 (2.5) children who was complaining intolerable pain and managed by analgesic. Late post-operative complications reported in 11 (13.75%) patients who developed urinary tract infection who assessed by urinalysis, managed by antibiotics and no other major infections seen and 11 (13.75%) patients had residual stone fragments

(CSRF) which assessed by postoperative ultrasonography and KUB and managed by ESWL later on and no case with CIRF (Table 4).

Table (4): Postoperative complications of the subject group

Clavian Grade	Complications	No.	%
	Early		
1	Fever Yes No	 4 76	 5 95
2	Leakage Yes No	 11 69	 13.75 86.25
1	Pain Yes No	 2 78	 2.5 97.5
	Late		
1	UTI Yes No	 11 69	 13.75 86.25
3a	Residual stone (CSRF) Yes No	 11 69	 13.75 86.25

CSRF:-Clinically significant residual fragments

4. Disscusion:

Percutaneous nephrolithotomy (PCNL) had bening accepted as a standard surgical approach for most renal calculi. With the widespread function of this technique, its safety in a broad diversity of clinical sites, including employment in small children, has bening reported **[13]**.

The present results comparable to most of the published data, Stone size was the only pre-operative, operative and post-operative variable that held a statistically significant correlation both with success P<0.05 and also with the complications P<0.03. Guy's stone scores, grade 1 and 2 associated with success and less complications compared to grade 3 and 4 linked with less success rate and more complications.

Thomas et al. [6] has found that the Guy's stone score can predict the SFR after PCNL [6] Which they have described the evolution and substantiation of the grading system. They found that as the level of complications increases, the success decreases. Grade 1 stones had an 81%, grade 2: 72.4% grade 3: 35% and grade 4: 29% stone free rates. The overall success rate was 62% and complications discovered in 52% of the patients with most of them Clavian grade 1 (30%).

Both success and complication rate is important for determination of the surgical outcome of PCNL. Success rates evaluated with a generally used < 4 mm cutoff point to define CIRF and combination of CIRF and stone free (SF).

In this work, the overall success rate was 86.25% and Guy's stone score 1 and 2 showed a statistically significant correlation with success P<0.05. The complication rate was 46.25% and Guy's stone scores 3 and 4 had significant correlations with the complications. It determined that as the score increases, the success rates decreases and a complications increase.

Mean hospital stay, days were 5 ± 1.6 (range was found (3 – 7 days). This was in all cases except one case of colonic injury who prolonged hospital stay up to 30 days, compared to previous studies as **Elderwy et al**. [**14**] was found to be 3- 4 days.

Hüseyin et al. [**15**] found that most patients had decreased blood hemoglobin levels following PCNL, due to haemodilution or bleeding. It is important to evaluate whether blood transfusion is necessary. Equipment size, operative time, and stone size suggested as clinical variables affecting blood loss in pediatric PCNL. In summation, the number of punctures has identified as a case of bleeding (Blood transfusion 9 (3.09), Double J stent fixation 8 (2.74), Fever7 (2.40) and Urinary infection 5 (1.71).

In this study, complications were bleeding in 9 children (11.25%) blood transfusion rate and we indicated that larger Amplatz sheath, stone burden and longer operative time related to the greatest transfusion rate. Four Children (5%) had a fever, which correlated with previous studies (**Table 5**). However; prolonged leak from nephrostomy site was found in 11 Children (13.75%), colonic injury realized in 1 child (1.25%) and pelvic injury seen in 7 children (8.75%) who were higher than previous studies due to in our series there were a large size which needs more running time and large Amplatz size.

Table (5): Comparison of complications in various studies:

Study	Bleeding %	Fever, %	Colonic injury %	Nephrostomy leak %	Pelvic injury %
Bayramet al. 2012(**16**)	21	31	0	0	0
Unsal et al. 2010 (9)	13.3	13.3	0	5.4	0
Nouralizadeh et al. 2007 (17)	6.65	13.3	2.8	8	6.65
Present study	11.25	5	1.25	13.25	3.75

Most complications were minor and insignificant. There were no major complications developed in this study as pneumothorax or hemothorax.

Limitations and weaknesses:

We have reasoned that the Guy's stone score can predict the stone free rate and have insignificant correlation with complications due to the small patient group of this study in which 80 patients studied.

On the other hand, the retrospective survey may have restricted the ability to capture some of the Clavian grade 1 complications.

Conclusions:

PCNL in pediatric patients is a highly efficient modality of discourse, albeit with a fairly high complication rate. Mini-PNL and micro-PNL concepts have introduced, which reduce tract dilatation and reduce severe complications such as bleeding. Mini-PNL is more common, especially in children, The guy's stone score has a good correlation both with success and complications.

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