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REVIEW ARTICLE

COMPARATIVE ANALYSIS OF MINI PERCUTANEOUS NEPHROLITHOTOMY VERSUS STANDARD PERCUTANEOUS NEPHROLITHOTOMY IN TERMS OF STONE FREE RATES, HOSPITAL STAY AND POST-OPERATIVE COMPLICATIONS IN PEDIATRIC POPULATION: A SYSTEMATIC REVIEW

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ABSTRACT

In the last decade, the number of children with nephrolithiasis increased to 50 cases per 100,000. Percutaneous nephrolithotomy (PNCL) has been shown to be a successful treatment. However, standard PCNL has resulted in a number of problems, in pediatric patients, because to the large nephroscope and amplatz size of 24-30 F. Aim of this systematic review was to compare available literature of Mini PCNL and Standard PCNL to assess efficacy and Stone free rates (SFR) in pediatric population. In this systematic review and meta-analysis investigating the effect of different amplatz sheath sizes for percutaneous nephrolithotomy (PCNL) in pediatric population. Our report follows the PRISMA protocol. A methodical search was conducted using multiple databases of research-based literature including PubMed, Cochrane, Google Scholar, and Web of Sciences. Statistical Package for Social Sciences (SPSS) version 22 and STRATA were used to sort, analyze, and present data graphically. Stone free rates were reportedly higher in standard PCNL in three (3/6) studies with 93.7% / 91.7%, 83.4% / 74.9% and 94.7% / 89.5% while all other studies reported mini PCNL SFR higher than Standard PCNL with 75.8% / 71.4% , 90.5% / 85.7 and 87.9% / 59.1% respectively. Multivariate analysis was reported in only 1 study with coefficient of 0.079 and 95% CI as 0.944 - 1.241 (Lower - Upper). When it comes to managing both simple and difficult renal calculi in children, mini-PCNL is just as safe and successful as SPCNL, with similar operational times, SFRs, and total problems.

KEYWORDS: Percutaneous nephrolithotomy; Stone free rates; Post-operative complications; Pediatric population.

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INTRODUCTION

Nephrolithiasis, often known as renal stones, is a prevalent illness in adults, with a lifetime frequency of 10.6% in males and 7.1% in women.[1-2] Nevertheless, the frequency of nephrolithiasis in pediatric patients is approximately 1-2% that of adults. In 2016, the number of children with nephrolithiasis increased to 50 cases per 100,000.[3] The majority of pediatric nephrolithiasis has been shown to be caused by metabolic abnormalities, including unequal metabolism of uric acid, calcium, oxalate, citrate, and cystine. It was established that the most frequent metabolic mistakes resulting in nephrolithiasis in children were hypercalciuria and hypocitraturia. [4]

In children with nephrolithiasis, the primary goal of interventional treatment is to achieve stone-free status in a single intervention without resulting in complications. Numerous intervention techniques are available, including retrograde intrarenal surgery (RIRS), percutaneous nephrolithotomy (PNCL), and

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extracorporeal shock wave lithotripsy (ESWL). On the other hand, PCNL has been shown to be successful in treating bigger stones that do not respond to ESWL therapy.[5]

For staghorn stones, stones bigger than 20 mm, lower pole stones larger than 10 mm, cystine stones, and failure to respond to conventional therapies, the European Association of Urology recommends PCNL, for both adult and pediatric patients with big and complex kidney stones.[6] PCNL has been shown to be a successful treatment, however, standard PCNL has resulted in a number of problems, including hemoglobin depletion, the need for transfusions, renal parenchyma disintegration, and post-operative discomfort in pediatric patients, because to the large nephroscope and amplatz size of 24-30 F.[3]

As a result, PCNL was created to be performed in an amplatz and nephroscope that were smaller, measuring 14-20 F. This is referred to as miniperc or mini-PCNL. After a month-long intervention with an average hospital stay of 3.8 days, the mini-PCNL's stone-free rate was 84.7%, whereas the regular PCNL's stone-free rate was 70.1% in a different trial.[7] On the other hand, it is still unknown how well mini-PCNL and regular PCNL compare in terms of effectiveness in pediatric patients.[8] Furthermore, a comparison of the stone-free rate presented above was based on several researches, which means it may have biases. There have been some studies that have detailed the drawbacks of mini-PCNL, including increased intraoperative renal pressures, decreased visibility, and difficulty retrieving stones, longer operating times, and a higher incidence of infectious complications. However, it is unknown how safe mini-PCNL is in comparison to standard PCNL.[9]

Aim of this study was to assess the comparative factors between mini-PCNL and standard PCNL in pediatric population.

MATERIALS AND METHODS

This was a systematic review and meta-analysis investigating the effect of different amplatz sheath sizes for percutaneous nephrolithotomy (PCNL) in pediatric population. Our report follows the PRISMA protocol.[10] Systematic reviews, Meta-analysis and studies analyzing single amplatz sheath size, adult population, comparison between PCNL and other lithotripsy techniques were excluded from the review. A methodical search was conducted using multiple databases of research-based literature including PubMed, Cochrane, Google Scholar, and Web of Sciences. We have limited our search to psychological studies, no language restriction was applied. Table 1 shows a comprehensive search strategy. In each of the aforementioned datasets, we used a search method that involved multiple keyword combinations in the following order:

A. "Mini PCNL versus standard PCNL in pediatric population" [Title/Abstract]

B. "Different sheath sizes for PCNL in pediatric population" [Title/Abstract]

C. "Comparision of mini and conventional PCNL in pediatric population" [Title/Abstract]

D. "A + B + C" [Title/Abstract]

The investigator retrieved the most relevant studies based on abstracts and titles. After reviewing the complete articles, the most pertinent ones were chosen in accordance with the eligibility requirements. Tables with the pertinent data were created, saved, and required data was extracted. Two investigators extracted the data from eligible articles, and compression of extracted data was discussed to resolve discrepancies. The third investigator reported any remaining differences, and each study was reported in the form of a table along with the first author, purpose/aim of the study and conclusion. Statistical Package for Social Sciences (SPSS) version 22 and STRATA were used to sort, analyze, and present data graphically. Reported test results of relevant data including chi-square, Multivariate survival analysis, Time-dependent survival analysis, Hazard ratio, and incidence rates were reported from all included studies.

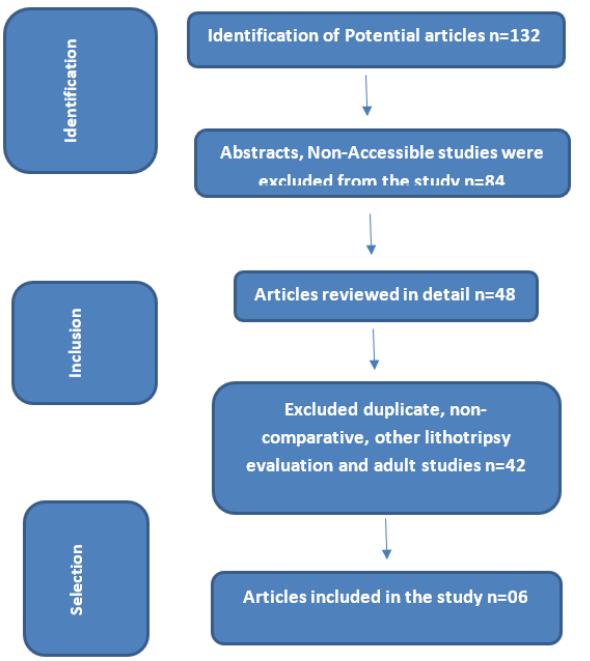

Fig 1: PRISMA flow chart of study selection for Meta-analysis.

RESULTS

Total 132 studies were shortlisted for evaluation, after reading abstracts 84 were excluded for been not eligible of study criteria, remaining 48 studies were evaluated thoroughly by researchers, duplicate studies, studies evaluating other lithotripsy methods

(RIRS, SWL) were excluded and after complete consideration 6 studies were included in the review. (Fig 01) Cross-sectional retrospective study design was reported in 3 studies, single study had randomized design while remaining two had comparative analysis design. Three studies were from Turkey, one study was from Iraq, one from Indonesia and one from Pakistan. (Table 1)

Reported comparison were between stone size, post-operative bleeding was estimated with hemoglobin drop and days of hospitalization after surgery, the overall p-value for stone size comparison was reported as significant in three studies. HB Drop was significant in both studies, while hospitalization p-value was reported as significant in 4 studies. (Table 2)

Stone free rates were reportedly higher in standard PCNL in three (3/6) studies with 93.7% / 91.7%, 83.4% / 74.9% and 94.7% / 89.5% while all other studies reported mini PCNL SFR higher than Standard PCNL with 75.8% / 71.4% 90.5% / 85.7% and 87.9% / 59.1% respectively. (Fig 2)

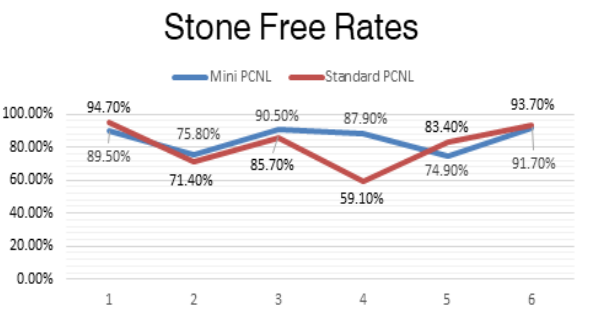

Fig 2: Over all stone free rates from included studies.

Multivariate analysis was reported in only 1 study with coefficient of 0.079 and 95% CI as 0.944 - 1.241 (Lower - Upper). Over all outcomes of included studies reported with reference of mini PCNL the results indicated better Stone free rates, lower post-operative pain, reduced blood loss, lower hospitalization and lower post-operative complication rates. A few studies indicated reduced operative time

Table 1: Included studies details e.g., Study design, site and sample size.

S.#	Study	Sample Size (Renal units)	Study design	Study site
1	1	45	Retrospective, cross sectional	Ankara, Turkey
2	11	220	Retrospective, cross sectional	Malatya, Turkey
3	12	134	Retrospective, cross sectional	Sulaymania, Iraq
4	3	654	Comparative study	Adana, turkey
5	6	62	Randomized study	Karachi, Pakistan
6	5	42	Cross-sectional study	Jakarta, Indonesia

Table 2: Comparative analysis of stone sizes, HB drop and hospitalization between mini PCNL and Standard PCNL included studies.

Variables	Study	Mini PCNL	Standard PCNL	P-Value
Stone size	1	1.9 ± 1.1	2.2 ± 1.4	0.003
	11	1.6 ± 0.6	2.0 ± 0.1	<0.0001
	12	2.9 ± 0.6	3.1 ± 0.3	0.08
	3	1.8 ± 0.7	2.1 ± 0.5	0.04
	6	2.8 ± 1.2	2.9 ± 1.9	0.09
	5	2.3 ± 1.4	3.4 ± 2.6	0.07
HB drop	5	0.354 ± 0.29	0.568 ± 0.332	0.016
	6	3.1 ± 0.3	4.8 ± 1.0	0.007
Hospitalization	12	1.91 ± 1.15	2.41 ± 1.14	0.007
	3	5.2 ± 1.8	5.6 ± 2.1	0.24
	6	2.1 ± 0.8	3.2 ± 0.7	0.01
	5	4.8 ± 2.8	5.7 ± 3.9	0.003

and opioid use after surgery as well. (Table 03)

Table 3: Outcomes reported from included studies.

S.#	Study	Outcomes
1	1	better SFR
2	11	Lower post-operative bleeding,
3	12	Reduced hospital stay and HB drop.
4	3	Reduced operative duration, lower HB drop and higher SFR
5	6	Decreased HB drop, Post-operative opoid use, hospital stay and post operative complications.
6	5	higher SFR and tubeless follow up

DISCUSSION

According to this study, mini-PCNL had a stone-free rate event that was 0.75 times (95% CI 0.22; 2.54) higher than that of standardized PCNL.[12] Mini PCNL increased the risk of complications in Clavien grades I and II by 0.65 times (95% CI 0.27; 1.54) and 0.48 times (95% CI 0.19; 1.22), respectively, in terms of safety.[13-14] The difference between the groups was not statistically significant based on the pooled analysis of both the complications grades. Numerous studies regarded small PCNL as having high effectiveness and safety, despite the negligible findings. [15]while maintaining high stone-free rates. Recently, miniaturized PCNL techniques have further expanded, and can currently be classified into mini-PCNL, minimally invasive PCNL (MIP A research evaluating mini PCNL on 234 patients less than 3 years old found that 97.2% of the patients were stone-free[5]. In pediatric patients with stone sizes greater than 20 mm, another research found a 90.8% stone-free rate.[3] Stone free rates were also recorded in four investigations, with the ranges being 85%, 95%, 86%, and 85%, respectively.[5,13,16,17] To guarantee that there would be no stone-related incident caused by leftover stone, the stone-free rate was a crucial component.[9] A study found that there is a 69% chance that residual stone size of less than 5 mm will result in an increase in stone size. [18] As a result; achieving an ideal stone-free rate was a significant predictor of future stone recurrence. Because efforts have been made recently to reduce peri-operative morbidity while keeping a high SFR, mini-PCNL has become more and more popular.[19] The idea behind the use of smaller instruments through smaller diameter sheaths was based on the idea that the renal parenchyma would be less damaged by a smaller PCNL tract, which would reduce related morbidity without sacrificing therapeutic efficacy.[6,18] Several writers have employed a range of endoscopes with access sheath diameters between 11 Fr and 20 Fr to remove and fracture stones.[20] In recent years, mini-PCNL has grown in popularity; stone removal has been reported to reach 80-85% following just one MPCNL session used as immunotherapy.[19] The current study found no discernible difference in the stone clearance rate between SPCNL and MPCNL in children (89.5% versus 94.7%).[21] The results of the study support those of other studies that used instruments of different sizes to obtain essentially comparable rates of stone removal (SPCNL vs. MPCNL), despite the extremely small amount of comparison data that has been published to date.[22] MPCNL group had better stone removal than the SPCNL group, as according to this pooled analysis, even though the MPCNL group's operating time was greater than the SPCNL group's, the difference did not achieve statistical significance.[14] This discrepancy may be explained by the narrower field of vision offered by tiny endoscopes and the decreased irrigation flow caused by decreasing the sheath diameter, which eventually affects sufficient visualization. Longer operation times were also caused by the requirement to break the stones into tiny pieces in order to remove them through smaller tracts more thoroughly. Analysis of the current trial showed that, in comparison to SPCNL, MPCNL led to noticeably shorter hospital stays.[7]

It would seem logical to have shorter hospital stays with MPCNL in order to achieve reduced perioperative morbidity and lessen patient pain through the use of a smaller, less traumatic nephrostomy tract.[16] Although it was noted in the current study that patients who underwent SPCNL experienced higher rates of postoperative fever, bleeding, and blood transfusions than patients who underwent MPCNL, the differences between the two groups were not statistically significant. Studies have revealed that patients who received SPCNL had considerably greater rates of hemoglobin reduction[1], bleeding during surgery[19] and blood transfusions[18] than those who underwent MPCNL, despite the fact that both groups' total complication rates were equal.[3]

Postoperative problems in MPCNL may be impacted by applying a smaller sized tract; however, this was not demonstrated in the current investigation.[20] However, this was not demonstrated in the current investigation.[17] On the other hand, the narrow tract employed in MPCNL may result in a greater pressure in the collecting system, causing pyelovenous or pyelosinus backflow with later postoperative fever.[9] For pediatric patients, bleeding is a major risk factor both before and after surgery, with the size of the tract being a major factor in determining how much blood is lost during PCNL.[23] Nonetheless, a number of studies have shown that when it comes to consequences, such bleeding and kidney damage, using smaller devices and limiting access have comparable effects in youngsters. In the current investigation, the MPCNL group saw a considerably smaller drop in

hemoglobin levels.[2] The rate of bleeding, the need for blood transfusions, and the decline in hemoglobin were not shown to differ significantly in another investigation.[12,18] MPCNL is a suitable option to reduce the peri-operative morbidity linked with SPCNL without compromising the procedure's results. It should be the treatment of choice for skilled endourologists, with no age limitations, as it is a safe and practical method for achieving maximum stone removal.[24]

CONCLUSION

When it comes to managing both simple and difficult renal calculi in children, mini-PCNL is just as safe and successful as SPCNL, with similar operational times, SFRs, and total problems. Mini-PCNL led to a decreased hemoglobin drop and a shorter hospital stay. Comparing smaller sheaths to their larger counterparts, smaller sheaths led to better post-operative recovery and patient comfort, less Hb drop, a lower rate of complications, a lower need for postoperative opioid analgesia, a lower VAS Pain score, a shorter hospital stay, and so on. But when it comes to shorter working durations, larger size sheaths are ideal. As technology progresses, endocrinologists must acquire the skills necessary to further improvise results and lower the rate of complications while utilizing ever more compact devices. Miniaturization of PCNL is a safe and necessary evolution of this technique.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	JAJ, AM
Acquisition, Analysis or Interpretation of Data:	JAJ, AM, IA, ST, TAJ
Manuscript Writing & Approval:	JAJ, AM, IA, ST, TAJ

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.