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Assessment of Necessity of Retrograde Filling during PCNL Tract Dilatation

Syed Ali Raza Jaffry, Javed Altaf Jat, Waqar Ahmed Memon, Abdul Qayoom Ghangro, Ahsan Ali Arain, Tamoor Jatoi

ABSTRACT

Objective: To investigate the impact of retrograde filling on tract dilatation and associated outcomes among patients presenting at a tertiary care hospital, Pakistan.

Methodology: A prospective cohort study was conducted at a tertiary care hospital's urology department from February 2022 to February 2023. A total of 126 patients undergoing elective PCNL were included, categorized into exposed (retrograde filling utilized) and unexposed (standard PCNL without retrograde filling) groups. Patient demographics, stone characteristics, and procedural details were recorded. Comparative analyses were performed to assess ease of tract dilation and infection rates using appropriate statistical tests.

Results: The use of retrograde filling did not significantly influence the ease of tract dilation during PCNL. Moreover, the exposed group exhibited a significantly higher rate of post-procedure infections (55.4%) compared to the unexposed group (36.5%). Multivariate logistic regression analysis, controlling for potential confounding variables, confirmed that retrograde filling was associated with a substantial increase in the odds of post-operative infection (adjusted odds ratio of 2.48).

Conclusion: Retrograde filling during PCNL is associated with risk of post-procedure infections and does not provide significant benefits in terms of ease of tract dilation. Moreover, the study emphasizes the economic and logistical implications of incorporating retrograde filling, including increased costs and the need for additional personnel. Therefore, urologists are advised to carefully consider the potential drawbacks and benefits before deciding on the adoption of retrograde filling in PCNL procedures.

Keywords: Ease of tract dilation, Percutaneous Nephrolithotomy (PCNL), Renal calculi, Retrograde filling, Tract dilatation, Normal saline infusion

How to cite this Article:
Jaffry SAR, Jat JA, Memon WA, Ghangrom AQ, Arain AA, Jatoi T. Assessment of Necessity of Retrograde Filling during PCNL Tract Dilatation. J Bahria Uni Med Dental Coll. 2025;15(2):80-85 DOI: https://doi.org/10.51985/JBUMDC2024450

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Received: 03-10-24
Accepted: 26-03-25
1st Revision: 05-11-24
2nd Revision: 19-02-25
3rd Revision: 25-03-25

INTRODUCTION

Renal calculi afflict a substantial portion of the global population, with an estimated prevalence of 10% to 15%, making them a prevalent urological condition. [1-3] The incidence rate, influenced by various factors including dietary habits and genetics, underscores the persistent need for effective and efficient stone removal techniques.[4,5]

As the leading approach in addressing complex renal calculi, Percutaneous Nephrolithotomy (PCNL) has become the gold standard, presenting a minimally invasive stone removal technique.[6] PCNL is proved to be associated with lesser morbidity, decreased complications rate and greater success rates.[7] PCNL involves the creation of a nephrostomy tract into the renal collecting system, followed by stone fragmentation through this tract to allow safe and efficient removal of stones.[8]

Percutaneous nephrolithotomy (PCNL) has emerged as a cornerstone in the management of renal calculi, particularly for stones larger than 2 cm. The procedure's evolution has led to the integration of various techniques aimed at enhancing efficacy and minimizing complications. Among these techniques, retrograde filling during tract dilatation has

gained attention for its potential benefits in improving access and visualization during the procedure. This essay explores the role of retrograde filling in PCNL tract dilatation, examining its implications for surgical outcomes, complications, and overall patient management. The supine position during PCNL has been advocated for its advantages in airway control and ventilation, which are crucial for high risk cardiac patient.[9] In this context the combination of retrograde and antegrade approaches can be done in supine position, known as endoscopic combined intrarenal surgery (ECIRS), has demonstrated promising results in enhancing stone-free rates, particularly for complex stone burdens.[10]

Recent advancements in PCNL technique introduced the concept of retrograde filling during tract dilatation. Retrograde filling, often utilizing normal saline or non-ionic contrast is the process of instilling a fluid medium into the renal collecting system prior to making the tract followed by continue filling during tract dilatation. This technique has gained attention due to its benefits, including facilitating tract dilation, minimizing trauma & if water is coming out to the dilators that means the tract is perfect, that potentially reducing the risk of injury to adjacent structures.[11]

The necessity of retrograde filling remains a subject of debate and very limited data is available on it. Hence, the use of retrograde filling, particularly with regard to the use of normal saline, the allocation of additional technician, and the risk of infection, need thorough investigation. Thus, this study aims to see the effect of retrograde filling on tract dilatation during PCNL among patients presenting at tertiary care hospital. The findings can guide the adoption or refinement of retrograde filling practices, contributing to the optimization of PCNL outcomes.

METHODOLOGY

This was prospective cohort study conducted at the department of Urology, LUMHS, Pakistan from Feb 2022 to Feb 2023. Sample size of 126 was estimated using Rao Soft sample size calculator, by taking statistics of stone free rate after PCNL as 85%, margin of error as 6% and 95% confidence level. Patients who were undergoing elective PCNL, aged 18 years and above of either sex were included in the study. Patients who underwent emergent or urgent PCNL procedures due to acute complications (e.g., obstructive uropathy, sepsis), pregnant patients, patients with history of PCNL, hypertension, diabetes, chronic kidney disease and patients with compromised immune systems were excluded from the study. Patients were selected consecutively for the study.

Institutional review board (IRB) approval was sought prior to study commencement (Ref# LUMHS/REC/48). Informed consent was obtained from all participating patients. Patients were divided into two groups, exposed group: patients undergoing PCNL with the utilization of retrograde filling (normal saline / non-ionic contrast infusion) during tract dilatation and unexposed group patients undergoing standard PCNL without retrograde filling.

Baseline demographic information (age, gender), stone characteristics (size, location), and surgical details (time of procedure and site of puncture) were collected. During the PCNL procedure with and without retrograde filling, time required for tract dilatation, data on ease of tract dilation and hospital stay was noted. Patients in both groups were followed up postoperatively to monitor for the development of infections for 2 weeks. The presence of a high-grade fever (>100°F), a WBC count >11,000, and a positive urine culture was classified as a urinary tract infection.

Descriptive statistics were summarized for patient characteristics and baseline demographics. Comparative analyses for numeric and categorical variables between the exposed and unexposed groups using independent samples t-test/Chi-square/Fisher exact test. Multivariate logistic regression was applied to see the association between infection and potential confounding factors. Odds ratio along with 95% Cis were reported. A p-value less than 5% was considered as significant.

RESULTS

Total 137 eligible participants were recruited for the study. Among them 9 patients lost to follow-up. Total 126 patients were included in the final analysis. Out of 126 patients, 74 patients were in exposed group and 52 patients were in unexposed group.

The mean age in both groups was similar: 36.25 years in the exposed group and 35.92 years in the unexposed group, with p-value=0.829. In both groups, majority of the patients were males. The size of stones was similar between the exposed and unexposed groups, with means of 3.01 cm and 3.19 cm, respectively (p-value=0.098). The most common stone location was the pelvis, observed in 38.1% of all cases. There were no significant differences in stone location between the exposed and unexposed groups, except for a slightly higher prevalence of stones located in the pelvis in the exposed group. The mean duration of the procedure also showed insignificant difference between both groups (p-value=0.075). The majority of punctures were performed in the lower pole of the kidney (72.2% of cases), followed by the upper pole (23.8%). Similar distribution of puncture sites was observed between the exposed and unexposed groups. (Table 1)

The time required for tract dilatation was comparable between the exposed and unexposed groups, with means of 2.74 minutes and 2.83 minutes, respectively (p = 0.437). The percentage of cases involving successful "first go tract in" was slightly higher in the exposed group (98.6%) compared to the unexposed group (90.4%), although this difference did not reach statistical significance (p = 0.081). The occurrence of "first go tract out" was rare, observed in only 1.4% of the exposed group and 9.6% of the unexposed

group. The duration of hospital stay was similar in both groups, with means of 1.51 days in the exposed group and 1.44 days in the unexposed group (p = 0.435). The exposed group showed a higher infection rate (55.4%) compared to the unexposed group (36.5%), with a statistically significant difference (p = 0.037). Moreover, the odds of infection was 2.15 folds higher among patients undergoing PCNL with the utilization of retrograde filling as compared to odds of infection in patients undergoing standard PCNL without retrograde filling (OR=2.15, 95% CI=1.04-4.46). (Table 2)

Given the significant difference in infection rates between the exposed and unexposed groups, the logistic regression was conducted to explore the association between the exposure and the likelihood of infection, while considering potential confounding factors. After adjusting the potential confounding factors for infection in a multivariate logistic model, patients with retrograde filling had a statistically significant increased odds of post-operative infection (p = 0.026). The adjusted odds ratio was 2.48, with a 95% CI of 1.11-5.53. This implies that patients with retrograde filling were 2.48 times more likely to experience post-operative infection compared to those without retrograde filling. Neither age (p = 0.335) nor gender (p = 0.723) exhibited a statistically significant association with post-operative infection. The adjusted odds ratios for age and gender were 0.98 (95% CI: 0.95-1.01) and 0.86 (95% CI: 0.38-1.94), respectively. Stone location, as categorized, did not show statistically significant associations with infection rates. Stone size also did not exhibit a statistically significant association with post-operative infection rates (p = 0.276). The adjusted odds ratio for stone size was 1.43 (95% CI: 0.76-2.63). (Table 3)

DISCUSSION

Renal calculi remain a significant burden globally,

Table 1: Baseline characteristics of patients in both groups (n=126)

	Overall	Exposed group (n=74)	Unexposed group (n=52)	p-value
Age in years	36.25±14.26	36.49±15.44	35.92±13.51	0.829
Gender				
Male	84 (66.7%)	50 (67.6%)	34 (65.4%)	0.789
Female	42 (33.3%)	24 (32.4%)	18 (34.6%)	
Size of stones (cm)	3.01±1.03	2.88±1.08	3.19±0.94	0.098
Location of stones				
Pelvis	48 (38.1%)	34 (45.9%)	14 (26.9%)	0.124
Lower Pole	8 (6.3%)	4 (5.4%)	4 (7.7%)	
Pelvis+Lower Pole	34 (27%)	16 (21.6%)	18 (34.6%)	
Pelvis+Upper Pole	21 (16.7%)	14 (18.9%)	7 (13.5%)	
Pelvsis+Lower Calyx	1 (0.8%)	1 (1.4%)	0	
Pelvis+Upper Calyx	9 (7.1%)	3 (4.1%)	6 (11.5%)	
Pelvis+Middle Calyx	5 (4%)	2 (2.7%)	3 (5.8%)	
Time of procedure (mins)	69.56±12.96	67.78±12.46	72.02±13.36	0.075
Site of puncture				
Lower Pole	91 (72.2%)	55 (74.3%)	36 (69.2%)	0.796
Middle Pole	3 (2.4%)	1 (1.4%)	2 (3.8%)	
Upper Pole	30 (23.8%)	17 (23%)	13 (25%)	
Middle Pole+Lower Pole	2 (1.6%)	1 (1.4%)	1 (1.9%)	

Table 2: Comparison of outcomes between both groups (n=126)

Outcomes	Exposed group (n=74)	Unexposed group (n=52)	p-value	OR (95% CI)
Time required for tract dilatation (mins)	2.74±0.66	2.83±0.47	0.437	0.70 (-0.129-0.296)
Access tract management				
First go tract in	73 (98.6%)	47 (90.4%)	0.081	7.76 (0.88-68.56)
First go tract out	1 (1.4%)	5 (9.6%)		
Hospital stay (days)	1.51±0.50	1.44±0.50	0.435	-0.07 (-0.25-0.11)
Infection				
Yes	41 (55.4%)	19 (36.5%)	0.037	2.15 (1.04-4.46)
No	33 (44.6%)	33 (63.5%)		

Table 3: Multivariate logistic regression analysis for post-procedure infection

	p-value	Adjusted OR (95% CI)
Retrograde filling		
No		1
Yes	0.026	2.48 (1.11-5.53)
Age in years	0.335	0.98 (0.95-1.01)
Gender		
Male		1
Female	0.723	0.86 (0.38-1.94)
Location of stones		
Pelvis		1
Lower Pole	0.115	0.166 (0.018-1.54)
Pelvis+Lower Pole	0.843	0.87 (0.24-3.16)
Pelvis+Upper Pole	0.997	1.00 (0.19-5.30)
Pelvis+Lower Calyx	0.999	-
Pelvis+Upper Calyx	0.394	0.42 (0.06-3.01)
Pelvis+Middle Calyx	0.240	4.40 (0.37-52.17)
Stone size (cm)	0.276	1.43 (0.76-2.63)

necessitating efficacious stone removal techniques.[12,14] Evidence showed that the prevalence of renal stones is 16% in Pakistan, mostly affecting people of age more than 30 years.[4,15] In past decades, PCNL, as a minimally invasive approach for complex renal calculi, has demonstrated superior outcomes compared to other methods, prompting continuous refinement of its techniques.[13,14] Recently, the utilization of retrograde filling during tract dilatation has gained attention.[6,16,17] Many studies have been conducted to assess the effect of PCNL on renal stones, but to best of our knowledge no study is conducted to see the association of retrograde filling during PCNL tract dilatation with post-procedure outcomes. Therefore, the present study sought to see the effect of retrograde filling on tract dilatation during PCNL among patients presenting at tertiary care hospital, Pakistan.

Evidence showed that PCNL is significantly associated with systemic inflammatory response syndrome. Almost 26% to 40% of the patients get infected after PCNL, even if pre-operative prophylactic treatments were given and almost 0.4% to 3% suffered from sepsis.[18] The idea of using retrograde filling for the ease of tract dilatation during PCNL may further increase the odds of infection. This is due to the possibility of extravasation of normal saline into the retroperitoneum and renal pelvis with the bacterial dissemination during retrograde filling, which could consequently lead to bacterial sepsis.[19] In the current study, we also observed that the odds of infection was significantly higher in patients who had retrograde filling for tract dilatation during PCNL as compared to those who had not, even after controlling for potential confounding factors. This finding prompts careful consideration of the benefits and risks associated with retrograde filling. The introduction of external substances like normal saline into the body, even when performed under controlled conditions, can inadvertently disturb the body's equilibrium and immune responses, rendering patients more susceptible to microbial invasions.[2]

In the current study, we found insignificant differences in ease of tract dilation between the exposed and unexposed groups. This observation aligns with the notion that the primary goal of retrograde filling—streamlining tract dilation—may not yield appreciable advantages in terms of ease of the procedure, as evidenced by the negligible variance in tract dilation experiences between the two groups. The absence of significant differences in ease of dilation contradicts the potential notion that retrograde filling could inherently enhance tract expansion. This implies that, at least in terms of ease of tract dilation, the use of retrograde filling might not present substantial added value. However, the adoption of retrograde filling may inadvertently introduce economic implications by adding to the procedure's cost due to the usage of extra normal saline. Additionally, this practice could demand the involvement of an extra technician to oversee the administration of retrograde filling.

The effectiveness of retrograde filling during tract dilatation can be attributed to its ability to enhance the visibility of the renal anatomy. Studies have demonstrated that retrograde pyelography can significantly aid in identifying the optimal access point for nephrostomy, particularly in challenging anatomical situations[18]. Furthermore, the use of retrograde filling may reduce the risk of complications associated with blind puncture techniques, such as vascular injury or inadvertent damage to surrounding structures. By providing real-time feedback on the anatomy, retrograde filling can facilitate more precise needle placement and tract dilation, ultimately leading to improved surgical outcomes. The choice between standard PCNL and mini-PCNL is also influenced by the use of retrograde techniques. Mini-PCNL, characterized by smaller nephrostomy tracts, has been associated with reduced morbidity and shorter recovery times compared to standard PCNL[19]. However, the success of mini-PCNL often hinges on the surgeon's ability to achieve adequate access and visualization, which can be enhanced through retrograde filling. The integration of retrograde techniques in mini-PCNL procedures has been shown to improve stone-free rates while maintaining a favorable safety profile [20]. This is particularly relevant for patients with complex stone anatomies, where traditional approaches may fall short. Complications remain a significant concern in PCNL, with bleeding, infection, and organ injury being the most common adverse events reported.[21] The incorporation of retrograde filling during tract dilatation may mitigate some of these risks by improving the accuracy of needle placement and reducing the need for extensive dissection. Studies have indicated that the use of retrograde techniques can lead to lower complication rates, particularly in high-risk populations, such as those with anatomical abnormalities

or prior surgical interventions.[22] Moreover, the ability to visualize the renal collecting system in real-time allows for immediate identification and management of potential complications, further enhancing patient safety. The role of retrograde filling extends beyond the initial access phase of PCNL. During the procedure, continuous retrograde irrigation can help maintain visibility and prevent the formation of clots or debris that may obstruct the surgical field.[23] This is particularly important in cases involving large stone burdens or complex stone morphologies, where the risk of intraoperative complications is heightened. By ensuring a clear view of the surgical site, retrograde filling can facilitate more efficient stone fragmentation and removal, ultimately leading to improved stone-free rates. In addition to its technical advantages, retrograde filling during PCNL has implications for postoperative outcomes. Studies have shown that patients undergoing PCNL with retrograde assistance experience shorter hospital stays and faster recovery times compared to those who do not receive such interventions.[24] This is likely due to the reduced need for additional procedures or interventions to address complications arising from inadequate access or visualization. Furthermore, the enhanced stone-free rates associated with retrograde filling may translate into lower rates of recurrent stone formation, thereby improving long-term patient outcomes.[25] The integration of retrograde techniques into PCNL protocols is not without challenges. The need for skilled personnel proficient in both retrograde and antegrade techniques can complicate the implementation of these approaches, particularly in resource-limited settings.[26] Additionally, the learning curve associated with mastering these techniques may pose barriers to widespread adoption among urologists. However, the potential benefits of retrograde filling in terms of improved access, reduced complications, and enhanced patient outcomes warrant further investigation and training in this area. In conclusion, retrograde filling during PCNL tract dilatation represents a significant advancement in the management of renal stones.[27-29] By enhancing access and visualization, this technique has the potential to improve surgical outcomes while minimizing complications. As the field of urology continues to evolve, the integration of retrograde techniques into standard PCNL protocols may become increasingly common, ultimately benefiting patients with complex renal stone burdens. Future research should focus on optimizing these techniques and evaluating their long-term impact on patient outcomes, paving the way for more effective and safer management of renal calculi.

The current study brings several strengths to the forefront. Firstly, the study's prospective cohort design lends itself to robust data collection and minimizes recall bias. Our study has few limitations. Firstly, the study's single-center design may limit the external validity of the findings to other healthcare settings. Secondly, the absence of blinding among the surgical team and patients introduces the potential for performance and detection bias. Furthermore, the short follow-up duration of two weeks might not capture delayed infections that could manifest beyond this timeframe. It is recommended that urologists carefully weigh the advantages of retrograde filling against its potential drawbacks. While retrograde filling may not significantly influence ease of tract dilation, its introduction could lead to increased procedural costs due to the use of normal saline and necessitate the involvement of an additional technician. Therefore, adopting retrograde filling should be driven by a judicious assessment of its benefits in relation to these potential costs and logistical complexities.

CONCLUSION:

The use of retrograde filling during tract dilatation is significantly associated with post procedure infection. Furthermore, it is not associated with ease of tract dilation, its introduction carries implications for cost-effectiveness and procedural logistics.

Authors Contribution:
Syed Ali Raza Jaffry: Objective, data
Javed Altaf Jat: final approval
Waqar Ahmed Memon: data collection
Abdul Qayoom Ghangro: data entry, write-up
Ahsan Ali Arain: Write-up, ethics
Tamoor Jatoi: data analysis

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