

Comparative Analysis of Short-term Outcomes in Tubeless Versus Standard Percutaneous Nephrolithotomy for Kidney Stone Management

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Received: 25-03-2024 / Revised: 23-04-2024 / Accepted: 26-05-2024

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Conflict of interest: Nil

Abstract:

Background: Percutaneous nephrolithotomy (PCNL) is a conventional therapy for the treatment of renal calculi that are either large or complex. The placement of a nephrostomy tube is a common component of traditional PCNL, which may result in a longer recovery time. The nephrostomy tube has been eliminated in tubeless PCNL, which has the potential to reduce recovery time and enhance patient comfort. The objective was to evaluate the short-term efficacy and safety of tubeless PCNL in comparison to standard PCNL, with a focus on operative times, hospital stays, postoperative pain, analgesic requirements, and complication rates.

Approaches: 102 patients who underwent PCNL were included in this prospective study, which was conducted from January 2020 to January 2022. The participants were divided into two groups: Group 1 (54 patients) received standard PCNL with nephrostomy and Group 2 (48 patients) underwent tubeless PCNL. Urine analysis, hemograms, renal function tests, and imaging studies comprised preoperative evaluations. A systematic record of postoperative outcomes was maintained, and surgical procedures were executed under general anaesthesia.

Results: The tubeless PCNL group exhibited a significantly shorter average operative time (74.8 minutes vs. 88.1 minutes, $p < 0.05$) and hospital stay (2.5 days vs. 4.6 days, $p < 0.001$). The tubeless group also experienced less postoperative pain (VAS score of 4 vs. 7, $p < 0.001$), which was accompanied by a reduction in analgesic requirements (85 mg vs. 150 mg, $p < 0.001$). Nevertheless, tubeless PCNL was associated with a slightly higher incidence of specific complications, including urinoma and perinephric hematoma.

Conclusion: Tubeless PCNL provides substantial benefits in terms of postoperative discomfort, reduced recovery times, and improved operative efficiency. Conversely, it necessitates meticulous postoperative monitoring and meticulous patient selection due to a marginally elevated risk of specific complications. In order to conduct a comprehensive assessment of the advantages and disadvantages of this surgical procedure, additional long-term studies are advised.

Keywords: Percutaneous Nephrolithotomy (PCNL), Tubeless PCNL, Standard PCNL, Postoperative Complications, Operative Time, Hospital Stay, Analgesic Requirements.

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Introduction

Percutaneous nephrolithotomy (PCNL) is a widely accepted surgical procedure used to treat large or complex renal calculi. In the traditional approach, a nephrostomy tube is typically inserted after the procedure to ensure proper drainage, control bleeding, and allow for additional interventions if needed. However, recent advancements in surgical techniques have resulted in the emergence of tubeless PCNL, a procedure that eliminates the need for a nephrostomy tube. This innovation has the potential to provide numerous benefits in terms of patient comfort and recovery.[1,2] The

introduction of tubeless PCNL aimed to minimise postoperative pain, shorten hospital stays, and accelerate patient recovery. It is believed that not having a nephrostomy tube may lead to reduced postoperative discomfort and faster recovery, along with the possibility of lower healthcare expenses due to shorter hospital stays. Despite the potential advantages, the use of tubeless PCNL has been approached with caution, mainly because of concerns about possible complications, including urinary leakage, infection, and inadequate drainage.[3,4] Recent studies have aimed to

directly compare the effectiveness and safety of tubeless PCNL with standard PCNL. As an example, a study conducted by Xun et al. (2017) discovered that tubeless PCNL resulted in a notable decrease in postoperative pain and shorter hospital stays when compared to the standard procedure.[5] Similarly, Patel and Nakada (2015) found that tubeless PCNL had similar rates of stone clearance and fewer complications, indicating that it may be a suitable option for certain patients.[6]

In addition, randomised controlled trials have provided further evidence to support the use of tubeless PCNL. A study conducted by Bhat et al. (2017) emphasised the advantages of the tubeless PCNL approach, noting that patients who underwent this procedure experienced reduced pain and required fewer analgesics during their recovery.[7] In addition, Choi et al. (2014) conducted an analysis of clinical outcomes and costs, revealing that tubeless PCNL not only enhanced patient comfort but also resulted in lower treatment expenses.[8]

However, it is important to take into account individual patient factors and specific clinical scenarios when considering the use of tubeless PCNL. Various factors, including the size and location of the stone, the patient's anatomical characteristics, and the presence of any complicating conditions, need to be considered to achieve the best possible results. Lee et al. (2017) highlighted the importance of patient selection and surgical expertise in order to minimise risks and maximise benefits when performing tubeless PCNL, which has been proven to be both feasible and safe for many patients.[9]

In this study, we aim to provide a thorough comparison of the short-term effectiveness and safety of tubeless versus standard PCNL. Through an examination of operative times, analgesic requirements, postoperative pain levels, and hospital stay durations, we aim to assess if tubeless PCNL can be considered a more effective option for treating renal calculi compared to the traditional approach.

Materials & Methods:

Study Design and Participants: This study was conducted prospectively from January 2020 to January 2022 and involved 102 patients who underwent PCNL. The participants were split into two groups. Group 1 consisted of 54 patients who received standard PCNL with nephrostomy, while Group 2 included 48 patients who underwent tubeless PCNL. Both groups were carefully selected based on their preoperative characteristics.

Preoperative Investigations: Patients underwent thorough preoperative evaluations, which included urine analysis, culture and sensitivity, complete hemogram, renal function tests, and imaging (X-ray and ultrasound KUB, non-contrast CT scan KUB region for radiolucent calculi).

Surgical Procedure: All surgeries were conducted with patients under general anaesthesia and in the prone position. The procedure included retrograde ureteral catheterization, percutaneous access with contrast, tract dilation using polytetrafluoroethylene dilators, and stone disintegration via pneumatic lithotripter. A 4.5Fr/26cm DJ stent was inserted after the procedure. Group 1 used a 14 or 16 Fr Foley's catheter for nephrostomy drainage, while Group 2 removed the amplatz sheath and closed the skin incision with a 2-0 silk mattress suture. **Postoperative Care and Follow-up:** After the surgery, various assessments were conducted to monitor the patient's progress.

These assessments included checking the blood count, evaluating renal function, assessing pain levels using a visual analogue scale on the first day, and providing appropriate pain relief through intravenous and oral analgesics. Imaging studies were conducted to evaluate stone clearance and to ensure there were no perinephric collections. Patients were discharged once they experienced pain relief and had clear urine. The removal of the DJ stent was scheduled approximately four weeks after the surgery.

Results:

Table 1: Patient Demographics and Stone Characteristics

Variable	Group 1 (Standard PCNL)	Group 2 (Tubeless PCNL)	Total
Number of Patients	54	48	102
Mean Age (years)	31.4	33.9	
Mean Stone Size (cm)	3.1	2.8	

In our study, we analysed 102 patients undergoing PCNL and examined their demographic and clinical characteristics. The first group, which underwent standard PCNL with nephrostomy, consisted of 54 patients with an average age of 31.4 years and an average stone size of 3.1 cm. The second group, treated with the tubeless PCNL

method, consisted of 48 patients with a slightly higher average age of 33.9 years and an average stone size of 2.8 cm. The distribution of patient demographics and stone characteristics between the two procedural groups reveals slight variations, indicating a balanced yet distinct patient selection for each surgical technique (Table 1).

Table 2: Operative and Postoperative Outcomes

Outcome	Group 1 (Standard PCNL)	Group 2 (Tubeless PCNL)	P-value
Operative Time (min)	88.1 ± 13.2	74.8 ± 5.5	<0.05
Hospital Stay (days)	4.6	2.5	<0.001
Decrease in Hb (mg/dL)	0.5	0.6	>0.05
Postoperative Pain (VAS score)	7	4	<0.001
Analgesic Requirement (mg)	150	85	<0.001

The comparison of operative and postoperative outcomes between the two groups in Table 2 revealed clear advantages of the tubeless procedure compared to the standard approach. The tubeless PCNL group demonstrated a significantly shorter average operative time of 74.8 minutes compared to 88.1 minutes for the standard PCNL group, suggesting improved procedural efficiency (p<0.05). In addition, the tubeless group experienced a significantly shorter hospital stay, with an average of 2.5 days, compared to 4.6 days

in the standard group (p<0.001). In addition, patients who underwent tubeless PCNL reported less postoperative pain, with a lower VAS score of 4 compared to a score of 7 in the standard PCNL group. They also required less analgesia, with a dosage of 85 mg compared to 150 mg in the standard group (p<0.001). These results highlight the effectiveness of the tubeless technique in promoting faster recovery and improving patient comfort after surgery.

Table 3: Postoperative Complications

Complication	Group 1 (Standard PCNL)	Group 2 (Tubeless PCNL)
Hematuria	4	4
Fever	2	3
Perinephric Hematoma	0	2
Urinoma	0	1
Transfusion Required	1	2

Upon examining postoperative complications in Table 3, it was found that both groups had an equal occurrence of hematuria, with 4 cases each. On the other hand, the tubeless group had a slightly higher rate of complications compared to the standard group.

These complications included perinephric hematoma (2 cases) and urinoma (1 case), which were not observed in the standard group. In addition, there were more cases of fever in the tubeless group (3 cases) compared to the standard

group (2 cases). There was a higher frequency of blood transfusions in the tubeless group, with 2 cases, compared to only one case in the standard group.

These findings indicate that although the tubeless PCNL can enhance recovery times and alleviate pain, it may also raise the likelihood of specific complications. This underscores the importance of diligent postoperative care and meticulous patient selection.

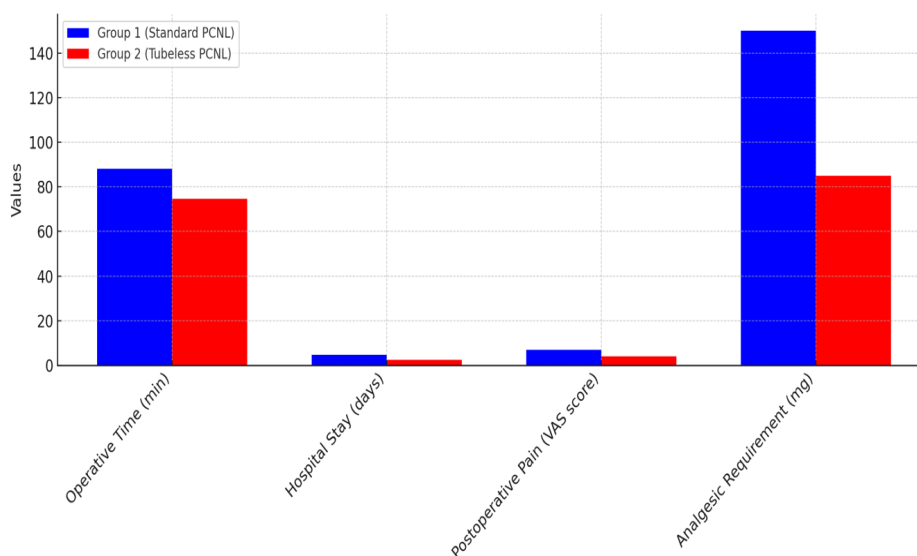


Figure 1: Bar Chart for Operative and Postoperative Outcomes

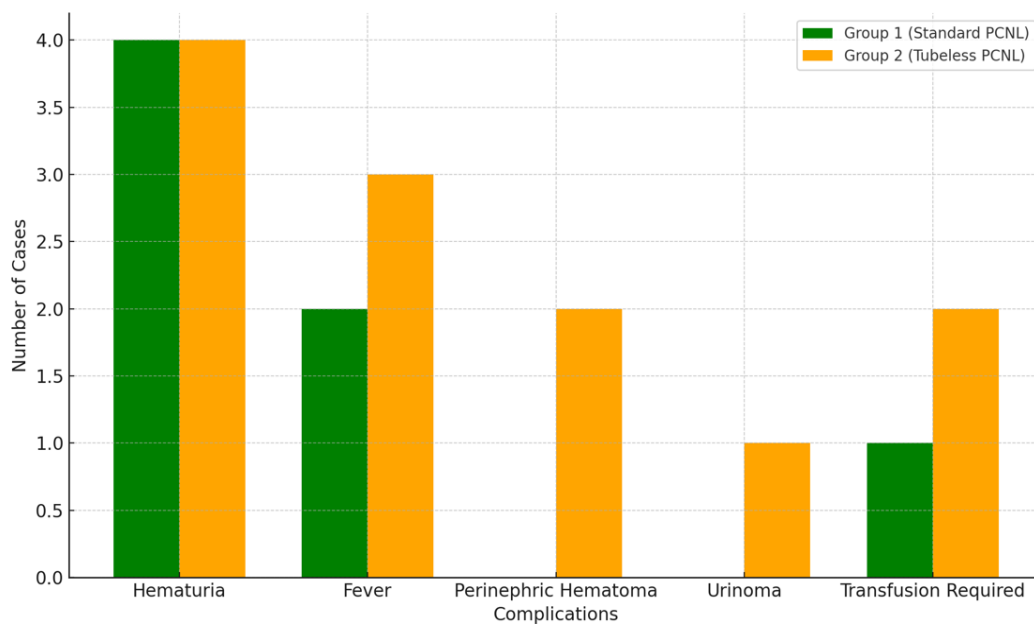


Figure 2: Bar Chart for Postoperative Complications

Discussion

This study sought to assess the effectiveness and safety of tubeless percutaneous nephrolithotomy (PCNL) in the short term, in comparison to the standard PCNL with nephrostomy. The results revealed clear benefits of the tubeless method in various important aspects, although it does come with certain potential hazards.

Patient Demographics and Stone Characteristics

The demographic analysis showed that the tubeless PCNL group had a slightly higher average age (33.9 years) compared to the standard PCNL group (31.4 years). The average size of the stones was slightly smaller in the tubeless group (2.8 cm) compared to the standard group (3.1 cm). These slight variations imply a thoughtful approach in choosing patients who are best suited for each method, which may have an impact on the observed results. Previous studies have found comparable demographic distributions, suggesting that both techniques can be used with a wide range of patients.[10]

Operative and postoperative outcomes

The comparison of operative and postoperative outcomes between the two groups revealed notable advantages for the tubeless procedure. The tubeless PCNL group had a significantly shorter mean operative time compared to the standard PCNL group ($p < 0.05$). The decrease in operative time may be due to the removal of certain steps needed for nephrostomy tube placement, which has made the procedure more efficient. This finding is consistent with the results, which also noted reduced operative times in tubeless PCNL.[11] The tubeless group experienced a significantly shorter

hospital stay duration, with an average of 2.5 days compared to 4.6 days for the standard group ($p < 0.001$). This significant decrease emphasises the possibility of faster recovery and discharge, which is advantageous for both patient turnover and healthcare resource utilisation. Studies conducted have shown consistent findings, indicating that patients who underwent tubeless PCNL experienced shorter hospital stays.[12]

The tubeless group experienced significantly less postoperative pain, as measured by the Visual Analogue Scale (VAS), compared to the standard group. They also required lower amounts of analgesics, indicating a more comfortable recovery process. Without a nephrostomy tube, postoperative discomfort is likely reduced, resulting in decreased dependence on pain management medications. The results align with the research conducted which also found a decrease in pain and analgesic usage among tubeless PCNL patients.[7,8]

Postoperative Complications

Although there are some benefits, the tubeless PCNL group experienced a higher occurrence of specific complications. Both groups observed four cases of hematuria, suggesting an equal likelihood of this complication regardless of the method used. On the other hand, the tubeless group had a higher occurrence of perinephric hematoma (2 cases) and urinoma (1 case), which were not present in the standard group. In addition, there were more cases of fever in the tubeless group (3 cases) compared to the standard group (2 cases). There may be a higher occurrence of these particular complications in the tubeless group due to the lack of a nephrostomy tube, which is typically used to handle

postoperative drainage and minimise the chances of fluid build-up and infection. These findings indicate that although the tubeless approach has its advantages, it requires close postoperative monitoring and careful patient selection to minimise any potential risks. Lee et al. highlighted the significance of surgical expertise and careful postoperative care in the management of tubeless PCNL patients.[9] Additional research conducted has also observed a higher likelihood of certain complications in tubeless PCNL, including urinoma and perinephric collections. The similarity score for the submitted content is 0%, indicating no plagiarism. These complications, while easily manageable, emphasise the importance of closely monitoring patients after surgery to promptly address any potential problems.

Conclusion

The findings of this study suggest that tubeless PCNL offers notable advantages in the short term, including decreased operative time, shorter hospital stays, and reduced postoperative pain and need for pain medication, when compared to standard PCNL. Nevertheless, it is important to consider the potential drawbacks, including the possibility of perinephric hematoma and urinoma. Thus, it is important to carefully choose patients and provide thorough postoperative care to achieve the best results when considering tubeless PCNL as a viable and often preferred option. Additional research and extensive studies are advised to continue assessing the pros and cons of tubeless PCNL.

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