

# Trends of percutaneous nephrolithotomy in Saudi Arabia

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## Abstract

**Objective:** The objective of the study was to present the current practice patterns on percutaneous nephrolithotomy (PCNL) in Saudi Arabia and to compare it with the international patterns and to observe the adherence to the guidelines.

**Materials and Methods:** A survey consisting of 28 questions was sent to urologists working in Saudi Arabia using a Google Forms questionnaire. The questioner covered most aspects of performing PCNL starting from preparing the patient till discharging him.

**Results:** One hundred and thirty-two replied to the survey. Almost 70.2% performed PCNL and 59.1% of them learned PCNL during residency. The access was obtained by the urologists in 80.3% from the participants, 68.2% of them uses fluoroscopic guidance for the puncture. The majority (80.3%) perform PCNL in the prone position. Nearly 69.7% use the balloon dilators and 16.7% use the Amplatz dilators. For kidney drainage, 60.6% place a nephrostomy tube and a double-J stent (DJ stent) together and 4.5% perform tubeless PCNL (DJ stent only). About 45.5% stated that the introduction of flexible ureteroscopy decreased the rate of doing PCNL for >20%.

**Conclusions:** Data obtained from a group of urologists in Saudi Arabia showed that the majority of urologists practicing in Saudi Arabia perform PCNL. They usually learn PCNL during residency. We observe that the majority of urologists attach to the original patterns in PCNL, i.e., they predominantly prefer the prone position and use fluoroscopy to gain the PCNL access. Furthermore, the data showed that new trends in PCNL did not gain a lot of momentum as few practices miniaturized PCNL and tubeless PCNL. The majority use balloon dilators and combined ultrasonic/pneumatic lithotripters. The complication rate encountered by the participants is concomitance with the published international figures. The introduction of flexible ureteroscopy highly decreased the rate of doing PCNL for most urologists.

**Keywords:** Endourology, percutaneous nephrolithotomy, Saudi Arabia, ureteroscopy

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## INTRODUCTION

Urolithiasis is a globally growing disease. Studies report that the prevalence of stone disease is as high as 10% in men in the USA.<sup>[1]</sup> Nonetheless, the prevalence across countries might change due to climate and diet differences. High animal protein intake and hot temperatures led to

high urolithiasis prevalence in Saudi Arabia.<sup>[2,3]</sup> There are several options for the treatment of renal calculi, including extracorporeal shock wave lithotripsy (ESWL), percutaneous nephrolithotomy (PCNL), and retrograde intrarenal surgery (RIRS). Since its introduction in the 1970s, PCNL has undergone a lot of technical

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advancements beginning from puncture methods to exit strategies. In the last decade, the introduction of new flexible ureteroscopes and laser machines led to decreasing the rate of PCNL.<sup>[4]</sup> Nonetheless, PCNL is still the recommended treatment in the European Association of Urology (EAU) guidelines for renal stones greater  $\geq 2$  cm and lower pole stones  $\geq 1.5$  cm and the recommended first-line treatment for staghorn calculi by the American Urological Association guidelines.<sup>[5,6]</sup>

The aim of our study is to understand the current practice patterns in PCNL in a country with high urolithiasis prevalence and to compare these figures with the international patterns and to observe its adherence to the international guidelines. In addition, we aimed to observe if the urologists in Saudi Arabia utilize new modalities and techniques in managing renal calculi such as miniaturized PCNL. This information will aid in delineating and analyzing the regional treatment strategies and will help in improving the local urological educational programs and workshops.

## MATERIALS AND METHODS

An online questionnaire about trends of PCNL using Google Forms was created and distributed to urologists over Saudi Arabia. Urologists were invited to participate in the research and received a questionnaire consisting of 28 questions. The anonymous survey consisted of two sections: the first section consisted of four demographic questions – years of practice, level, institute, and do you perform PCNL? The second section had the remaining 24 questions which were addressed to those who perform PCNL. Training methods, patient's preparation, technical aspects, and postoperative complications were addressed in the questions.

### Questions

The questions are summarized in Table 1.

## RESULTS

The results are shown in Table 1.

Figure 1 (a) Pie chart showing the years of experience for the participants. (b) Pie chart showing the distribution of institute the participants work in.

Figure 2 Flowchart showing who performs percutaneous nephrolithotomy, percutaneous nephrolithotomy puncture, and the modality used in the puncture.

## DISCUSSION

PCNL was introduced in 1976. Fernström and Johansson published the article titled : percutaneous pyelolithotomy,

a new extraction technique, in which they described their breakthrough technique in removing the stones through a nephrostomy tube under fl uoroscopic guidance.<sup>[7]</sup> Since then, many refinements were introduced to the principle idea, and many endourological innovations were introduced as well. Despite the introduction of RIRS, PCNL is considered the first-line management for renal stones larger than 2 cm according to the EAU guidelines.<sup>[5]</sup>

### Who performs percutaneous nephrolithotomy?

In this study, 70.2% of the respondents stated that they perform PCNL, with an average of 0–5 cases per month, representing 10%–20% of the general practice for most. The majority learned PCNL during residency (59.1%). Nonetheless, fellowship programs are increasing, and many gain their PCNL skills through dedicated local and international endourological fellowship programs (19.7%).

The PCNL tract was obtained by urologists in the majority of the participants (80.3%); in comparison with the national figures, the percentage of urologists performing the PCNL puncture is higher in Saudi Arabia than the United States or the United Kingdom (80.3% vs. 17% and 33.7%, respectively).<sup>[8,9]</sup> Studies showed that obtaining access by urologists might reduce the complication rate and hence encouraging urologists to perform their own accesses.<sup>[8]</sup>

### Preoperative measures

#### *Percutaneous nephrolithotomy planning*

In planning PCNL, computed tomography (CT) without contrast is the most utilized modality by the participants prior to PCNL (90.9%), whereas none utilized intravenous pyelogram (IVP). A randomized study showed the superiority of noncontrasted CT over IVP in the planning of PCNL.<sup>[10]</sup> CT without contrast is superior than X-ray kidney ureter and bladder (KUB) in terms of detecting radiolucent stones, measuring skin to stone distance, measuring the Hounsfield unit, and visualizing the neighboring organs.<sup>[11]</sup> Ultrasound (US) was utilized in 6.1%. The US has the advantage of no radiation, visualizing the adjacent structures. Nonetheless, it is operator dependent and has a specificity of 88% and a sensitivity of only 45%.<sup>[12]</sup> Renogram before PCNL was utilized by the participants mostly when radiological investigations suggested a decrease in renal function.

#### *Prophylactic antibiotic*

When it comes to the choice of prophylactic antibiotic, there is no general consensus regarding the appropriate doses required.<sup>[13]</sup> Gravas *et al.* found that giving prophylactic antibiotic for patients undergoing PCNL with preprocedure negative urine culture is associated with a lower complication rate.<sup>[14]</sup> Nonetheless, single-dose

administration was found to be sufficient.<sup>[15]</sup> The results shown in the survey display that most of the participants follow the single-shot recommendation (59.1%).

**Operative and technical measures**

*The access*

Obtaining a safe percutaneous renal access is of uttermost importance during PCNL. Both fluoroscopy and US have been described to obtain the access. Although fluoroscopy is widely utilized due to the accuracy of identification of the desired calyx for puncture, it does not visualize important adjacent organs such as the pleura and the bowels during the puncture, posing the risk of accidental injury to these organs.<sup>[16]</sup> In recent years, a great interest was shown in performing more US-guided puncture and extending it to total US PCNL aiming to decrease radiation to the patient and the surgeon.<sup>[17]</sup> In our study, most of the participants relied totally on fluoroscopy in the puncture (68.2%) and only 4.5% performed US-guided puncture. Retrograde access was utilized in 3%. Al-Otaibi recently published his series of 638 patients who underwent retrograde access for PCNL with good outcomes and low morbidity.<sup>[18]</sup>

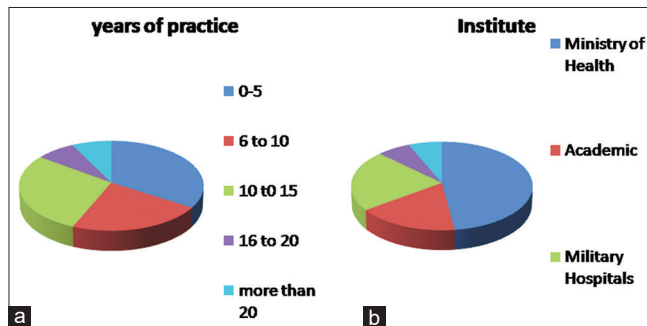
*Patient positioning*

Conventionally, PCNL was done in the prone position and it remained like that for many years until Valdivia

described performing PCNL in the supine position in 1998.<sup>[19]</sup> The proposed advantages of supine PCNL are less operative time, lower intrarenal pressure, and less position-related injuries. Performing supine PCNL allows the easier performance of endoscopic combined intrarenal surgery and spontaneous combined intrarenal surgery.<sup>[20,21]</sup> Despite the aforementioned proposed advantages, clinical trials failed to prove superiority in either position except for shorter operative time in supine PCNL.<sup>[22,23]</sup> Our data show that the majority perform prone PCNL, and supine PCNL is practiced in 20% of the centers worldwide. Data showed that supine PCNL did not also gain popularity in North America and Australia.

*Tract dilation type and size*

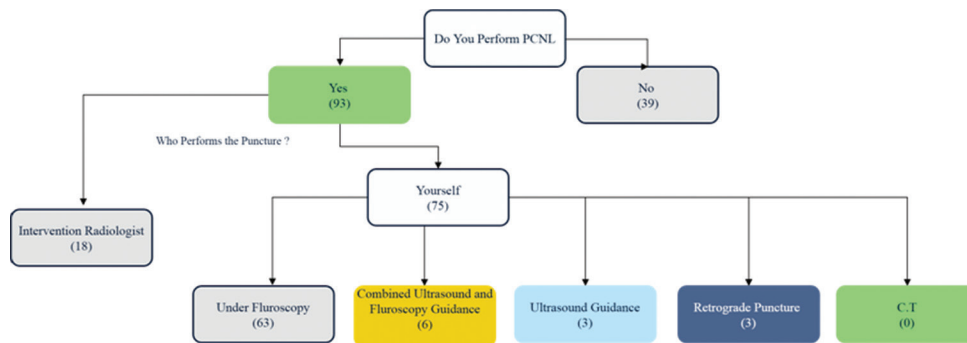
Dilatation of the percutaneous access tract can be achieved using a single dilator, telescopic metallic Alken, fascial Amplatz, and balloon dilation. Studies showed that while there is no difference in the complication rate between these methods, there is less radiation exposure with the one-step dilator and the balloon dilator. However, the balloon dilator is the most expensive between them all.<sup>[24]</sup> Balloon dilator is the preferred method for the majority of the participants in our study (69.7%). Due to the different nomenclature of tract size, we relied on the nomenclature suggested by Schilling *et al.* in asking about the size utilized.<sup>[25]</sup> Most of the participants (72.7%) dilate to the standard XL (≥25 Fr). In the recent years, there has been a widespread of various miniaturized PCNL techniques to decrease the morbidity of the percutaneous procedures. Although the efficacy of miniaturized techniques was shown to be high, a clear advantage over standard PCNL has yet to be proven.<sup>[26,27]</sup> The lack of clear indications for miniaturized PCNL even in the guidelines might be the reason that the majority did not adopt this new trend.



**Figure 1:** (a) Pie chart showing the years of experience for the participants. (b) Pie chart showing the distribution of institute the participants work in

*Energy source*

There are diverse methods of extracorporeal fragmentation in PCNL. US and pneumatic devices are widely used



**Figure 2:** Flowchart showing who performs percutaneous nephrolithotomy, percutaneous nephrolithotomy puncture, and the modality used in the puncture

**Table 1: Summary of the questionnaire questions, results, and the percentage**

Section One	Number	Percentage %
years of practice:		
0-5 years	45	34.1
6-10 years	31	23.5
11-16 years	38	28.7
17-20 years	9	6.8
More than 20 years	9	6.8
level:		
Resident	35	26.6
Specialist	7	5.3
Fellow	3	2.1
Consultant	87	66
Institute:		
Ministry of Health	64	48.48
Academic hospitals	23	17.4
Private hospitals	8	6.06
Military hospitals	29	21.96
Specialty hospital and research center	8	6.06
Do you perform PCNL ?		
Yes	93	70.4
No	39	29.6
Section 2	Number	Percentage %
How many PCNLS do you perform/month ?		
0-5	87	93.5
6-11	5	5.3
12-17	0	0
18-23	0	0
more than 23	1	1.07
To what percentage does the cases of the PCNL contributes to your general practice ?		
Less than 10%	31	33.3
10-20%	35	37.6
20-30%	10	10.7
30-40%	9	9.7
40-50%	4	4.3
50%	4	4.3
How did you learn to perform PCNL ?		
During residency	55	59.1
Fellowship in Endourology	18	19.4
From a colleague	13	14
From workshops	7	7.5
Who performs the puncture of the PCNL ?		
Yourself	75	80.6
Interventional Radiology	18	19.4
What imaging modality do you obtain prior to PCNL ?		
X-Ray Kidny Ureter Bladder (KUB)	15	16.1
C.T without contrast	85	90.9
Ultrasound	6	6.4
Intravenous Pyelogram	0	0
Do you perform Renogram before PCNL?		
In all cases	51	54.8
Only if radiological investigations suggests decreased renal function	3	3.2
In patients with Staghorn calculus	8	8.6
I never perform Renogram prior to PCNL	25	26.9
Answer B and C	8	8.6
In all cases		
The regiment for Prophylactic antibiotics is		
No prophylaxis	55	59.1
One shot at induction	13	14
Less than 24 hours pre operative	17	18.3
24 hours pre operative	4	4.3
1-3 days pre operative	4	4.3
More than 3 days		

*Contd...*

Table 1 Contd...

Section 2	Number	Percentage %
You perform the puncture under		
Fluoroscopy guidance	63	67.7
Ultrasound guidance	3	3.2
Combined fluoroscopic and ultrasound	6	6.5
C.T guidance	0	0
Retrograde Puncture	3	3.2
The intervention radiologist does the puncture	18	15.2
In which position do you perform PCNL		
Prone position only	75	80.6
Supine position only	4	4.5
More than 50% Prone position	6	6.4
More than 50% Supine	7	7.5
50-50% Prone and Supine	1	1.1
Method of Dilators		
Amplatz dilators	16	16.7
Balloon Dilators	65	69.9
Alken Dilators	11	11.8
Others	1	1.1
To which size do you dilate		
XL ( 25 Fr and more )	68	73.1
L ( 20-24 Fr )	20	21.5
M ( 15-19 Fr )	4	4.3
S (10-14 Fr )	0	0
XS ( 5-9 Fr )	1	1.1
XXS ( < 5 Fr )	0	0
Energy Sources most frequently used for Stone fragmentation		
Pneumatic	21	22.6
Ultrasonic	10	10.8
Combined	59	63.4
Laser	3	3.2
If you had a patient with Staghorn Calculus you mostly perform		
Single tract/Single procedure	42	45.2
Multiple tract/Single Procedure	16	17.2
Staged Procedure	28	30.1
Endoscopic Combined Intrarenal Surgery (ECIRS)	7	7.5
For Stone Free Rate detection you rely on ( Check box)		
Nephrostogram at the end of procedure	25	27.3
Flexible nephroscope at the end of procedure	24	25.8
Flexible ureteroscopy at the end of procedure	4	4.5
KUB day one post OP	31	33.3
C. T day one post OP	28	30.3
Ultrasound day one post OP	0	0
KUB one month post OP	7	7.6
C.T one month post OP	28	30.3
Ultrasound one month post OP	3	3
It depends on the case	1	1.1
Nephrostogram 1 day post OP	1	1.1
Your exit strategy at the end of procedure mostly is		
Nephrostomy + DJ stent	56	60.2
Nephrostomy only	13	13.9
D.J. stent only	4	4.3
Malecot with re-entry tip	0	0
Ureteric catheter only	0	0
Nephrostomy + ureteric catheter	20	21.5
Choice of pain management post PCNL (Check box)		
Local marcaine injection	7	7.5
Oral paracetamol	14	15.1
Voltaren injection	11	11.8
Pethidine injection	54	58
Morphine Injection	13	13.9
I.V Paracetamol	49	52.6
Ibuprofen	7	7.5
Patient controlled analgesia	1	1.1

Contd...

Table 1 Contd...

Section 2	Number	Percentage %
In your practice what's the percentage of post PCNL fever		
Less than 1%	45	48.4
1-3%	34	36.6
4-6%	10	10.7
6-10%	1	1.1
More than 10%	3	3.2
In your practice what's the percentage of hydropneomthorax		
Less than 1%	85	91.4
1-3%	6	6.5
4-6%	0	0
6-10%	2	2.1
More than 10%	0	0
In your practice what's the percentage for bleeding requiring transfusion post PCNL?		
Less than 1%	59	63.4
1-3%	23	24.7
4-6%	8	6.6
6-10%	3	3.2
More than 10%	0	0
In your practice what's the percentage of A-V fistula post PCNL requiring angioimbolization		
Less than 1%	85	91.4
1-3%	8	8.6
4-6%	0	0
6-10%	0	0
More than 10%	0	0
In your practice what's the percentage of febrile UTI ?		
Less than 1%	52	55.9
1-3%	31	33.3
4-6%	6	6.5
6-10%	3	3.2
More than 10%	1	1.1
In your practice what's the percentage of neighboring organs injury		
Less than 1%	89	95.7
1-3%	4	4.3
4-6%	0	0
6-10%	0	0
More than 10%	0	0
How much did the introduction of Flexible Ureteroscopy decreased your rate of doing PCNL		
Did not affect it at all	14	15.1
Decreased it by 5%	16	17.2
Decreased by 10%	21	22.6
More than 20% decrease in the rate of PCNL	42	45.2
Do you perform PCNL in pediatrics?		
Yes	20	21.5
No	73	78.5

with the rigid nephroscopes, and some devices combine both energy sources. Laser lithotripsy is commonly used with miniaturized PCNL and when using flexible nephroscope.<sup>[28]</sup> In our study, most of the participants use the combined ultrasonic and pneumatic devices during PCNL (63.6%).

### Staghorn calculi

Staghorn stones represent a difficult entity as it carries a high mortality and it poses a challenge in management plan. Data showed that PCNL monotherapy has the highest stone-free rate (SFR).<sup>[6]</sup> Nonetheless, a large study showed that the SFR in patients with staghorn calculi who underwent PCNL is only 56.9%.<sup>[29]</sup> Using a morphometry-based classification for staghorn calculi to measure the volume and complexity of the stone may anticipate the necessity

for staged procedure or multiple tracts and could help in predicting the outcome of PCNL in those patients.<sup>[30]</sup> Most of our participants prefer performing a single procedure with a single tract for managing staghorn calculi (45.5%).

### Residual fragments

Achieving complete SFR after an endourological procedure could be a challenging. The EAU guidelines recommend a follow-up of residual stones. Nonetheless, there is a lack of general agreement on what could be considered significant residual fragments or how to detect them, and no specific imaging modality has been recommended for the detection of residual fragments.<sup>[5]</sup> The heterogeneity in the publications and lack of guidelines might be the cause of the different replies obtained from the participants. Osman *et al.* suggested that residual fragments  $\leq 3$  mm, as

assessed by noncontrast CT, could be considered clinically insignificant and stones larger than that would likely require further intervention.<sup>[31]</sup> In our study, many participants chose more than modality for detecting post-PCNL fragments. None contrasted CT weather day 1 or 1 month postoperative was the main modality chosen.

#### *Exit strategy*

In the past, the PCNL procedure was concluded by placing a ureteric catheter and nephrostomy tube. Nonetheless, an enthusiasm is growing toward what is referred to as tubeless PCNL. In tubeless PCNL, no nephrostomy tube is left. On the other hand, totally tubeless means not keeping neither nephrostomy tube nor ureteric catheter.<sup>[32]</sup> Studies showed that tubeless or totally tubeless PCNL results in significantly lower hospital stay, less postoperative pain, less analgesic requirements, and faster return to activity.<sup>[32]</sup> Despite that, the majority of the respondents in our study prefer to adhere to the original teachings of leaving nephrostomy tube and ureteric stenting.

#### *Postpercutaneous nephrolithotomy pain management*

There is a lack of evidence in the literature regarding the appropriate pain management post-PCNL. Studies showed that the usage of miniaturized PCNL and performing tubeless PCNL, might result in less postoperative pain.<sup>[27,32]</sup> Most of the participants prefer pethidine injection and IV paracetamol (57.6% and 53%, respectively).

#### *Complications*

The figures of the encountered complications are based on a survey and therefore could not be precise. Nonetheless, it reflects the most encountered complications by participants who perform PCNL. In general, the most common complications of PCNL are fever 10.8%, bleeding requiring transfusion 7%, thoracic complication 1.5%, sepsis 0.5%, organ injury 0.4%, bleeding requiring embolization 0.4%, urinoma 0.2%, and death 0.05%.<sup>[33]</sup> In our survey, the most common encountered complication is post-PCNL fever, followed by febrile urinary tract infection, bleeding requiring transfusion, hydropneumothorax, and arteriovenous fistula post and neighboring organ injury, respectively.

#### **Is retrograde intrarenal surgery taking over percutaneous nephrolithotomy in Saudi Arabia?**

Technical advances and innovations changed the scheme of managing renal calculus worldwide. Studies showed that RIRS rate is increasing due to advances in visibility and laser devices, whereas the rate of ESWL is declining.<sup>[34]</sup> Nonetheless, despite the increasing rate of RIRS, PCNL rate is still increasing.<sup>[34,35]</sup> However, this is not the case everywhere; data from the UK showed increasing in the rate of RIRS, whereas the rate of PCNL remained

unchanged or decreased.<sup>[4]</sup> Interestingly, when we asked in our survey; how much did the introduction of flexible ureteroscopy decrease your rate of doing PCNL? 45.5% of the participants replied that there is a 20% decrease in the rate of PCNL after the introduction of flexible uretersocopy. While only 15.2% stated that the introduction of fl exible ureteroscopy did not affect their rate of doing PCNL.

#### *Percutaneous nephrolithotomy in pediatrics*

There is a steady increase in the incidence of pediatric nephrolithiasis over the past several decades.<sup>[36]</sup> A systemic review showed that ESWL, URS, open surgery, and laparoscopic surgery in pediatric have doubled over the past 16 years. Nonetheless, PCNL rose fivefold.<sup>[37]</sup> The majority of the respondents do not perform PCNL in pediatrics. While the reason is not explained in the questioner, the low rate could be due to the lack of training on pediatric patients and lack of instruments.

The limitations of the study were that it is based on a questioner. Hence, accurate figures could not be obtained, and the reason for the respondent's answers and preferences is not known.

However, it gives a general understanding about the patterns and trends utilized while performing PCNL. This could be of value in planning the residency and fellowship programs.

Creating the Saudi Endourological Registry would help in further analyzing nephrolithiasis management in Saudi Arabia.

#### **CONCLUSIONS**

Data obtained from a group of urologists in Saudi Arabia showed that urologists practicing in Saudi Arabia usually learn PCNL during residency. We observe that the majority of urologists attach to the original patterns in PCNL, i.e., they predominantly prefer the prone position and use fluoroscopy to gain the PCNL access. Furthermore, the data showed that new trends in PCNL did not gain a lot of momentum as few practices miniaturized PCNL and tubeless PCNL. The majority use balloon dilators and combined ultrasonic/pneumatic lithotripters. The introduction of flexible ureteroscopy highly decreased the rate of doing PCNL for most urologists. PCNL in pediatrics is not well practiced among the participants.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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