

# CHANGES IN CARDIOVASCULAR STATUS AND SERUM ELECTROLYTE LEVELS DURING PERCUTANEOUS NEPHROLITHOTOMY

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### Abstract:

**Background:** Due to advancement of endourology, percutaneous nephrolithotomy (PCNL) is a common procedure for removal of renal stones. Intravascular absorption of normal saline during the PCNL may result in fluid overload, electrolyte imbalance and cardiovascular instability.

**Objective:** To evaluate the changes in cardiovascular status and serum electrolyte levels in patients undergoing percutaneous nephrolithotomy.

**Method:** Sixty adults underwent percutaneous nephrolithotomy were studied. Among them male female ratio was 13:7 and age ranging from 20-50 years. Heart rate, blood pressure and serum electrolytes were monitored before irrigation, during irrigation and post operatively. Stone size, duration of irrigation, volumes of irrigation fluid used and amount of absorption of irrigation fluid were recorded.

**Result:** The mean heart rate, systolic and diastolic blood pressure levels were significantly higher ( $p < 0.05$ ) during PCNL compared to base line values. Serum sodium, potassium levels were decreased during the operation compared to the baseline levels ( $p < 0.005$ ) but mean chloride concentration increased gradually compared to baseline but it was significantly higher at 120<sup>th</sup> min of irrigation and postoperatively ( $p < 0.05$ ). There was no significant change of serum bicarbonate concentration compared to base line value ( $p > 0.05$ ). The volume of irrigation fluid varied from 10000 ml to 24000 ml with mean volume 17045( $\pm 3383$ ) ml. Total duration of irrigation varied from 30 min to 120 min. Total absorbed irrigant varied from 200-1000 ml with mean volume absorbed 526.27( $\pm 215$ ) ml.

**Conclusion:** In conclusion, these changes in cardiovascular status and serum electrolyte levels during percutaneous nephrolithotomy (PCNL) may be due to the invasive nature of the intervention to the kidney and the continuous irrigation of this vital organ.

**Keywords:** PCNL, Cardiovascular status and Serum Electrolyte.

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### Introduction

Urinary stone disease is one of the most common problem in urological practice. The lifetime prevalence of kidney stone disease is estimated at 1% to 15%, with the probability of having a stone varying according to age, gender, race, and geographic location[1].

Percutaneous nephrolithotomy (PCNL) is a commonly used technique for treatment of kidney stones with the advantages of lower morbidity rates, decrease in post-operative pain with faster post-operative recovery, minimum duration of hospital stay and formation of minimal scar tissue[2].

Percutaneous nephrolithotomy (PCNL) needs continuous irrigation of kidney during the procedure. Normal saline (0.9% NaCl) is the fluid used most often for this purpose. The absorption of irrigation fluid can occur as a result of intravascular absorption during the procedure[3,4].

The absorption of significant volumes of irrigation fluid may result in fluid overload, electrolyte imbalance and cardiovascular instability. Malhotra et al. emphasized the importance of monitoring the volume of absorbed irrigation fluid, irrigation time and rate of irrigation of fluid during PCNL[5].

Malhotra et al showed, significant amount of irrigation fluid absorption occurred during PCNL among 28% of study population[5]. A large amount of saline extravasation can lead to clinically significant respiratory distress or cardiac failure due to volume overload[6].

The few studies which have been conducted to assess haemodynamic, electrolyte and acid–base changes during PCNL have given varied opinions[7,8]. In one study, a tendency to hyponatremia, hypokalaemia and metabolic acidosis developed in addition to a rise in blood pressure[7], whereas another study found no significant changes in fluid–electrolyte balance and haemodynamics when 0.9% NaCl was used in PCNL[8].

In view of inconsistent results of the previous studies available in literature, the present study was conducted to evaluate the changes in cardiovascular status and serum electrolyte levels in patients undergoing percutaneous nephrolithotomy and to correlate these changes with irrigation time and volume of irrigation fluid absorbed during the procedure.

#### Method:

This was a prospective observational study carried out in the Department of Urology, National Institute of Kidney Diseases and Urology, Dhaka from January 2015 to June 2016. Sixty adult patients with renal stone admitted during

the study period and underwent PCNL, in the Department of Urology, National Institute of Kidney Diseases and Urology, Dhaka, were included in the study. Patients with Staghorn calculi, bleeding disorder and urine culture positive were excluded from this study. The heart rate, blood pressure were recorded before irrigation, at 15<sup>th</sup> min, 30<sup>th</sup> min, 60<sup>th</sup> min, 90<sup>th</sup> min, 120<sup>th</sup> min of irrigation and postoperative period. Serum electrolyte levels were estimated preoperatively for base line and then after beginning of irrigation, at 30<sup>th</sup> min, 60<sup>th</sup> min, 90<sup>th</sup> min, 120<sup>th</sup> min of irrigation and postoperative period. Time of beginning and end of irrigation were noted down to calculate duration of irrigation. The volume of total irrigation fluid used and total effluent fluid were measured and the difference between these two was taken as volume of fluid absorbed. The effluent fluid was collected in a bucket during the procedure. The fluid spilt on the floor was mopped with a wet mop and squeezed into the same bucket. The volume of the fluid thus collected was measured. In addition to this, 500 ml was added to this volume to account for soakage of drapes. Number of blood units transfused and complications if any were also recorded.

#### Result:

**Table I**

Demographic profile of the study population (n=60)

Age in year (Mean ±SD)	38.45±8.89 (20-50)
Sex	
Male	39 (65%)
Female	21 (35%)
Male:female	13:7
Stone size in cm (long axis)	3.07±0.70

In this study mean age of the patients was 38.45±8.89 years. Among 60 cases 65% patients were male and 35% patients were Female. Male to female ratio was 13:7. mean stone size (long axis) was 3.07±0.70 cm.

**Table II**

Changes of heart rate and blood pressure during PCNL

	Heart rate (beats/min)		Systolic BP (mmHg)		Systolic BP (mmHg)	
	Mean±SD	p-value	Mean±SD	p-value	Mean±SD	p-value
Baseline	73.3±7.7		118.1±15.6		71.4±7.7	
Before irrigation	80.1±6.2	<0.001	122.4±11.1	<0.001	76.6±8.5	<0.001
at 15 <sup>th</sup> min of irrigation	81.0±5.3	<0.001	123.6±10.1	<0.001	78.7±5.3	<0.001
at 30 <sup>th</sup> min of irrigation	83.3±5.2	0.070	126.6±10.2	<0.001	79.8±5.6	0.020
at 60 <sup>th</sup> min of irrigation	87.2±4.7	0.680	132.0±8.5	0.002	80.7±7.4	0.230
at 90 <sup>th</sup> min of irrigation	88.1±4.1	0.550	128.2±12.3	0.300	80.0±7.4	0.220
at 120 <sup>th</sup> min of irrigation	85.0±7.1	<0.001	115.0±21.2	0.420	75.0±7.1	0.260
Post operative	92.4±6.8	0.140	128.9±11.4	0.002	82.4±7.4	0.070

p value was reached by Paired t test.

There were statistically significant changes of heart rate occurred before starting of irrigation (80.1±6.2), at 15<sup>th</sup> min of irrigation (81.0±5.3) as well as at 120<sup>th</sup> min of irrigation (85.0±7.1) compared to base line values. But the changes of heart rate at 30<sup>th</sup> min, 60<sup>th</sup> min, 90<sup>th</sup> min of irrigation and post-operatively were statistically insignificant compared to base line values. Systolic blood pressure was increased gradually before irrigation, at 15<sup>th</sup> min, at 30<sup>th</sup> min, at 60<sup>th</sup> min of irrigation and postoperatively, which were statistically significant. But changes of systolic blood pressure at 90<sup>th</sup> min, 120<sup>th</sup> min of irrigation were statistically insignificant compared to base line values. Diastolic blood pressure was increased gradually before irrigation, at 15<sup>th</sup> min, at 30<sup>th</sup> min of irrigation which was statistically significant. But changes of diastolic blood pressure at 60<sup>th</sup> min, at 90<sup>th</sup> min, 120<sup>th</sup> min of irrigation and postoperatively were statistically insignificant compared to base line values.

Sodium ion concentration decreased at 30<sup>th</sup> min, at 60<sup>th</sup> min, at 90<sup>th</sup> min, at 120<sup>th</sup> min of irrigation and postoperatively compared to base line value which were statistically significant. Potassium ion concentration

decreased gradually at 30<sup>th</sup> min, at 60<sup>th</sup> min and postoperatively compared to base line value which were statistically significant. But there was no significant change of K<sup>+</sup> at 90<sup>th</sup> min and 120<sup>th</sup> min of irrigation. Chloride ion concentration increased gradually at 120<sup>th</sup> min and post operatively compared to base line value which was statistically significant. Serum Bicarbonate concentration decreased gradually from base line values but this change was not statistically significant.

There was no statistically significant changes of Na concentration upto 600 ml of irrigation fluid absorption during PCNL, where as statistically significant change towards hyponatremia (p value <0.05) occurred when absorbed volume of irrigant was 601 to 1000 ml. Statistically significant change (p value <0.05) towards hypokalemia occurred at 90<sup>th</sup> min and 120<sup>th</sup> min of operation when absorbed volume of irrigant was 801 to 1000 ml. Changes towards hyperchloremia occurred at 90<sup>th</sup> min, 120<sup>th</sup> min of operation and post operative period when absorbed volume of irrigant was 801ml to 1000 ml. There was no statistically significant changes (p value >0.05) of HCO<sub>3</sub><sup>-</sup> concentration in relation to amount of irrigation fluid absorption during PCNL.

**Table III**  
*Changes of Serum electrolytes concentration (Na<sup>+</sup>, K<sup>+</sup>, Cl<sup>-</sup> & HCO<sub>3</sub><sup>-</sup>) during PCNL.*

	Na <sup>+</sup> (mmol/L)		K <sup>+</sup> (mmol/L)		Cl <sup>-</sup> (mmol/L)		HCO <sub>3</sub> <sup>-</sup> (mmol/L)	
	Mean±SD	p-value	Mean±SD	p-value	Mean±SD	p-value	Mean±SD	p-value
Base line	142.7±3.4		3.81±0.34		98.9±3.2		25.08±2.8	
at 30 <sup>th</sup> min of irrigation	139.9±3.8	<0.001	3.68±0.31	<0.001	98.9±2.9	0.960	24.12±2.3	0.810
at 60 <sup>th</sup> min of irrigation	135.1±3.3	<0.001	3.57±0.21	<0.001	99.84±3.9	0.380	24.16±2.8	0.720
at 90 <sup>th</sup> min of irrigation	131.9±4.8	<0.001	3.62±0.21	0.080	101.6±4.1	0.170	23.22±2.7	0.440
at 120 <sup>th</sup> min of irrigation	127.5±3.5	0.002	3.75±0.35	0.120	107.0±1.2	0.002	23.09±2.6	0.360
Post- operative	136.1±5.2	<0.001	3.64±0.28	0.002	102.3±3.7	<0.001	23.54±2.5	0.480

P- value was reached by paired t test.

**Table IV**  
*Amount of irrigation fluid used and amount of absorbed irrigant during PCNL.*

Parameters	Mean ±SD	Range (Min-max)
Amount of irrigation fluid (ml) used during PCNL	17045.76 ± 3383.18	10000 - 24000
Amount of absorbed irrigant (ml) during PCNL	526.27 ± 215.02	200 - 1000

Table IV shows amount of irrigation fluid used during PCNL and amount of absorbed irrigation fluid. Mean amount used 17045( $\pm$ 3383) ml ranging from 10000 to 24000 ml. Mean absorbed amount was 526( $\pm$ 215) ml, ranging from 200 to 1000 ml.

### Discussion:

Percutaneous nephrolithotomy (PCNL) is a widely accepted method for removal of kidney stones with many advantages. However, very few studies have assessed changes in cardiovascular status and serum electrolyte levels during this procedure.

Mean age was 38.45 $\pm$ 8.89 years and male to female ratio was 13:7 in our study. Mean age of was 33.7 $\pm$ 12.3 years and male to female ratio was 13:7 in the study of Mohta et al.[2]. In study of Xu et al.[9], mean age was 45.3  $\pm$  13.5 years.

In this study mean stone size (long axis) was 3.07 $\pm$ 0.70 cm, which is nearly compatible with other studies done by Atici et al.[7]. and Xu et al.[9]. with mean stone size 3.23 $\pm$ 1.81 cm and 4.14  $\pm$  1.09 cm respectively.

There were statistically significant changes of heart rate before starting of irrigation 80.1 $\pm$ 6.2 beats/min, at 15<sup>th</sup> min of irrigation 81.0 $\pm$ 5.3 beats/min as well as at 120<sup>th</sup> min of irrigation 85.0 $\pm$ 7.1 beats/min comparing baseline. But the changes of heart rate at 30<sup>th</sup> min, 60<sup>th</sup> min, 90<sup>th</sup> min of irrigation and post-operatively were statistically insignificant. These findings were not compatible with studies done by Mohta et al.[2].; Koroglu et al.[8].; Atici et al.[7]. and Xu et al.[9]., they observed no significant change of mean heart rate during PCNL.

Systolic blood pressure increased gradually before irrigation, at 15<sup>th</sup> min, at 30<sup>th</sup> min, at 60<sup>th</sup> min of irrigation and postoperatively compared with base line values, which were statistically significant ( $p$  value  $<$ 0.05). But changes of systolic blood pressure at 90<sup>th</sup> min, 120<sup>th</sup> min of irrigation were statistically insignificant ( $p$  value  $>$ 0.05). Diastolic blood pressure before irrigation, different period of irrigation (at 15<sup>th</sup> min, 30<sup>th</sup> min, 60<sup>th</sup> min, 90<sup>th</sup> min, 120<sup>th</sup> min) and post operative period were compared with base line values. Diastolic blood pressure increased gradually before irrigation, at 15<sup>th</sup> min, at 30<sup>th</sup> min of irrigation which were statistically significant ( $p$  value  $<$ 0.05). But changes of diastolic blood pressure at 60<sup>th</sup> min, at 90<sup>th</sup> min, 120<sup>th</sup> min of irrigation and post-operatively were statistically insignificant ( $p$  value  $>$ 0.05). This result was not compatible with other studies done by Mohta et al[2];

Xu et al.[9].; Atici et al.[7]. and Kukreja et al.[10]. where they showed no statistically significant changes of heart rate and systolic blood pressure during PCNL. But mean diastolic blood pressure was observed to be higher during irrigation compared to post-operative levels this appeared to be due to some hormonal and autonomic changes caused by renal dilatation and irrigation[7]. which was compatible to this study. Lingeman et al.[11]. also reported increased diastolic blood pressures during PCNL.

In this study, Sodium ion concentration decreased gradually at 30<sup>th</sup> min, at 60<sup>th</sup> min, at 90<sup>th</sup> min, at 120<sup>th</sup> min of irrigation and post-operatively which were statistically significant ( $p$  value  $<$ 0.05). In comparison to base line K<sup>+</sup> values 3.81( $\pm$ 0.34) mmol/L mean potassium ion concentration decreased gradually at 30<sup>th</sup> min, at 60<sup>th</sup> min and postoperatively which were statistically significant ( $p$ -value  $<$ 0.05). But there was no significant change of K<sup>+</sup> at 90<sup>th</sup> min and 120<sup>th</sup> min of irrigation ( $p$ -value  $>$ 0.05). Atici et al.[7]. measured serum sodium levels and potassium levels preoperatively, at 15<sup>th</sup> min and at 60<sup>th</sup> min of irrigation during PCNL and found that serum sodium and potassium level significantly decreased at 60<sup>th</sup> min of irrigation compared to preoperative level. They attributed hyponatremia and hypokalemia to renal tubular dysfunction due to mechanical irritation of kidneys. There were decreased in potassium levels at 60<sup>th</sup>, 90<sup>th</sup>, 1<sup>st</sup> 120<sup>th</sup> min of irrigation in PCNL.[9]. These results were in concordance with our study. But other studies done by Mohta et al.[2]., Koroglu et al.[9]., Khoshrang et al[12] and Aghamir et al[13]. reported that serum sodium and potassium did not change significantly during PCNL. In this study base line mean chloride ion (Cl<sup>-</sup>) concentration was 98.9 $\pm$ 3.2 mmol/L, which increased gradually during operation but at 120 min of irrigation and post operatively it was 107 $\pm$ 1.2 mmol/L and 102.3 $\pm$ 3.7 mmol/L respectively. It was statistically significant ( $p$ -value  $<$ 0.05). This result was compatible with the study done by Xu et al.<sup>9</sup> where they explained chloride (Cl<sup>-</sup>), which was high to 154 mmol/L in normal saline, could be largely absorbed into blood circulation during irrigation. In this study there were no significant changes of serum bicarbonate concentration during the procedure as well as postoperatively, which was in concordance with the studies done by Mohta et al[2]. We also observed statistically significant changes of serum electrolytes level towards hyponatremia, hypokalemia and hyperchloremia when amount of absorbed irrigation

fluid  $\geq 600$  ml (i.e 600ml to 1000ml) during the procedure. In this study we observed that volume of irrigation fluid used depends on duration of operation and stone disintegration time. Absorption of irrigation fluid depends on total volume of irrigation fluid used, size of the stone and duration of operation as well as irrigation pressure and height of irrigation column. In our series total volume of irrigation fluid varied from 10000 ml to 24000 ml with mean volume 17045( $\pm 3383$ ) ml. Total duration of irrigation varied from 30 min to 120 min. Total absorbed irrigant varied from 200-1000 ml with mean volume absorbed 526.27( $\pm 215$ ) ml. In this study there was positive correlation volume of irrigation fluid used and absorption of irrigant which was statistically significant ( $p < 0.05$ ).

### Conclusion:

There occurs some changes in cardiovascular status and serum electrolyte levels during this procedure. A trend towards significant increase heart rate, increased blood pressure, hyponatremia, hypokalemia and hyperchloremia were observed during PCNL. These changes may be clinically significant specially in patients with compromised cardio-respiratory, renal functional status and paediatric patients.

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