Original research article

Biochemical and Haemodynamic Changes during Transurethral Resection of Prostate and Percutaneous Lithotripsy – A Observational Study

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Abstract

Background: Fluid absorption and associated electrolyte derangement is an inevitable complication of Transuretheral Resection of Prostate (TURP) and Percutaneous Lithotripsy (PCNL) irrigation during transurethral resection of prostrate and PCNL.

Aim: to analyse changes in serum electrolytes, Lactate Dehydrogenase (LDH) and acid base status, and to evaluate their role as early predictors of clinical and haemodynamic changes following continuous irrigation during transurethral resection of prostrate and PCNL.

Materials and Methods: The present observational study was conducted on 20 patients, who underwent TURP and 20 patients who underwent PCNL. A 1.5% glycine and 0.9% normal saline were used for irrigation during TURP and PCNL, respectively. The levels of serum sodium, potassium, free calcium ion, LDH and acid base status were monitored in all patients preoperatively, intraoperatively, at the end of surgery, 6 hours and 24 hours postoperatively. Intraoperative and postoperative haemodynamic parameters were also studied. Results were expressed in the form of mean and standard deviation. A p-value <0.05 considered significant.

Results: In TURP group, statistically significant changes were seen in serum sodium, potassium, LDH and free calcium ions. There was no change in acid base status of patients. In PCNL group, statistically significant changes were seen in serum sodium, LDH, free calcium ion and acid base status. It was observed that some of these changes persisted even 24 hours, postoperatively. However, despite the above changes, the haemodynamic parameters remained within normal limits.

Conclusion: Changes in serum sodium, serum potassium and free calcium ion during TURP and PCNL were consistent findings which implies fluid absorption. These changes persist upto 24 hours postoperatively. The monitoring of these parameters in postoperative period should be continued especially in patients suspected to develop or having TURP syndrome.

Keywords : Hyperkalemia, Hypocalcaemia, Hyponatremia, Prostectomy lithotripsy

Introduction

Endoscopic urologic procedures like TURP for Benign Prostatic Hyperplasia (BPH) and PCNL for renal stones require the use of continuous irrigation. Irrigating fluid absorbed into systemic circulation may lead to various physiological, biochemical, metabolic, haemodynamic and haematological changes[1]. In most patients, fluid absorption is mild to moderate resulting in fluid shifts and volume changes. However, in some patients it may manifest through acute change in intravascular volume and plasma solute concentrations in form of TURP syndrome [2].

Inspite of improved instruments, technique of surgery and utilisation of "non haemolytic" solutions, TURP syndrome has an incidence of 10%-15% of all procedures and a mortality of 0.2%-0.8%. It may occur within 15 minutes of start of resection to 24 hours postoperatively. Since, TURP syndrome lacks a stereotypical presentation it's diagnosis is difficult. However, early diagnosis and prompt institution of therapy is the key to successful management of TURP syndrome. Hahn RG and Drobin D et al., demonstrated that measurement of volume absorption by volumetric analysis and Nitrous Oxide (N_2O) absorption were unreliable clinical tools for measuring fluid absorption during TURP(3,4). Coppinger SW et al., demonstrated a method to measure fluid absorption using local cell transducers which is expensive and not easily available[5]. Few studies regarding physiological, biochemical, metabolic, haematological, hormonal and haemodynamic changes during TURP and PCNL have been done in past, but their role in predicting clinical manifestations and haemodynamic changes are not well defined[6,7,8,9]. Hence, there is a need to have a reliable and easily available methods to measure fluid absorption both during endourological procedures.

The present study was conducted to assess changes in serum electrolytes, LDH (as markers of haemolysis) and acid base status, to evaluate their role as early predictors of clinical and haemodynamic changes following continuous irrigation during TURP and PCNL.

Materials and Methods

This observational study was carried out in Netaji Subhash Medical College and Hospital, Bihta, Patna, Bihar between March 2021 to September 2021. Twenty patients presenting for TURP and 20 patients for PCNL were included in this prospective observational. Written informed consents were taken from every patient.

Inclusion criteria:

Patients under American Society of Anaesthesiologists (ASA) grade I to III who underwent TURP and PCNL were included in the study.

Exclusion criteria:

Patients having chronic renal failure, hepato-biliary dysfunction, biochemical derangements (sodium, potassium), local anaesthetic allergies, contraindications to subarachnoid block (in TURP patients), and ASA grade >III were excluded from the study.

Sample size calculation:

Sample size was calculated by taking effect size of 0.7 for sodium for preoperative and postoperative value [10]. By taking effect size as 0.7 and 80% power to declare that the mean of the paired differences is significantly different from zero, i.e., a two-sided p-value is less than 0.05, a random sample of 20 pairs was required.

Study Procedure

A detailed history, thorough physical examination and relevant laboratory investigations like haemoglobin, total leukocyte count, serum electrolytes, blood urea, serum creatinine, random blood sugar were conducted.

The TURP was done under subarachnoid block and 1.5% glycine was used as irrigant solution. PCNL was done under general anaesthesia and normal saline (0.9%) as irrigant solution. Lactated Ringer's solution was used as intravenous fluid in all patients. All patients were monitored using continuous electrocardiography, non invasive blood pressure, heart rate, pulse oxymetry, capnography and temperature. Changes of more than 20% from baseline in heart rate and blood pressure were taken as clinically significant.

All patients were carefully observed perioperatively for restlessness, dizziness, confusion, shortness of breath and bradycardia (under regional anaesthesia) and significant changes in cardiac rate or rhythm, blood pressure and oxygen saturation (under general anaesthesia) for early detection of possibility of TURP syndrome. The procedure was terminated when there were early manifestations of TURP syndrome.

Venous and arterial blood samples were drawn preoperatively (at the time of insertion of cannula), 30 minutes after starting irrigation, 30 minutes after the end of irrigation in PCNL or 30 minutes after completion of procedure (Foley's catheter insertion) in TURP, 6 hours and 24 hours postoperatively. Venous samples were analysed for sodium, potassium and LDH. Arterial samples were analysed for pH, bicarbonate, carbon dioxide and free calcium ion levels. Surgical parameters like duration of operation (for both PCNL and TURP), irrigant fluid (amount and duration of irrigation), height of irrigation fluid, and weight of resected prostate were noted.

Statistical Analysis

Recorded parameters were analysed using Graph PadIn Stat 3.10 version and Statistical Package for the Social Science (SPSS) 17 software. Repeated measure Analysis of Variance (ANOVA) was applied to obtain the differences within the group. Tukey's test was used for multiple comparison and p-value less than 0.05 was taken as significant. Results were expressed in the form of mean and standard deviation.

Results

The demographic profile and surgical parameters of the patients in the two groups are shown in [Table- 1,2], respectively. Patients undergoing TURP were older (mean age, 62.7 years) as compared to PCNL (mean age, 37.2 years). A statistically significant increase in serum LDH was observed in both the groups. In TURP, statistically significant increase in serum LDH was seen at intraoperative 30 minute, postoperative- 30 minute, 6 hours and 24 hours; while in PCNL, statistically significant increase in serum LDH was seen at postoperative- 30 minute, 6 hours and 24 hours from baseline [Table -3].

Table 1 : Demographic Profile

Parameters		**TURP**	**PCNL**
Age (yrs)	Range	50-75	20-50
	Mean±SD	62.7±6.62	37.2±9.59
Weight (kg)	Range	43-78	45-82
	Mean±SD	61.25±8.57	60.35±9.56
Height (cm)	Range	165-175	155-174
	Mean±SD	171.05±2.54	166.3±6.25

Table 2 : Surgical Parameters in TURP and PCNL groups

Parameters	TURP	PCNL
Anaesthetic time (min)	72.75±14.46(40-100)	134.75±27.93(90-185)
Operative time (min)	59.5±14.46(20-85)	106.5±22.83(65-145)
TURP time (min)	48.5±13.68(15-70)	-
Amount of irrigation fluid (L)	14.1±4.4(3-22)	8.5±2.27(6-14)
Time of irrigation (min)	49±13.53(15-70)	54.25±11.95(30-80)
Height of irrigation (cm)	58.9±4.29(50-65)	60.2±2.37(55-65)
Weight (gm) of prostrate	20.15±6.61	-
IVF (L)	1.54±0.43(1-3)	2.09±0.45(2-3)
Irrigation fluid	1.5%Glycine	Normal saline

Table 3 : Serum LDH (U/L) levels at different time intervals in both groups

Group		Preop	Intraop	Postop 30 (min.)	Postop 6 (hr)	Postop 24 (hr)	p-value
TURP	Range	180-320	190-343	182-392	188-380	186-332	0.001
	Mean±SD	220.50±38-96	244.95±43.60	264.85±56.39	262.45±51.75	247.60±39.43	
	Change	-	24	44	41	27	
PCNL	Range	180-298	130-305	190-340	184-365	180-321	0.001
	Mean±SD	224.55±32.29	232.20±38.82	274.80±45.88	282.50±53.15	249.70±3961	
	Change	-	7	50	58	17	

The mean levels of preoperative, intraoperative and postoperative sodium in patients undergoing TURP and PCNL are given in [Table -4]. There was statistically significant reduction in the mean sodium levels in patients undergoing TURP with 1.5% glycine and PCNL with 0.9% normal saline as irrigating fluid [Table -4].

Table 4 : Serum Sodium (mEq/L) levels at different time intervals in both groups

Group		Preop	Intraop	Postop 30 (min.)	Postop 6 (hr)	Postop 24 (hr)	p-value
TURP	Range	133-146	129-145	126-145	124-145	130-145	0.001
	Mean±SD	139.15±3.57	136.95±4.04	134.30±5.09	133.90±5.59	135.90±3.93	
	Change	-	(-)2.2	(-)4.85	(-)5.25	(-)3.25	
PCNL	Range	136-144.1	133-143.2	133-141	132-142	136-142	0.001
	Mean±SD	140.26±2.27	139.13±2.82	137.00±2.64	137.15±2.83	138.84±1.96	
	Change	-	(-)1.13	(-)3.36	(-)3.11	(-)1.42	

There was statistically significant increase in the mean levels of potassium when 1.5% glycine was used as irrigating fluid during TURP. The potassium levels were not significantly altered when normal saline was used as irrigating fluid during PCNL [Table -5]. There was decrease in free calcium level intraoperatively and postoperatively, which was below normal level and was statistically significant in both groups[Table -6].

Table 5 : Serum Potassium (mEq/L) levels at different time intervals in both groups

Group		Preop	Intraop	Postop 30 (min.)	Postop 6 (hr)	Postop 24 (hr)	p-value
TURP	Range	3.7-5.4	3.5-5.1	3.9-5.5	3.2-5.5	3.6-4.9	0.002
	Mean±SD	4.32±0.46	4.34±0.45	4.62±0.46	4.37±0.51	4.27±0.38	
	Change	-	0.02	0.3	0.045	-0.055	
PCNL	Range	3.9-5.2	3.8-5.2	3.7-5.5	3.7-5.7	4.0-5.6	0.255 (NS)
	Mean±SD	4.40±0.42	4.48-0.54	4.67±0.42	4.57±0.39	4.40±0.35	
	Change	-	0.08	0.27	0.165	0	

Table 6 : Calcium (mmol/L) levels at different time intervals in both groups

Group		Preop	Intraop	Postop 30 (min.)	Postop 6 (hr)	Postop 24 (hr)	p-value
TURP	Range	1.08-1.30	1.01-1.24	0.95-1.18	1.01-1.24	1.05-1.25	0.001
	Mean±SD	1.173±0.0561	1.106±0.0713	1.048±0.0813	1.106-0.0585	1.131±0.0528	
	Change	-	(-)0.067	(-)0.125	(-)0.067	(-)0.042	
PCNL	Range	1.10-1.29	1.06-1.30	1.01-1.24	0.98-1.20	1.05-1.31	0.001
	Mean±SD	1.195±0.0580	1.173±0.0755	1.092±0.0718	1.095±0.0545	1.146±0.0643	
	Change	-	(-)0.021	(-)0.102	(-)0.099	(-)0.049	

During TURP, acid base status was found to be within normal limits perioperatively. In PCNL group, slight decrease in pH associated with decrease in bicarbonate was observed perioperatively [Table -7,8]. This change was statistically significant 30 minutes postoperatively.

Table 7 : Arterial Blood pH at different time intervals in both groups

Group		Preop	Intraop	Postop 30 (min.)	Postop 6 (hr)	Postop 24 (hr)	p-value
TURP	Range	7.342-7.484	7.392-7.472	7.320-7.470	7.345-7.512	7.342-7.595	0.333(NS)
	Mean±SD	7.399±0.041	7.384±0.041	7.373±0.036	7.394±0.044	7.408±0.060	
	Change	-	(-)0.0157	(-)0.0269	(-)0.0059	0.0082	
PCNL	Range	7.356-7.451	7.297-7.444	7.290-7.410	7.291-7.451	7.351-7.443	0.001
	Mean±SD	7.394±0.028	7.381±0.041	7.349±0.031	7.384-0.046	7.399±0.032	
	Change	-	(-)0.0137	(-)0.045	(-)0.0108	0.0041	

Table 8 : ABG-HCO_3- (mmol/L) at different time intervals in both groups

Group		Preop	Intraop	Postop 30 (min.)	Postop 6 (hr)	Postop 24 (hr)	p-value
TURP	Range	20.3-26.2	20.3-25.2	19.1-24.1	18.0-26.0	20.0-29.0	0.001
	Mean±SD	23.66±1.466	22.80±1.494	21.83±1.302	22.87±2.018	24.17-1.875	
	Change	-	(-)0.855	(-)1.83	(-)0.79	0.51	
PCNL	Range	22.2±26.4	22.1-24.9	18.1-25.2	21.0-25.0	14.0-27.0	0.001
	Mean±SD	24.02±1.219	23.10±0.848	21.57±1.603	23.65±1.082	24.00±2.646	
	Change	-	(-)0.92	(-)2.45	(-)0.375	(-)0.025	

It was observed that some of these changes persisted even 24 hours postoperatively in both groups. However, despite the above changes, the haemodynamic parameters like heart rate, blood pressure, ECG and oxygen saturation remained within normal limits [Table -9,10].

Table 9 : Haemodynamic parameters at different time intervals in TURP.

Time Interval	HR	SBP	DBP
0 min	78.67±13.58	132.83±9.57	81.78±7.30
5 min	77.89±13.04	120.39±15.84	76.06±9.03
10 min	75.56±12.44	119.33±13.621	73.00±9.31
15 min	74.94±12.51	117.61±13.267	73.83±9.06
20 min	74.28±11.61	117.89±13.55	71.83±7.93
30 min	71.50±11.92	121.17±9.74	74.06±6.36
45 min	70.33±10.39	123.89±10.58	73.94±7.16
60 min	68.89±10.52	126.33±11.60	76.17±7.37
40 min	71.56 ±9.55	125.83±9.94	77.94±7.05
PO 0 min	72.83±10.95	126.17±11.58	78.50±7.13
PO 15 min	70.78±11.55	126.44±12.38	77.94±6.83
PO 30 min	71.56±10.17	125.39±10.73	78.72±7.89
PO 60 min	<0.001	<0.001	<0.001
p-value	78.67±13.58	132.83±9.57	81.78±7.30

Table 10 : Haemodynamic parameters at different time intervals in PCNL

Time Interval	HR	SBP	DBP
0 min	86±11.26	86.00±8.62	124.8±9.59
5 min	85.36±10.26	113.0±14.37	72.79±10.92
10 min	83.07±12.16	109.71±14.67	71.5±10.23
20 min	80.29±11.73	110.0±12.77	73.3±9.57
30 min	79.14±10.20	108.6±10.06	71.2±9.48
45 min	78.86±14.58	111.4±8.26	71.5±9.81
60 min	77.36±12.60	117.1±9.59	74.36±9.30
75 min	77.21±10.40	117.0±9.80	75.2±8.31
90 min	78.71±11.16	116.4±10.69	75.2±9.31
105 min	80.21±12.26	115.1±7.12	76.4±7.33
120 min	81.00±13.94	118.4±9.29	74.9±6.90
PO 0 min	84.57±10.39	123.6±7.14	79.1±8.42
PO 15 min	84.00±9.30	122.9±7.37	78.1±7.17
PO 30 min	83.57±10.04	123.6±6.23	77.7±7.25
PO 60 min	83.93±8.09	124.5±6.58	76.7±5.92
p-value	<0.001	<0.001	<0.001

In TURP group, one patient presented with restlessness and pain in abdomen. Patient's blood pressure, heart rate, oxygen saturation, acid base status was comparable to baseline throughout perioperatively. But reduction in serum sodium (133-124 mEq/L) and free calcium ion (1.19-0.95 mmol/L) was noted. An increase in serum potassium (4-4.8 mEq/L) and serum LDH (206-380 U/L) was also noted. Eighteen litres of 1.5% glycine containing irrigation fluid was used over 45 minutes and 25 grams of prostate was resected.

Another patient in TURP group presented only with restlessness. Similar changes in serum sodium (136-125 mEq/L), serum potassium (3.7-4.4 mEq/L), serum LDH (180-270 U/L) and free calcium ion (1.12-0.95 mmol/L) were noted. Eighteen litres of 1.5% glycine containing irrigation fluid was used over 65 minutes and 30 grams of prostate was resected. This patient had clinically significant blood loss.

One patient undergoing PCNL presented with significant changes in blood pressure (systolic: 120-90 mmHg, diastolic: 74–51 mmHg, HR: 86–70 beats/min). This change was observed after excluding effects of anaesthetic drugs. Ten litres of normal saline was used over 60 minutes for irrigation. Decrease in free calcium ion (1.19-1.06 mmol/L) and increase in serum potassium (4.4-4.8 mEq/L) was noted. Minimal changes in serum sodium (142-139 meq/L) and LDH (180-220 mEq/L) were also noted. Metabolic acidosis was also seen in this patient (pH 7.419-7.293 and associated decrease in bicarbonate). A decrease in temperature (0.90°C) was noted. Blood pressure returned to baseline over next 24 hours without any critical event.

Discussion

In the present study, decrease in serum sodium from baseline was seen in patients that underwent TURP below normal limits but it was not clinically significant. The maximum decrease in sodium values was noted at 6 hours postoperatively and values did not return to baseline even 24 hours postoperatively. Ghanem AN and Ward JP; and Aziz W and Ather MH who used 1.5% glycine as irrigation fluid, reported reduction in serum sodium value similar to our findings [11,12]. Georgiadou T et al., used mannitol-sorbitol and sterilised water and noted decrease in serum sodium [13]. Similarly, decrease in serum sodium from baseline was seen in PCNL, but value remained within normal limits. The maximum decrease in sodium values during PCNL was noted at 30 minutes postoperatively and values did not return to baseline even 24 hours postoperatively. Feizzadeh B et al., using distilled water as irrigation fluid noted reduction in serum sodium level during PCNL while Mohta M et al., using normal saline as irrigation fluid did not observe any significant changes in serum sodium during PCNL [14,15].

Haemodilution as well as urinary loss of sodium due to forced diuresis leads to decrease in serum sodium level. Reduction in sodium concentration depends upon amount and nature of irrigation fluid and physiological adaptive response of the patients. Absorption of non electrolyte containing solutions like glycine usually leads to more hyponatremia than electrolyte containing solution.

In this study, increase in serum potassium from baseline was observed in both groups. Though this increase was clinically non significant in both groups, it was statistically significant in TURP group. Changes in serum potassium have been reported in the past by few authors only, but the findings were inconsistent. Moorthy HK and Philip S [6] found increase in serum potassium when 1.5% glycine was used as irrigation fluid in TURP but no change was observed by Mohta M, when normal saline was used as irrigation fluid during PCNL [15]. Atici S et al.,using distilled water reported decrease in serum potassium during PCNL, while Hahn RG et al., found elevation of serum potassium intraoperatively [9,16].The exact cause of serum potassium changes is not clear. Initial decrease in serum potassium may be due to haemodilution. But when large amount of irrigation fluid is absorbed, increase in serum potassium is noticed which may be explained by physiological cell volume “regulatory volume decrease” mechanism [17] or potassium release due to red blood cell haemolysis.

Increased LDH levels signify haemolysis due to fluid absorption. In TURP patients, statistically significant increase in serum LDH was observed but values remained within normal range. Chen SS et al., using distilled water and Beal JL et al., using distilled water and 1.5% glycine as irrigation fluid noticed haemolysis during TURP [7,18]. Beal JL et al., also noted that though haemolysis was greater in distilled water group, but danger of haemolysis also occurs with other hypotonic solutions, including 1.5% glycine . In PCNL patients, statistically significant increase in serum LDH was observed but values remained within normal range. Aghamir SM et al., used sterile water and isotonic water as irrigation fluid and did not notice haemolysis during PCNL [19] while Purkait B et al., found normal saline causes less haemolysis hyponatermia and hypokalemia in renal failure patients than distilled water [20]. Extent of haemolysis depends on nature and amount of irrigation fluid absorbed, which inturn, depend on many surgical factors. Our findings are similar to those of Saxena D et al., who demonstrated a significant fall in serum sodium and haemolysis in patients undergoing PCNL using normal saline which was corelated significantly to volume of irrigation fluid used and the duration of surgery [21].

So there is possibility of haemolysis during TURP as well as PCNL particularly when TURP time, irrigation time and irrigation fluid amount tend to be higher. If haemolysis is severe enough or if patient's renal functions are impaired, renal damage may not be reversible and could lead to acute renal failure. Haemolysis along with coagulopathy has been demonstrated to be present in patients undergoing TURP by Shin HJ et al using thromboelastography [22]. Hence, markers for haemolysis must be monitored when organ functions like renal function are compromised or surgical factors exceed accepted limits.

Decrease in serum osmolality and free calcium ion is marker of haemodilution due to fluid absorption. Hahn RG reported that changes in serum sodium and free calcium ion concentration occurred to the same extent during irrigation by glycine [23]. In our study, biochemically as well as statistically significant decrease in free calcium ion was noticed in all patients. Exact mechanism of free calcium ion changes and the clinical importance of hypocalcaemia during these endourological procedures have not been studied extensively in the past but could be associated with coagulation abnormalities and increase INR. Usually hypocalcaemia remains biochemically and clinically non significant, but dilutional hypocalcaemia should be expected to co-exist with hyponatremia in patients who develop TURP syndrome and in patients with persistent hypotension [24] not responding to vasopressor or inotropes during these procedures.

In the present study, no change in acid base status was seen during TURP whereas slight metabolic acidosis was seen during PCNL. This change was physiologically non significant. Mohta M et al., using normal saline as irrigation fluid had similar findings during PCNL. Hahn RG and Scheingraber S et al., concluded that larger irrigant fluid absorption might lead to clinically relevant metabolic acidosis[25,26].
In most patients, fluid absorption is mild to moderate leading to minor biochemical, metabolic, haematological and haemodynamic changes without clinical symptoms and signs. But patient may present with signs and symptoms if fluid absorption is significant or in elderly patients or patients with compromised cardiovascular, respiratory and renal functions. Two patients (10%) in TURP group and one patient (5%) in PCNL group presented with early feature of TURP syndrome. These two patients of TURP group were given injection frusemide. These patients were observed closely and managed conservatively.

Conclusion

The results of the study indicated that use of irrigation fluids in TURP and PCNL lead to haemodilution, decrease in serum sodium and free calcium ion levels and increase in serum potassium concentration and increase in LDH levels signifying haemolysis due to irrigation fluid absorption. Hence, authors recommend monitoring of biochemical, metabolic, haematological and haemodynamic parameters mainly serum sodium and free calcium ion for predicting changes due to fluid absorption. Further studies with a larger number of patients are required to validate our findings.

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