ENDOUROLOGY
Original Article

Is normal saline the best irrigation fluid to be used during percutaneous nephrolithotomy in renal failure patient? A prospective randomized controlled trial

Böbrek yetmezliği olan hastada perkütan nefrolitotomi için en iyi irigasyon sıvısı normal salin mi? Bir prospektif randomize kontrollü çalışma

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ABSTRACT

Objective: Endoscopic procedures like percutaneous nephrolithotomy (PCNL) needs continuous irrigation for better vision and to wash away stone fragments and blood clots. Systemic absorption of irrigation fluids may lead to fluid overload and electrolyte disequilibrium. Renal failure patients are more prone to these electrolyte disturbances. We have evaluated the outcomes of normal saline as irrigation solution to be used in renal failure patient in comparison to distilled water.

Methods: Seventy-six patients with renal calculi were enrolled in this study between September, 2014, and December, 2015. All patients have compromised renal functions (creatinine >1.6 mg/dL). All patients were randomized into two groups as Group A (normal saline irrigation), and Group B (distilled water irrigation). Serum electrolytes, hemogram were measured pre- and post operatively.

Results: The mean duration of irrigation was 53.34 min in Group A and 52.80 min in Group B (p=0.12). Serum sodium, potassium and hematocrit levels were changed significantly after the PCNL in Group B (p=0.03, 0.04 and 0.02, respectively). The most significant drop was observed in sodium level (139.21±3.65 vs. 136.20±4.10 mEq/L) in Group B. Though Hemoglobin drop was similar in both groups, there was a significant drop in hematocrit value in Group B (p=0.02).

Conclusion: Distilled water is associated with hyponatremia and drop in hematocrit level in renal failure patients. Serum potassium level may be significantly altered during distilled water irrigation. Normal saline is safe for PNCL in renal failure patient and its use should be recommended for this purpose.

Keywords: Distilled water; irrigation; normal saline; PCNL; renal failure; renal stone.

ÖZ

Amaç: Perkütan nefrolitotomi (PNL) gibi endoskopik işlemlerde daha iyi bir görüş sağlamak, taş parçacıkları ve kan pıhtılarını yıkamak için sürekli irigasyon sıvılarını kullanmaya gerek vardır.İrigasyon sıvılarının sistemik emilimi aşırı sıvı yüklemeleri ve elektrolit dengesizlilerine yol açabilmektedir. Böbrek yetmezliği hastaları bu elektrolit bozukluklarına daha fazla yatkındır. Böbrek yetmezliği olan hastalarda distile su ile karşılaştırmalı olarak irigasyon çözeltisi olarak normal salin kullanmanın sonuçlarını değerlendirdik.

Gereç ve yöntemler: Böbrek taşı olan 76 hasta Eylül 2014 ile Aralık 2015 tarihleri arasında bu çalışmaya alınmıştır. Hastaların hepsinde böbrek fonksiyonları risk altındaydı (kreatinin >1,6 mg/dL). Hastaların hepsi iki gruba randomize edilmişti: Grup A (normal salin irigasyonu), B (distile su irigasyonu). Ameliyat öncesi ve sonrası serum elektrolitleri ölçülmüş ve hemogramlar değerlendirilmiştir.

Bulgular: A ve B gruplarında ortalama irigasyon süresi sırasıyla 53,34 ve 52,80 dakika idi. Serum sodyum, potasyum ve hematokrit düzeyleri B grubunda PNL'den sonra anlamlı derecede değişmişti (sırasıyla p=0,03, 0,04 ve 0,02). En önemli düşüş B Grubunda ve sodyum düzeyinde gözlenmiştir (139,21±3,65'e karşın 136,20±4,10 mEq/L). Hemoglobin her iki grupta da benzer olmasına rağmen, B grubunda hematokrit düzeyinde anlamlı bir düşüş mevcuttu (p=0,02).

Sonuç: Distile su böbrek yetmezliği olan hastalarda hiponatremiye ve hematokrit düzeyinde düşüşe neden olmaktadır. Distile suyla irigasyonda serum potasyum düzeyi anlamlı derecede değişebilmektedir. Böbrek yetmezlikli hastalarda yapılan PNL'de normal salin güvenlidir ve bu amaçla kullanımı önerilmelidir.

Anahtar kelimeler: Distile su; irigasyon; normal salin; PNL; böbrek yetmezliği; böbrek taşı.

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Introduction

Percutaneous nephrolithotomy (PCNL) is a safe and effective treatment modality for renal stone in renal failure patients.[1-2] Endoscopic procedure like PCNL needs continuous irrigation of fluids for better vision and to wash away stone fragments and blood clots formed.[3] Systemic absorption of irrigation fluids sometimes leads to fluid overload and electrolyte imbalances. There are a lot of debates regarding the choice of irrigation fluids during PCNL. Some studies performed in patients with normal renal function have compared sterile water versus normal saline for irrigation without any difference between them.[4] Type and amount of irrigation fluids are also important with this regard.

Normal saline and distilled water are the most commonly used irrigation fluids for PCNL. On the other hand, patients with compromised renal functions are already prone to fluid overload and electrolyte disturbances. Any study investigating optimal type of irrigation fluid to be used in PCNL procedures in this group of compromised renal function patients has not been performed up to now. We have evaluated the outcomes of normal saline as irrigation solution to be used in renal failure patient in comparison to distilled water.

Material and methods

Experienced urologists have performed all PCNL procedures. Informed consent was obtained from all participants. The study was approved by our institutional ethical committee. Renal stones were diagnosed with plain X ray, ultrasound and non-contrast computed tomography (NCCT) of kidney, ureter and bladder. Urine cultures were obtained for all patients and treated accordingly if needed. Patients with bilateral renal calculi were operated 2-3 weeks apart. Stone size was calculated by multiplying two largest diameters of the stones measured on available radiograms. Eighty (80) adult patients (>18 years) with renal calculi were enrolled in this study between September, 2014 and December, 2015 and 76 patients were randomized into two groups after exclusion of ineligible patients. All patients had compromised renal functions (serum creatinine >1.6 mg/dL). Small or pick up stones were excluded from the study. Stone size >2 cm was taken for inclusion criteria. Patients were randomized into two groups as Group A (normal saline irrigation, n=38) and Group B (distilled water irrigation, n=38).

Surgical technique

All patients underwent fluoroscopy-guided PCNL under spinal anesthesia. With the patient in the lithotomy position, ureteric catheter was inserted via transurethral route and fixed to the urethral catheter. Patients were turned into prone position and percutaneous access was made after obtaining air and contrast pyelograms. A flexible guidewire was inserted and tract was dilated over guidewire up to 24-28 Fr, and rigid nephroscope (24 Fr) was used for all patients. Stone fragmentation was performed using pneumatic lithotripter (EMS Swiss Lithoclast, Electro Medical Systems, Nyon, Switzerland). Larger fragments were retrieved with stone forceps. In Group A, normal saline and in Group B, distilled water were used for irrigation from a height of 70 cm above the head of the patient. Extra percutaneous access was performed if needed. Stone clearance was confirmed by fluoroscopy and nephroscopy after the procedure. After complete stone clearance, we antegradely inserted double DJ stent (5 Fr) and nephrostomy tube (22-20). Ureteral catheter was kept in situ for patients who needed second- look PCNL. Intravenous normal saline (0.9% NS) and dextrose in normal saline (DNS) irrigations were used at a ratio of 1:1 for all patients intra- and post- operatively. All patients received the same anaesthetic drugs. Patients started to receive oral intake 8-12 hrs after operation. In the next morning, intravenous fluid was stopped. A second- stage procedure was done after 2-3 days if needed.

Laboratory evaluation

Peroperatively, blood pressure, pulse rate, mental status, and any complication developed 1 and 24 hours after the procedure were evaluated. Laboratory parametres as complete blood count, serum creatinine, serum sodium, potassium, calcium were evaluated both preoperatively and at 1, and 24. hours postoperatively.

Statistical analysis

All data were analyzed using the Statistical Package for the Social Sciences version 16, (SPSS Inc; Chicago, IL, USA). Comparison between the two groups was done with *chi*-square/ Fisher's exact test. Before and after the procedures comparisons were performed using one way analysis of variance (ANOVA). P value of <0.5 was considered as the level of statistical significant.

Results

Baseline characteristics of the participants of the two groups were similar (Table 1). Mean age of the study population was 37.34 years in Group A and 36.88 years in Group B. Median duration of irrigation was 53.34 mins in Group A and 52.80 mins in Group B. Postoperatively, serum creatine was higher in 5 patients (2 in Group A and 3 in Group B) in comparison to preoperative values. The changes in electrolyte values are depicted in Table 2.

Serum sodium levels during pre- and postoperative periods had been subjected to most notable changes. In 6 patients in the distilled water irrigation group (Group B) serum sodium levels were below 130 mEq/dL. Variations in serum potassium levels at postoperative 1, and 24. hours were not significant in both groups.

Table 1. Patients' baseline characteristics

Variables	Normal saline (n=38)	Distilled water (38)	p
Age			
Mean±SD (yrs)	37.34±11.20	36.88±12.30	0.68
Range (yrs)	18-64	18-63	
Male/Female	26/12	20/18	0.34
BMI (kg/m^2)			
Mean±SD (kg/m^2)	19.56±2.33	20.11±2.45	0.44
Range (kg/m^2)	16.50-28.60	16.76-29.20	
Stone size (mm)			
Mean±SD (mm)	31.45±11.23	32.10.56±11.67	0.23
Range (mm)	26.27-56.50	27.50-54.80	
Previous stone surgery			
Cystolithotomy	2	1	
Duration of irrigation			
Mean±SD (min)	53.34±17.56	52.80±16.70	0.12
Range (min)	45-134	40-132	
Irrigation volume (Liter)			
Mean±SD (Liter)	8.15±4.25	8.50±4.12	0.72
Range (Liter)	6.78-13.40	7.11-12.60	
Comorbidities			
Diabetes mellitus	2	1	0.55
Hypertension	3	4	
Heart Disease	1	0	

SD: standard deviation; BMI: body mass index;

Table 2. Serum biochemical parameters before and after percutaneous nephrolithotomy

Variables (Mean±SD)	Before operation	Postop.1 hour	Postop. 24 hours	p
Saline Irrigation				
Sodium (mEq/L)	139.40± 3.50	140.12± 2.24	139.22± 3.42	0.23
Potassium (mEq/L)	4.22± 0.51	4.23± 0.25	4.31± 0.45	0.45
Calcium (Total) (mg/dL)	10.24± 1.54	10.36± 1.35	10.11± 1.22	0.55
Creatinine (mg/dL)	2.14± 0.53	2.25± 0.24	2.04± 0.31	0.16
Hemoglobin (g/dL)	12.82± 1.43	11.22± 1.32	11.24± 1.43	0.12
Hematocrit (%)	36.22± 2.8	34.12± 2.9	35.12± 2.78	0.22
Distilled water Irrigation				
Sodium (mEq/L)	139.21± 3.65	136.20± 4.10	136.71± 3.92	0.03
Potassium (mEq/L)	3.98±0.35	3.65±0.35	3.67±0.56	0.04
Calcium (Total) (mg/dL)	10.12± 1.62	10.34± 1.43	10.22± 1.60	0.23
Creatinine (mg/dL)	2.31± 0.44	2.27± 1.33	2.14 ± 1.20	0.34
Hemoglobin (g/dL)	13.04± 1.34	11.51± 1.56	11.62± 1.48	0.15
Hematocrit (%)	36.34± 2.90	31.55± 3.26	32.17± 3.61	0.02

SD: standard deviation

There was no significant change of serum total calcium and hemoglobin levels between the two groups before and after the procedure. Hematocrit values significantly decreased in 8 patients in Group B. The postoperative first hour sample had significantly lower hematocrit level in comparison with preoperative hematocrit value (31.55±3.26 vs. 36.34±2.90, p<0.02). The mean changes in serum sodium and hematocrit values were statistically significant in Group B (p=0.03 vs. 0.04) (Table 3).

The stone- free rate was 95% after the auxiliary procedure in both Groups (94.5% in Group A vs. 95% in Group B). Overall complications were noted in 22 (28.02%) patients. Fourteen patients (17.94%) required blood transfusions, and 3 patients

Table 3. Mean changes in serum biochemical parameters-before and after PCNL (normal saline vs. distilled water)

Variables Mean change (before-after)	Normal saline (n=38)	Distilled water (n=38)	p
Sodium (mEq/L)	-0.41±3.56	-1.80±3.66	0.03
Potassium (mEq/L)	-0.25±0.56	-0.22±0.45	0.16
Calcium (mg/dL)	-0.34±0.21	-0.16±0.44	0.13
Hemoglobin (g/dL)	-0.67±0.88	-0.72±0.84	0.23
Hematocrit (%)	-0.21±0.43	-0.18±0.34	0.04
Serum creatinine (mg/dL)	-0.12±0.20	-0.13±0.23	0.24

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developed postoperative fever and 2 patients developed hematuria which were managed with hydration, nephrostomy tube clamping and pressure dressing. Three patients in postoperative period required hemodialysis because of fluid overload, electrolyte imbalance and raised serum creatinine levels. Both patients were in Group B. Pelvic perforations did not occur in both groups.

Discussion

Endoscopic procedure has a potential risk of irrigation fluid absorption into the systemic circulation. Transurethral resection syndrome (TUR syndrome) is classically described as a complication of systemic absorption of irrigation fluids, more commonly defined for transurethral resection of prostate (TURP). This can be prevented or decreased using normal saline. In the same manner, irrigation fluids used during PCNL may enter into systemic circulation and lead to hemodilution and fluid overload. Absorption of fluids depends on type, duration and amount of irrigation fluids used.

Though there are some studies showing effectiveness of both distilled water and normal saline used for irrigation, the effects of irrigation in renal failure patients have not been studied yet. To the best of author's knowledge, this is the first study comparing effects of irrigation fluids in renal failure patients in a randomized fashion. Aghamir et al.[4] reported that sterile water may be a safe alternative to normal saline for PCNL but they have included only the patients with normal renal function (ie. normal serum creatinine)in their study.

Renal failure patients are prone to hemodynamic and electrolyte imbalance during perioperative period. Electrolyte disturbances after PCNL have been also reported in the literature.[3,5]Glycine has been associated with hyponatremia during PCNL procedure and for the same reason normal saline has been recommended by some authors.[6,7]

The amount of absorbed fluid and level of electrolyte imbalance in PCNL have been also studied. One study showed that approximately 696.7 mL of irrigation fluid may get absorbed after PCNL.[8] Again rate of absorption depends on the duration of the procedure in uncomplicated cases. In patients with renal failure, due to abnormal vascular leakiness, hematologic abnormality and tissue edema, increased fluid absorption into the systemic circulation is a higher probability.

The primary end point of our study was electrolyte disturbances after PCNL in renal failure patients. In our study, we have noted statistically significant hyponatremia in 5 patients in Group B. The drop in serum electrolyte happened most commonly during the immediate (≤ 1 hour) postoperative period.

Fourteen patients required blood transfusion because of excessive bleeding in our study.

Bleeding related to PCNL is the main cause for drop in hemoglobin and most common reason for blood transfusion although hemodilution also leads to drop in hemoglobin level. The etiology can be identified by measuring hematocrit value. In the setting of bleeding, the hemoglobin will decrease and hematocrit will increase due to hemoconcentration. In the setting of PCNL fluid absorption increases. In our study, 1st hour sample had lower hematocrit value than preoperative level in both groups. The 1st hour sample in Group B had significantly lower hematocrit value in comparison with Group A. This may be due to higher fluid absorption during distilled water irrigation which leads to fluid overload and hemodilution. The amount of bleeding and blood transfusion requirement were comparable in both groups.

The detrimental effects of fluid absorption include absorption of irrigation fluid into venous system and more commonly extravasation after rupture of the collecting system. Symptoms of fluid overload depend on volume of absorption and hemodynamic status.[9] It may lead to neurological or hemodynamic instability. Vascular problems may include bradycardia, hypertension, hypotension and decreased urine output. Neurological abnormalities may include nausea, vomiting, confusion, poor vision, and headache. The clinical status of patients during (when in spinal anaesthesia) and after operation must be checked periodically for early diagnosis of electrolyte imbalance and fluid overload. Though there were changes in electrolyte levels during the post operative period, no patients were over symptomatic in our study.

In some patients, serum creatinine levels was raised during postoperative period. Sepsis and surgical stress may contribute to the rise in creatinine levels. Usually urologists are less experienced in postoperative management of renal failure patients. The role of nephrologists in the post operative assessment is equally important.

The osmolarity of distilled water is less than the physiologic solution (normal saline). Low osmolar solution easily enters into cells with consequent cellular oedema and intravascular hemodilution. Thus distilled water has higher chance of systemic absorption than normal saline.

In conclusion, distilled water is associated with hyponatremia and drop in hematocrit level in renal failure patients. Serum potassium levels undergo changes during irrigation of distilled water rather than normal saline. Normal saline is safe for PNCL in renal failure patients and should be recommended for this purpose. Multicentre randomized controlled trials with larger sample size are needed for better understanding of this issue.

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