Distilled Water as an Irrigation Fluid in Percutaneous Nephrolithotomy

Behzad Feizzadeh, Hassan Doosti, Mohammad Movarrekh

Introduction: The aim of this study was to evaluate the effect of distilled water as an irrigation fluid for percutaneous nephrolithotomy (PCNL) on the serum concentrations of sodium.

Materials and Methods: A total of 30 patients with kidney calculi underwent tubeless PCNL using distilled water as the irrigation fluid. During the procedure, intravenous Ringer lactate solution was used if necessary. The patients received infusion of two-thirds dextrose 5% and one-third normal saline solution postoperatively. Four blood samples were taken to determine serum sodium and potassium levels at admission, just before the operation, after the operation, and on the first postoperative day.

Results: The mean distilled water used was 8.1 L (range, 5.6 L to 11.2 L). Target and complete stone-free rates were 100% and 80%, respectively. None of the patients developed hyponatremia. The mean serum levels of sodium (meq/L) were 141.5 (range, 140 to 143), 140.7 (range, 125 to 159), 139.7 (range, 125 to 164), and 138.9 (range, 125 to 146), respectively (P = .005). Comparing every 2 samples, a significant difference was seen only between samples 1 and 4 (P = .005). Serum levels of potassium were all in normal range and there was no difference between the 4 samples (P = .12).

Conclusion: Our findings showed that using distilled water as an irrigation fluid during PCNL does not result in a clinically significant decrease in the serum level of sodium and can be used if necessary. However, evaluation of the serum sodium level on the postoperative day is mandatory.

Keywords: distilled water, percutaneous nephrolithotomy, kidney calculi, hyponatremia

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INTRODUCTION

Percutaneous nephrolithotomy (PCNL) is the preferred method of treatment for complex kidney calculi and may be performed solely or as a part of a *sandwich* therapy.[1,2] The irrigation fluid routinely used during the PCNL has systemic absorption and results in hemodilution similar to the fluid absorption in transurethral prostate resection.[3] Also, there are some published studies that have reported hyponatremia after PCNL.[4,5] To prevent this complication, normal saline has been recommended for irrigation purposes.[6] To our best knowledge, there is no study on the safety of using distilled water in PCNL and its effect on the serum levels of sodium. Distilled water is available and cheap, but the risk of hyponatremia can be high with it. However, we had been using distilled water for PCNL in our center during the past years due to limitations in the availability of appropriate irrigation fluids. Since we did not experience any significant complication, we decided to evaluate the effect of distilled water as the irrigation fluid for PCNL on the level of serum sodium.

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MATERIALS AND METHODS

Between August 2005 and January 2006, 30 patients with kidney calculi were randomly selected and enrolled in our study. They were all candidates for tubeless PCNL. This study was approved by the review board of Mashhad University of Medical Sciences and all of the patients provided informed consent. The inclusion criteria were normal serum creatinine level, normal serum sodium (≥ 135 meq/L), unilateral PCNL in one session, using one access site, and no extensive extravasation. Intravenous urography (IVU) was performed and laboratory studies including complete blood count, blood urea, serum creatinine, urinalysis, and urine culture were done for all patients. The laboratory studies were repeated 1 day after the operation, as well as plain abdominal radiography (kidney, ureter, and bladder [KUB]) and ultrasonography. Four additional blood samples were taken to determine serum sodium and potassium levels; Sample 1, at admission; Sample 2, just before the operation; Sample 3, after the operation (in recovery room); and Sample 4; on the first postoperative day. The reference ranges for serum levels of sodium and potassium were 135 meq/L to 145 meq/L and 3.7 meq/L to 5.2 meq/L, respectively.

Percutaneous nephrolithotomy was performed using distilled water instead of other irrigation fluids. The height of water was about 100 cm above the patients' body level. Anesthesia was achieved by a same method for all patients: induction with thiopental, 5 mg/kg; atracurium, 0.5 mg/kg; and fentanyl, 2 μg/kg. It continued using halothane, 0.6% to 0.7%, and atracurium, one-third of the initial dose, every 30 minutes. If necessary, Ringer lactate solution was infused intravenously during the procedure. The patients received infusion of two-thirds dextrose 5% and one-third normal saline solution after the procedure (1000 mL for the first 10 kg, 500 for the second 10 kg, and 20 mL/kg, for the remaining body weight).

The operative time, from the first incision to its suturing, was recorded. The amount of the used distilled water, body mass index (BMI), complete and target stone-free rates, hospital stay, and the history of previous interventions were also recorded. Complete stone-free status was considered as not having a calculus larger than 5 mm.[7] The sizes of the calculi were measured in millimeters by KUB and ultrasonography (for nonopaque calculi).

The data of the patients were analyzed by SPSS software (Statistical Package for the Social Sciences, version 13.0, SPSS Inc, Chicago, Ill, USA) and the statistical tests including repeated measures and Bonferroni test were used.

RESULTS

The clinical and demographic characteristics of the patients are listed in Table 1. In all patients, PCNL was performed using the access from the inferior calyx. The mean operative time was 46.1 minutes (range, 25 to 120 minutes; 95% confidence interval [CI] = 38.82 to 53.30), and the mean distilled water used was 8.1 L (range, 5.6 L to 11.2 L; 95% CI = 6.88 to 9.31). Target stone-free rate was 100%, while complete stone-free rate was 80%. The mean hospital stay was 2.3 days (range, 2 to 4 days; 95% CI = 2.05 to 2.54).

The serum levels of sodium and potassium are listed in Table 2. All the measured electrolytes were within the reference ranges. None of the patients developed hyponatremia and no transfusion was required. The mean serum level of sodium showed a decreasing trend within the reference range. Using the repeated

Table 1. Patients' Demographic and Clinical Characteristics*

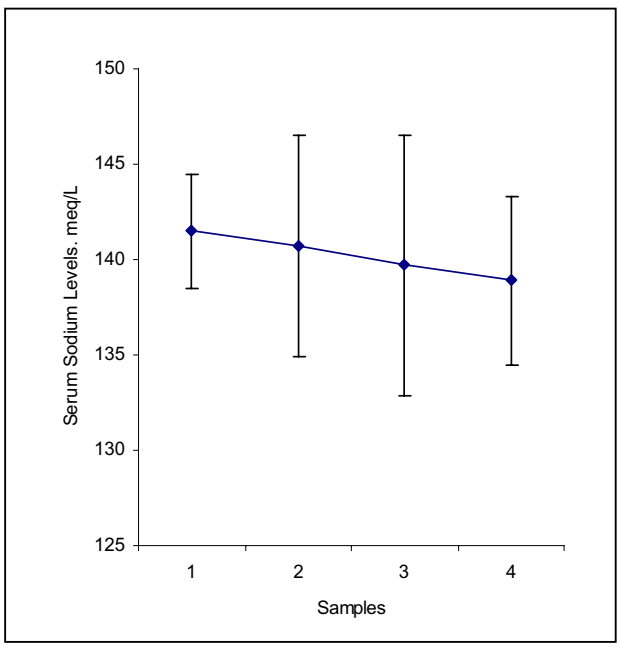
Characteristics	Values
Mean age (range), y	45.2 (10 to 73)
Male/female	16/14
Mean BMI (95% CI), kg/m^2	24.84 (23.20 to 26.65)
Mean calculus size (range), mm	37.9 (25.0 to 75.1)
Side of calculi	
Right	11 (36.7)
Left	19 (63.3)
Location	
Renal pelvis	13 (43.3)
Renal pelvis and the lower calyx	7 (23.3)
Superior calyx	3 (10.0)
Inferior calyx	2 (6.7)
Superior ureter	1 (3.3)
Staghorn	4 (13.3)
Previous Interventions	
Open surgery	2 (6.7)
SWL	
1 session	7
2 sessions	0
3 sessions	1
Transurethral pneumatic lithotripsy	3

*Values in parentheses are percents unless otherwise indicated. SWL indicates shock wave lithotripsy.

Table 2. Serum Levels of Sodium and Potassium in Blood Samples Before and After PCNL*

Electrolyte	Sample 1	Sample 2	Sample 3	Sample 4
Sodium, meq/L				
Mean	141.5 ± 3.0	140.7 ± 5.8	139.7 ± 6.8	138.9 ± 4.4
Range	140 to 143	125 to 159	125 to 164	127 to 146
95% CI	141.5 to 142.1	138.5 to 142.9	137.1 to 142.2	137.3 to 140.6
Potassium, meq/L				
Mean	4.14	4.26	4.34	4.14
Range	3.8 to 5.2	3.9 to 5.0	4.0 to 5.1	3.8 to 5.2
95% CI	4.01 to 4.26	4.01 to 4.50	4.10 to 4.59	3.96 to 4.35

*PCNL indicates percutaneous nephrolithotomy and CI, confidence interval.



Mean level of serum sodium in Samples 1 to 4. The levels of sodium on the days before and after the procedure (Samples 1 and 4) had statistical significant difference.

measurement method, the 4 samples where different significantly ($P = .005$; Figure). Using the Bonferroni test (for comparison of every 2 samples), a significant difference was seen only between samples 1 and 4 ($P = .005$). Serum levels of potassium were all in normal range and there was no difference between the 4 samples ($P = .12$).

DISCUSSION

Absorption of the irrigation fluid during the endoscopic procedures has been reported even in ureteroscopy.[8] Since 1980, when PCNL began to be routinely used, glycine 1.5% has been used as the irrigation fluid in this procedure. In a study on 12 patients, it was revealed that the systemic absorption exists in the PCNL procedure similar to the transurethral resection of prostate.[3] In another study on 150 patients, glycine 1.5% induced hyponatremia during the PCNL (a postnephrolithotomy syndrome) in 2% of the patients, and therefore, normal saline was recommended to be used instead.[9] In a study on 32 patients for whom ethanol 1% was used for monitoring the absorption of the irrigation fluid, it was revealed that a mean volume of 696.7 mL was absorbed during PCNL.[10] In a similar study on 148 patients, none of them showed electrolyte imbalance and it was concluded that using the Amplatz system, reducing the amount of the irrigation fluid, and operating in multiple stages might significantly reduce fluid absorption.[11] In a study on 23 patients whose irrigation fluid was normal saline, Koroglu and colleagues reported that the amount of fluid used and the duration of the procedure did not affected the level of electrolytes during PCNL.[12]

To our knowledge, there is no study evaluating distilled water as irrigation fluid for PCNL. Distilled water is cheap and available and is especially appropriate in developing countries; however, it may cause hyponatremia. According to the results of our study, there was a significant difference between the serum sodium levels of the serial samples taken before and after the operation. This may be explained by the absorption of the extravasated fluid or the routine use of two-thirds dextrose 5% and one-third saline solution during the procedure. However, the lowest measured serum sodium concentration in the laboratory studies of the first postoperative day was 127 meq/L, which was within the reference range for serum sodium level. We found no case of symptomatic or asymptomatic hyponatremia among our patients. Finally, regarding the mean levels of sodium in Samples 2 and 3, which were not different significantly, it can be concluded that the duration of the procedure, the fluid used, the side of PCNL, and

BMI had no significant effect on the serum level of sodium.

CONCLUSION

According to our findings, using distilled water during PCNL for irrigation does not cause any clinically significant decrease in serum levels of sodium. As an alternative irrigation fluid, it can be used with special attention to the level of serum sodium on the postoperative day. Larger studies on the efficacy and safety of distilled water for irrigation in endoscopic procedures are warranted.

CONFLICT OF INTEREST

None declared.

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