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ORIGINAL PAPER

An assessment of serum sodium within 48 h after percutaneous nephrolithotomy with half-strength saline solution

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Abstract The aim of this study was to evaluate the postoperative serum sodium changes after percutaneous nephrolithotomy (PCNL) with half-strength saline irrigation. PCNL operations from June to August 2008 were included. PCNL was performed according to the standard prone position with fluoroscopic guidance. Patients received 0.3% saline–3.3% dextrose by intravenous infusion in the first 24 h after operation. Serum sodium was measured before the operation and at 6, 24 and 48 h after the operation. 96 patients were included. Serum sodium slightly decreased from preoperative 140.3 ± 2.8 mEq/l to 140.1 ± 3.6, 139.1 ± 3.4 ($p < 0.01$) and 139.3 ± 2.7 ($p < 0.05$) at 6, 24 and 48 h after the operation, respectively. Half-strength saline irrigation does not result in considerable change in the postoperative serum sodium in simple PCNL operations. The use of intravenous solutions with hypotonic sodium is discouraged in PCNL patients with the possibility of high volume absorption of hypotonic irrigation fluid.

Keywords Percutaneous nephrolithotomy · Hyponatremia · Irrigation · Sodium

Introduction

Percutaneous nephrolithotomy (PCNL) is the treatment of choice for large renal stones. Continuous irrigation of the kidney is necessary during the procedure [6, 9]. The absorption of irrigation fluid has previously been reported during the procedure. Therefore the probability of electrolyte imbalance was raised. A variety of complications resulting from absorption of the irrigation fluid during PCNL including symptomatic hyponatremia have been reported [2–4, 7, 8, 10, 11]. Most of these complications occurred by the use of isotonic glycine and mannitol irrigation solutions.

Few studies were performed to evaluate the electrolyte changes during this procedure which have not given consistent results [1, 8]. In one study, a tendency toward hyponatremia was observed [1] whereas some other studies found no significant changes in serum sodium when 0.9% saline solution was used for irrigation [8, 12]. The effect of PCNL irrigation on postoperative serum sodium has been overlooked. This could be of importance as extravascular absorption of the irrigation fluid has been reported several hours after irrigation termination [6].

This study was performed to evaluate the effect of the half-strength saline irrigation solution on postoperative serum sodium.

Patients and methods

Adult patients were the candidates for the PCNL operation in Labbafinejad Hospital from June to August 2008. Indications for PCNL were kidney stones >2 cm, stones refractory to shock wave lithotripsy (SWL), and large proximal ureteral stones. Adult patients with preoperative serum sodium or creatinine outside the normal range were excluded from the study. Intravenous urography was performed for all cases before the surgery and stone free rate was determined with plain abdominal radiography and ultrasonography after the surgery. Percutaneous

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nephrolithotomy was performed according to the standard prone technique with fluoroscopic guidance and is summarized below.

Under general anesthesia a 5 or 6 F ureteral catheter was inserted and fixed to a Foley catheter then the patients were placed in the prone position. Under fluoroscopic guidance the desired calyx was punctured and the guide wire was inserted. After dilation and Amplatz sheath insertion, nephroscopy was performed and stones were fragmented by pneumatic lithotripter (Litho Crack, Sp. Swiss-Germany) and removed.

Thiopental sodium (5 mg/kg), atracurium (0.5 mg/kg) and sufentanyl were used for induction and halothane was used for the maintenance of anesthesia. Half-strength saline solution was used for continuous irrigation and the height of the fluid was constant at 80 cm above the operation table. Normal saline solution was infused as intravenous fluid in all cases during the surgery. Patients received 0.3% saline–3.3% dextrose solution during the first 24 h after the operation. Serum sodium, hemoglobin, urea and creatinine were measured before and at 6, 24 and 72 h after operation. Serum sodium measurement was performed by the flame photometric method (Eppendorf EFOX 5054, Hamburg, Germany). The study protocol did not include intervention to patients' treatment protocols or taking extra blood samples from the patients. Only the time of routine blood sample measurements after the operation and the postoperative days were adjusted to fulfill the objectives of the study.

Demographic and perioperative data such as age, sex, stone burden, laterality, comorbidities, stone opacity, operation time, numbers and sites of accesses and complications during and after the surgery were recorded by the surgeon. The operative time was calculated from anesthesia induction to nephrostomy fixation.

SPSS software version16.0 (SPSS Inc., Chicago, IL) was used to enter and analyze the data. Paired *t* tests were used to compare postoperative serum sodium at 6, 24 and 48 h with their preoperative values. Two sided *p* values <0.05 were considered statistically significant.

Results

Demographic and operative data is summarized in Table 1. From June to August 2008, 120 PCNL operations were performed at our centre from which 96 patients met the inclusion criteria.

The change of serum sodium before and after the operation is presented in Fig. 1. A slight decrease is observed up to 24 h after the operation and then a small increase is observed at 48 h after the operation. The average drops in serum sodium at 24 and 48 h after the operation were statistically significant relative to its preoperative value ($p < 0.01$ and $p < 0.05$, respectively). The lowest serum sodium before the operation and at 6, 24 and 48 h after operation were 134, 120, 124 and 130 mEq/l, respectively.

Table 1 Demographic data and operation characteristics

Characteristics	
Sex (male/female)	59/37
Age, year	43.9 ± 13.5
Side (left/right)	57/39
Solitary kidney	4 (4)
Preop creatinine (mg/dl)	1.0 ± 0.2
Operation duration (min)	86 ± 23
Approach	
Subcostal	85 (89)
Intercostal/supracostal	4 (4)
Multiple	7 (7)
Number of access	
One	84 (87)
Two	12 (13)

Data are presented as *N* (%), mean ± SD, or *N*/*N*

We calculated the changes in serum Na from 6 to 24 h after the operation. The percentage of patients with serum Na increase ≥2 mEq/l in this interval (6–24 h after operation) was 24.5 while the percentage of patients with serum Na decrease ≥2 mEq/l was 43.9.

Discussion

The results of this study show that serum sodium decreases after PCNL when half-strength saline solution is used for irrigation. However, the magnitude of this decrease is not clinically important. The highest average decrease, which was observed 24 h after the operation, was 1.24 mEq/l which is a very small decrease (Fig. 1). But on the other hand, if we look at the patients who experienced the highest drops in serum sodium, there were three patients with serum sodium <130 at 6 h after the operation. There were patients with serum sodium values of 120 and 124 at 6 and 24 h after the operation. Therefore the possibility of the considerable change in serum sodium of some patients remains.

The potential for electrolyte changes in PCNL came from the observation of fluid absorption through vascular and retro-peritoneal routes [8, 12]. The change in serum electrolytes are reported to be higher when solutions like glycine and mannitol are used for irrigation. In the case of irrigation by normal saline, some studies [4, 8, 9, 12, 13] reported no change in the serum sodium while Atici et al.

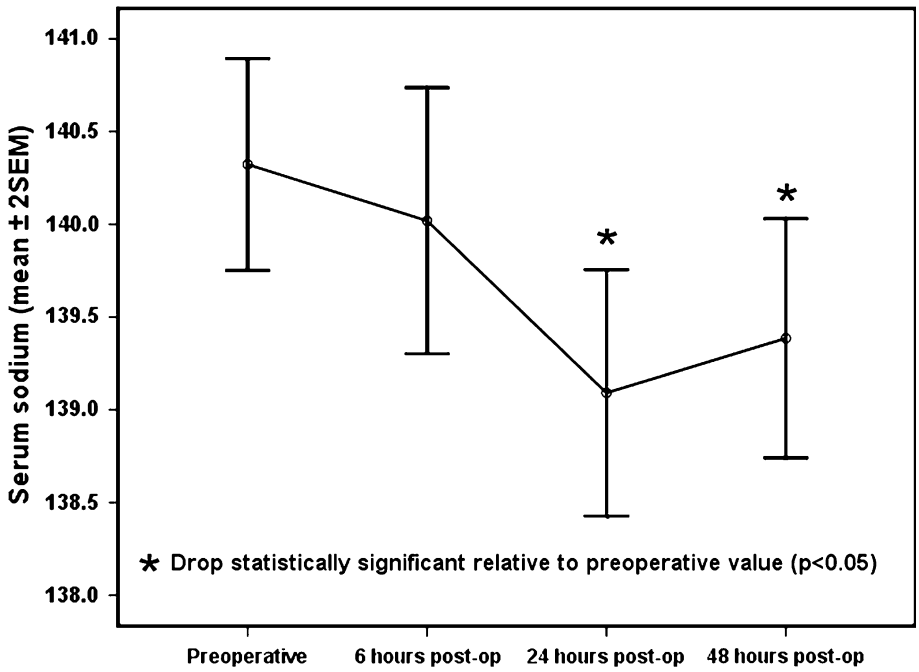

Fig. 1 Serum sodium before operation and at 6, 24 and 48 h after operation

[1] reported hyponatremia. The effect of PCNL irrigation on electrolyte balance depends on a number of other factors apart from the type of irrigation fluid. Renal pelvis perforation, Amplatz sheath dislodgement, high irrigation pressure and long duration of operation are the known risk factors [9]. We excluded staghorn stones and did not observe major pelvicalyceal perforation in this series.

Another interesting finding in this study was the fact that the highest average drop in the postoperative serum sodium was observed at 24 h after the operation and not at 6 h after the operation. The factors that can affect postoperative serum sodium are absorption of irrigation fluid and intravenous infusion solution which is infused after the operation.

The absorption pattern of irrigation fluid in PCNL has been studied by Gehring et al. [6]. He reported intravascular absorption (IVA) and extravascular absorption (EVA) of the irrigation fluid and their curves by measuring the blood ethanol concentrations when irrigation fluid contained a fixed concentration of ethanol. IVA peaked sooner than 100 min after irrigation termination and no IVA was observed 4 h after irrigation termination. EVA peaked at 175 min after irrigation termination and EVA was still present at a significant level 400 min after irrigation termination when they performed their last measurement. Therefore we cannot exclude the possibility that EVA could contribute to less serum sodium at 24 h after operation when we observed the highest drop. However, regarding the fact that the highest EVA is observed at 3 h after operation and that serum sodium at 6 h after operation was higher than 24 h after the operation, we hypothesize that intravenous fluid sodium concentration had a more important role in lowering the serum sodium at 24 h after the operation relative to serum sodium (the concentration of sodium in 0.3%saline–3.3%dextrose solution is one-third the concentration of sodium in serum). This idea can be very important as currently most researches or guidelines focus on the constitutions of irrigation fluid in PCNL to reduce the risk of electrolyte imbalance. The surgeons should be aware that intravenous fluid after PCNL, especially when there is a risk of significant EVA of hypotonic irrigation fluid, can adversely affect serum sodium.

The primary motivation for our institution to study the effect of half-strength saline irrigation in PCNL was the price difference between the normal saline and half-strength saline in our centre. In institutions where they buy both normal saline and half-strength saline solutions there is little price difference between them but in our centre, we mix distilled water with normal saline in equal volumes to make half-strength saline solution therefore its price is much lower than that of the normal saline solution. This saving may be negligible for the affluent world but it is a real saving for many developing countries.

Previously Feizzadeh et al. [5] reported no statistically significant postoperative hyponatremia when distilled water was used for irrigation but their sample size was limited ($N = 30$) and, however, not symptomatic but they reported patients with really low serum sodium ($Na = 120$).

In this study, we looked into one particular aspect of electrolyte changes after PCNL operation. There are some points to be considered when one studies the results of this study: (1) We did not measure serum potassium. There are some reports on the influence of PCNL irrigation on serum

potassium. (2) We did not measure serum sodium during intraoperative irrigation phase of PCNL, therefore the results and discussions of this study only pertains to serum sodium concentration after the operation and not during it.

In brief, the results of this study raise the possibility of considerable serum sodium changes after PCNL irrigation with half-strength saline solution and hypotonic infusion solution in some patients, however, in most patients no considerable change occur. Furthermore, we think that using solutions for intravascular infusion with hypotonic sodium concentrations should be discouraged for PCNL patients with low or low normal postoperative serum sodium concentrations or in cases in whom there is the possibility of significant absorption of a hypotonic irrigation fluid.

Conclusions

Half-strength saline irrigation fluid does not result in considerable change in postoperative serum sodium in simple PCNL operations but not in all. Using intravenous infusion solutions with hypotonic sodium is discouraged for PCNL patients with the probability of high volume absorption of hypotonic irrigation solution.

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