Serum sodium changes during and after transuretheral prostatectomy

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ABSTRACT

Objectives: This prospective study aims at determining the effect of transurethral resection of the prostate on serum sodium levels during and after the procedure.

Methods: One hundred consecutive unselected patients with prostatic obstructive symptoms over a period of 11 months underwent transurethral resection of the prostate using continuous flow irrigation with 1.5% glycine running from a height of 70 cm above the table level under epidural anesthesia and were given 1L of intravenous normal saline/hour during the procedure. Resection time ranged between 25 and 90 minutes (mean 32) and was less than 45 minutes in 91 patients (91%). No postoperative irrigation or diuretics were given and the patients were given food and liberal fluids immediately after the operation.

Results: Fifty-four patients (54%) had intraoperative reduction of serum sodium ranging between 2 and 7 mmol/L (mean 3.5), 18 of whom showed further drop of 2-10 mmol/L after 24 hours (mean 3.4). Twenty-five patients (25%) did not have any intraoperative change in their serum sodium level, 6 of whom dropped their serum sodium 24 hours later. After 24 hours, 41 patients (41%) ended with serum sodium lower than their preoperative level by 2-12 mmol/L (mean 4%), 3 of whom had a drop of 10-12 mmol/L. The reduction was manifested 24 hours after the procedure in 27 patients (27%). None of the patients had transurethral resection syndrome nor its prodromal manifestations.

Conclusion: After transurethral resection of the prostate, hyponatremia can occur as late as 24 hours postoperatively. Short operative time, giving intravenous sodium supplement intraoperatively and avoiding postoperative irrigation were perhaps factors in avoiding drastic hyponatremia and transurethral resection syndrome in this prospective series of unselected patients.

Keywords: Hyponatremia prostate, transurethral resection syndrome.

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During transurethral resection of the prostate (TURP) large quantities of irrigating fluid, up to 7 liters, may be absorbed into the vascular compartment causing cardiovascular and central nervous system (CNS) symptoms that are generally referred to as transurethral resection (TUR) syndrome[1] caused by hypervolemia and dilutional hyponatremia. The rapid osmotic shift of the water component of irrigation fluids into the intracellular compartment elevates serum sodium while causing wide cellular dysfunction of vital and non-vital organs. Various workers have proved that there is a direct relationship between fluid absorption and the closely related variables; operating time,[2-4] blood loss[2,3,5] and the weight of the resected prostate tissue.[2,6] Others have found that epidural block did not influence the absorption neither did the type of infusion.[7,8] A cancerous histology has no influence on the incidence of the syndrome compared to benign prostatic hypertrophy.[2] Elevated blood ammonia levels have been observed in patients with encephalopathic changes after TURP. There is only a slight tendency for the irrigating fluid containing glycine to produce hyperammonemia. Hyponatremia rather than hyperammonemia or hypo-osmolarity accounts for the major morbidity and mortality

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associated with TUR syndrome.[9-11] In the United States of America, the incidence of postoperative hyponatremia is about 1% or about 250,000 cases among the roughly 25 million inpatient operations that are performed each year.[12] This is a subject of great medical and surgical interest that causes much international concern and anxiety. Its presentation is elusive. The diagnosis and differential diagnosis are difficult. The exact pathophysiological etiology is unknown and management is highly controversial. The syndrome may be recognized by sudden onset of restlessness, confusion, headache and nausea occurring during or within a few hours of the TUR.[13] Signs include an initial phase of hypertension, bradycardia and cyanosis followed by hypotension, continuing bradycardia and circulatory collapse. Electrocardiogram (ECG) shows bradycardia, wide QRS complexes of increased amplitude and T wave inversion. Serum sodium is very low and pulmonary edema may develop as a result of the severe hyponatremia following TURP.[14,15] The degree and incidence of the unavoidable hyponatremia varies widely from 0 to 41%.[1,16,17] An incidence of 10%[2,18] with severe morbidity or mortality of 0.5%-1.5%[14] are the currently accepted figures. Severe or lethal cases are usually reported retrospectively.[1,19-21] Such cases may present with vascular shock[18,22] cardiac dysrhythmia, infarction, failure or arrest,[1,20] pulmonary edema[23] and cerebral convulsions, encephalopathic coma or infarction.[14] Renal failure with anuria is common.[18] Hepatic dysfunction, coagulopathies[21] and gastro-intestinal disorders may occur. A combination of these multiple system disorders[19] is common but one or 2 vital organ dysfunction may prevail. Severe and lethal cases have the features of the multiple vital organ dysfunction/failure (OD/F) syndrome. The syndrome may be attributed to any of the above well-known medical conditions. Multiple toxic (ammonia, glycine[5,10] and septicemia) and serum dilution hypotheses[3,4,6,15,22,24] have all been used, interchangeably and in combination for explaining the pathophysiology.[11] With prompt treatment, improvement is rapid but if diagnosis is missed further deterioration may follow the inappropriate administration of large volumes of intravenous fluids in a misguided attempt at correcting hypotension.[21] This study aims at investigating how serum sodium is influenced by TURP. A subordinate goal is to assess the effect of various parameters, namely; the avoidance of postoperative irrigation, operative time, and giving intraoperative intravenous normal saline, although the effect of these parameters is speculative because the study was not randomized.

Methods. A prospective study was undertaken on 100 consecutive unselected patients undergoing TURP over a period of 11 months. Patients age ranged between 45 and 90 years (mean 62). They all presented with outflow obstruction symptoms (poor interrupted stream 52, acute retention 30, and chronic retention 18), 39 (39%) of whom had irritative symptoms too. Q-max ranged between 3.6 and 15.2 ml/sec (mean 10.2). Eighteen (18%) had hematuria and 21 patients (21%) had impaired renal function with serum creatinine of 1.3-4.0 mg/dL, (mean 1.7) (normal 0.55-1.2). Five patients had history of bilharziasis and 9 had history of urological operation (vesicolithotomy 4, ureterolithotomy 2, nephrectomy 1, open prostatectomy 1, and TURP 1). Ultrasound was carried out in all patients and intravenous urogram (IVU) in 14 patients (14%). The ultrasound estimated weight of the prostate ranged between 40 and 80 gm (mean 45). Upper urinary tract abnormalities were detected in 15 patients (15%) (hydronephrosis 8, renal calculi 3, renal cysts 1, nephroptosis 1, ureteric calculi 2). Five patients (5%) had bladder diverticulae, 5 (5%) had vesical stones. Six patients (6%) had urinary tract infection on culture. None of these abnormalities influenced the decision to resect the prostate. Sixty-seven patients (67%) were suffering from other diseases (chronic respiratory disease 42, hypertension 21, cardiac disease 19 and diabetes 12).

Procedure. Transurethral resection of the prostate was performed by using Olympus resectoscope (26 Fr) under epidural anesthesia and continuous flow irrigation with 3-7 L (mean 4.5) of 1.5% glycine from a height of 70 cm above the table level. Resection time ranged between 20 and 90 minutes (mean 32) and it was completed within 30 minutes in 62 patients (62%) and within 45 minutes in 91 patients (91%) (Table 1). Patients were given 1 L of intravenous normal saline/hour throughout the procedure. The maximum amount of saline infusion was 1.5L. Meticulous hemostasis was ensured and great care was taken to avoid perforation of the

Table 1 - Operative time.

Number of patients	Time (minutes)
22	25
29	30
7	35
15	40
7	45
3	50
2	55
2	70
1	85
1	90

Table 2 - Resected weight of the prostate.

Number of patients	Weight (gm)
32	10 - 20
22	21 - 30
17	31 - 40
17	41 - 50
8	51 - 60
4	61 - 70

capsule. Otis urethrotomy or urethral dilatation were not routinely practiced. Five patients had vesical stones and were treated by electrohydraulic vesicolithotripsy before commencing the resection. Two patients had superficial transitional cell carcinoma (TCC) of the bladder and were resected at the beginning of the procedure. Two patients had urethral strictures which were dilated and another patient had meatal stenosis which required meatotomy. The resected weight of prostatic tissue ranged between 12 and 70 gm (mean 30.5%) and was 40 gm or less in 71 patients (71%) (Table 2).

Postoperative care and follow-up. None of the patients was irrigated postoperatively or given diuretic as means of preventing clot retention. Patients were given food and liberal fluids immediately after the operation. They were given 2L of intravenous isotonic dextrose - 0.18 saline for the first 24 hours and instructed to drink plenty of fluids. None of the patients were blood transfused during or after the operation. Prophylactically, 1 gm of ampicillin was given to patients who had sterile urine. The 6 patients who were infected preoperatively had their antibiotic treatment started 2 days before the procedure and continued postoperatively. Patients were discharged after removal of the catheter on the 2nd or 3rd postoperative day and were followed up after one month. They were advised to take 2 tablets of 480 mgm Co-trimoxozol daily for the same period.

Table 3 - Serum sodium changes.

Intraoperative	Postoperative (24 hours)			
	Decreased	No change	Increased	Restored
Decreased (54)	18*	14*	8	111
No change (25)	6*	14	5	-
Increased (21)	3*	5	8	5
*Reduced serum sodium 24 hours postoperatively - Total 41 (41%)				

Results. Twenty-five patients (25%) did not show any intraoperative sodium shift. Twenty-one (21%) showed an increase of 2-5 mmol/L (mean 2.7) and the remaining 54 (54%) showed intraoperative reduction of 2-7 mmpl/L (mean 3.5) (Table 3). Twenty-four hours postoperatively, of the 25 patients who were stable, 6 showed a drop of 2-4 mmol/L (mean 2.6). Of the 54 patients who had an intraoperative drop of serum sodium, 18 showed further drop of 2-10 mmol/L (mean 3.4) while 22 patients had their serum sodium either restored to its preoperative level (n=14) or increased (n=8). Of the 21 patients who had an intraoperative elevation of serum sodium, 3 dropped it by 2-4 mmol/L (mean 3) below their preoperative level, 5 restored to their preoperative value and the remaining 13 remained at a high level. Table 1 shows that by the end of 24 hours postoperatively, 41 patients (41%) ended with serum sodium levels below their preoperative value, by 2-12 mmol/L, 3 of whom (3%) had a reduction of 10-12mmol/L. Twenty-seven patients (27%) dropped their serum sodium 24 hours after the TURP. Fourteen patients (14%) had neither intraoperative nor postoperative change in their serum sodium level. A one mmol/L reduction in serum sodium was not considered. Histologically, 94 glands (94%) were benign and 6 (6%) were malignant. No TUR syndrome was encountered or its prodromal symptoms and there was no mortality. Clot retention occurred in 9 patients (9%). Seven patients (7%) who were not infected prior to TURP developed urinary tract infection, 5 of which were asymptomatic while 2 had epididymo-orchitis. One patient (1%) had a mild transient cerebral ischemic episode and another patient (1%) had acute cardiac failure and were both known to suffer from hypertension. Both were normonatremic and were 2 of the 14 patients who did not have a change in their serum sodium, neither intraoperatively nor postoperatively and known to have had suffered from these medical conditions before.

Discussion. More than half a century ago, Creevy attributed TUR syndrome to the hemolysis caused by the use of water irrigation.[24] This syndrome was also reported by others who used glycine or mannitol for irrigation.[1,6,15,20,21,23] It was postulated that hemodilution due to massive absorption of the irrigation fluid was the cause of the syndrome. Sudden death either on the operating table or in the immediate postoperative period was reported, and the mortality rate ranged between 15-40% in the older reports.[21,25] However Rhymer et al[6] believed that an intraoperative fall in serum sodium of 15 mmol/L or more might lead to serious consequences if untreated, although lesser reduction in serum sodium might occur in patients who exhibited the clinical features of TUR syndrome. They used continuous flow irrigation with 1.5% glycine and diuretic (1 mg Burinex) at the end of the

procedure. Their patients who exhibited the syndrome (7%) showed an intraoperative fall in serum sodium of 6-32 mmol/L (mean 16). Goel et al[13] noted that TUR syndrome and significant fall of serum sodium could be prevented by using a non-continuous irrigating resectoscope and 1.5% glycine for irrigation. They used continuous bladder irrigation with normal saline postoperatively. Gale and Notley[26] did not report TUR syndrome in their patients, which they attributed to the use of continuous irrigating resectoscope.

It is of note that the majority of the previous studies were performed retrospectively. However, this study's conclusions affirmed that of a previous prospective study.[18] In this prospective study using continuous flow irrigating resectoscope under epidural anesthesia while giving intravenous normal saline during the procedure without the use of diuretics or postoperative irrigation, there was no drastic shift in serum sodium and none of our patients suffered from TUR syndrome nor its prodromal symptoms. The fact that one or 2 liters of normal saline are better tolerated than the hypotonic 1.5% glycine does not mean a direct proportional relationship between its quantity and safety. Giving saline intraoperatively should not imply that saline is a safer type of volumetric overload. Although it causes apparent rise of serum sodium to normal or even above base line as in 21 of our patients (21%), it can also worsen the volumetric overload if given in large amounts.[18] Appearance of hyponatremia 24 hours after the procedure in 27% of patients is a significant finding and has clinical implications. Completing the resection within 30 minutes in 69 patients (69%) and within 45 minutes in 96 patients (96%) are perhaps other factors. Many workers have found that limiting the operating time to within 60 minutes is an important factor in the prevention of massive fluid absorption.[4,22] Allowing patients food and plenty of oral fluids immediately after the procedure could yet be another factor to replenish their sodium and to prevent clot retention. Local factors that relate to the TURP procedure are known to affect the irrigant absorption.[2,7,14] They mainly testify to the urologist's experience and dexterity with this highly technical procedure, and are of relevance to the prevention of fluid absorption.[2,11,14]

We conclude that hyponatremia can occur as late as 24 hours postoperatively and can not be avoided in many patients undergoing TURP. However its severity can be affected by factors such as shortening the operative time, giving one litre/hour of intravenous sodium supplement intraoperatively not exceeding a maximum of 1.5L and avoiding postoperative irrigation.

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