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A Comparative Study of 'Sterile Water' Versus 'Glycine (1.5%)' As Irrigation Fluid in Transurethral Resection of Prostate

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Abstract
Aims and Objectives: *The present research study was carried out with an objective to study and compare the effects of Sterile Water versus Glycine (1.5%) as an irrigation fluid in surgery of 'Trans-Urethral Resection of Prostate (TURP).*
Methods: *This was a prospective randomized double blind study. A total of 60 patients of (Age: 50-80 years) ASA grade I and II with Benign Prostatic Hyperplasia posted for trans-urethral resection of prostate were randomly allocated in two equal groups as Group W- Sterile Water group and Group G- Glycine1.5% group. The observations in relation to intra-operative haemo-dynamics, haemoglobin, blood urea, serum creatinine and serum electrolyte changes were noted and analyzed.*
Results: *Statistically there were similar changes in heart rate, systolic and diastolic blood pressures during the procedure in both the groups. Immediately after surgery and after 24 hrs, the comparable changes were seen in both the groups in relation to haemoglobin, blood urea and serum creatinine levels. Post-operative serum sodium concentration was decreased and serum potassium concentration was increased significantly in both groups. These changes in serum sodium & potassium were more so in Group W as compared to in Group G; but the difference in two groups was statistically insignificant. Incidence of perioperative complications was comparable amongst the groups.*
Conclusion: *As compared to Glycine (1.5%), Sterile Water was found to be safe and inexpensive irrigation fluid for 'Trans-Urethral Resection of Prostate' (TURP). In relation to safety profile, we did not find any difference between two irrigation fluids. As our sample size of study was small, needs further similar studies on large sample size to confirm the observations of present study.*
Keywords: *Irrigation fluids: Sterile water Vs. Glycine, Trans-Urethral Resection of Prostate (TURP), Benign Prostatic Hyperplasia, TURP syndrome.*

Introduction

Trans-urethral resection of prostate (TURP) is a standard endoscopy operative procedure for patients with benign prostrate hypertrophy. The benign prostatic hypertrophy (BPH) affects 50% of males at 55- 60 years and 90% at 85-year & > age group patients. TURP is the second most common surgical procedure (First most common

surgery: Cataract surgery) is being performed in elderly male patients/ population group with high incidence of cardiac, respiratory and renal disease [1, 2]. The procedure is performed endoscopically under direct vision using a diathermy current passed through a loop of wire at the tip of a resectoscope, which is inserted into the bladder through the patient's urethra. This enables hypertrophied prostate to be resected in pieces and washed out using an irrigation solution & removed via endoscope side port. TURP requires the use of irrigating fluid to gently dilate the mucosal spaces, remove blood and cut tissue in piece meals/ debris from the operating field. Apart from this issue, the irrigation fluid allows/ enables better vision. [2]

At present, most commonly used irrigation fluids are Sterile Water and 1.5% Glycine solution [1]. The sterile water used for irrigation of urinary bladder apparently causes intravascular haemolysis when absorbed via opened venous sinuses of bladder. Within few years, the modern non-electrolyte solutions containing Glycine, Mannitol or Sorbitol were introduced to prevent haemolysis, without dispersing the electric current used for cutting prostatic tissue with the resectoscope. However, other adverse effects due to fluid absorption soon became apparent. The adverse effects were more so related to cardiovascular and nervous systems and, in the late 1950s, were labelled as 'Trans-Urethral Resection of Prostate (TURP) syndrome [3]. Since then, several hundred life-threatening and even fatal TURP syndromes have been reported [4, 5].

Different methods for assessing the safety profile of irrigation fluid and electrolyte imbalance during TURP have been suggested to prevent and detect early irrigating fluid absorption. These include gravimetry [6], central venous pressure monitoring, measurement of isotopes, serum acid phosphatase [7, 8], and assessment of breath ethanol [9, 10] and monitoring of plasma concentration of fluorescein [11]. Smoking is the only known risk factor, associated with increased fluid absorption during TURP [12]. Preventive measures, such as low-pressure irrigation, [13] limiting the duration of resection [14] and monitoring fluid absorption during surgery might reduce the extent of fluid absorption, but do not eliminate this complication. Supportive care remains the most important therapeutic approach in the management of complications.

The present study was conducted to evaluate changes in vital parameters, electrolytes, safety profile, incidence of complications and also to assess endoscopy view and surgical comfort level of surgeon with either Sterile Water or 1.5% Glycine used as irrigant fluid in cases of trans-urethral resection of prostate (TURP) surgery.

Plan of study

After obtaining institutional ethics committee approval and written informed consent from all patients, this prospective, randomized double blind study was conducted in Department of Anaesthesiology at tertiary care hospital. It included 60 patients of ASA grade I or II & age of the patients were ranging from 50 - 80 years. Patients suffering from benign prostatic hyperplasia posted for transurethral resection of prostate, controlled hypertensive and/ or diabetic patients were included in the study. Patients were divided into two equal groups of 30 patients in each group. Sterile Water was used as irrigant fluid in Group-W & in Group: G Glycine (1.5%) was used as irrigant fluid. Exclusion Criteria: The following pts. were excluded from the study- Patients not willing/ no consent, ASA Grade III, IV pts., contraindications to spinal anesthesia e. g. skin infection over lumbar spine area, bleeding disorder or coagulopathy, spinal deformity etc. Patients with uncontrolled hypertension and/ or uncontrolled diabetes mellitus, patients with co-morbidities e. g. congestive cardiac failure, ischemic or valvular heart disease, patient on diuretic therapy etc, patients having renal insufficiency (Blood urea > 100 mg %, Serum Creatinine > 2 mg %), patients with sickle cell disease and thalassemia were excluded from the study.

All relevant investigations were done. A detailed pre-anaesthetic evaluation was done and & fitness for anaesthesia was given. Patients were kept nil by mouth for 6-8 hours prior to the time of surgery. Tab. Diazepam 10 mg and Tab. Pantoprazole 40 mg was given orally to each patient at 10 pm a night before the day of surgery. On the day of surgery, the surgical procedure, anaesthesia technique & its related advantages & disadvantages were explained to patient & his relatives in waiting room of operation theatre.

The IV access was achieved with 18 G intracath & Ringer's lactate 500 ml infusion started as maintenance fluid. Multipara monitor was attached and baseline parameters like heart rate, systolic blood pressure, diastolic blood pressure, SpO_2 and electrocardiogram were noted. Under all aseptic precautions, lumbar puncture was done in L3-L4 or L4-L5 inter-vertebral space in sitting position with 23G Quinke's spinal needle. On successful lumbar puncture & free flow of CSF, Inj. Bupivacaine heavy (0.5%) 3 ml was administered slowly over 5 - 6 seconds into the subarachnoid space and patient was turned supine. The time of spinal drug injection in to subarachnoid space was noted and spinal block effect was tested by skin touch and pin prick method.

The lithotomy position was given to patient only after the spinal anaesthesia effect had set in i.e. 10-15 min after the spinal drug injection and on complete external rotation of lower limb. Surgeon was allowed to proceed for the TURP procedure. The height of irrigant fluid reservoir was fixed/ kept at 60 cm above the operation table. Before the start of endoscopy TURP procedure, the irrigation fluid container was covered with sterile linen. The irrigation fluid used for the particular patient was neither known to the investigator nor to the doctor who was recruited to note down the intra-operative and post-operative observations. The total maintenance IV fluid used was one unit of Ringer's Lactate. Each patient was monitored for vital parameters. Vital parameters (Blood pressure & Heart Rate) were noted every 10 min from the administration of spinal drug till end of surgery. Intra-operative and post-operative blood transfusions if any and diuretics within 24 hours of surgery and quantity of off-label irrigation fluid administered used in OT as to be noted. Endoscopy comfort and ease of TURP procedure with the used irrigation fluid was assessed by the surgeon as Grade I- Excellent, Grade II- Satisfactory, Grade III- Poor. Duration of resection, resected tissue weight and perioperative complications was recorded. Any symptoms or signs suggestive of TURP syndrome during procedure or in postoperative period were noted (e.g. Nausea & vomiting, Confusion, Disorientation & / or Restlessness of patient). At the end of procedure, patient was shifted to respective surgical ward. In ward Inj. Diclofenac sodium 3 ml IM (gluteal) was used as rescue analgesia to relieve postoperative pain.

Immediately after surgery and after 24 hrs of surgery, blood samples of patient were obtained and sent for Hb%, blood urea, serum creatinine, serum sodium and potassium estimation. The reports of blood investigations were evaluated. Follow up of patient was done at 15th day and 30th day to rule out any neurological, renal or cardiovascular complications.

Statistical Analysis

The data was collected and statistical analysis of parameters was presented as Mean ± SD. Categorical values were expressed in actual numbers and percentages. Unpaired t-test was performed to compare demography, haemodynamic parameters, biochemical variables, prostate size and duration of transurethral resection of prostate (TURP). Categorical variables (side effects) were compared by Chi Square test. All the tests were two sided. P value of < 0.05 was considered as significant. Statistical software SPSS version 21 was used for statistical analysis.

Observations and Results

Sixty patients were selected for the study and were divided into Group 'G' and Group 'W';

thirty patients in each group. They were in the age group of 50-80 years. Mean age of patients was 66.5 ± 5.26 years in Group 'G' and 67.2 ± 6.36 years in Group 'W'. Majority of patients were in the range of 61-70 years of age.

The mean duration of surgery in Group 'G' was 47 ± 12.2 min and in Group 'W', it was 44.5 ± 10.19 min. This difference was statistically insignificant.

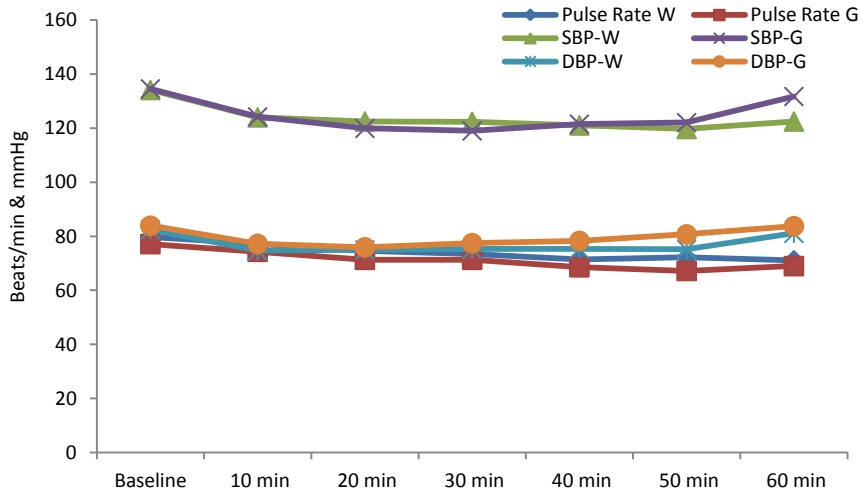
Mean volume of irrigation fluid used in Group 'G' and in Group 'W' was 10.7 ± 3.63 litres and 9.9 ± 4.21 litres respectively. All these parameters were comparable in the two groups (p value > 0.05), (Table 1).

Table – 1 Age, Duration of surgery & Irrigant Fluid

Parameters	Group 'G'	Group 'W'	P- value
Mean Age (yrs)	66.5 ± 5.26	67.17 ± 6.36	0.66
Duration of Surgery (min)	47 ± 12.22	44.5 ± 10.19	0.40
Amount of Irrigant Fluid (litres)	10.7 ± 3.63	9.9 ± 4.21	0.42

There were similar changes in vital parameters i.e. heart rate, systolic and diastolic blood pressures in both the groups. There was decrease in pulse rate in both the groups with increase in duration of surgery. Mean systolic blood pressure was decreased in both the groups in first 30 minutes and diastolic blood pressure in first 10 minutes of surgical procedure. Later on, rise in diastolic blood pressures was seen in both the groups. The difference in vital parameters amongst the study groups was insignificant at all times (p value > 0.05) (Figure 1).

Figure- 1 Comparison of Changes in Vital Parameters



There was no significant difference in baseline mean haemoglobin levels, mean blood urea and mean serum creatinine levels. The haemoglobin levels were found to be decreased slightly at the end of surgery in both groups. Slight rise in haemoglobin levels were seen after 24 hrs of surgery in both groups. This rise in haemoglobin difference was statistically insignificant (p value > 0.05).

Immediately after surgery and after 24 hrs, comparable changes were observed in both groups in relation to change in haemoglobin, blood urea and creatinine levels, (Table 2).

Table- 2 Changes in Haemoglobin, Blood Urea and Creatinine Levels

Mean Haemoglobin (gm/ dL)	Group 'G'	Group 'W'	P- value
Baseline	12.96 ± 1.08	12.60 ± 1.09	0.22
Post-operative (At the end of surgery)	11.87 ± 1.28	11.43 ± 1.00	0.16
Post-operative (After 24 hrs)	12.06 ± 1.12	11.77 ± 0.97	0.30

Mean Blood Urea (mg/ dL)	Group 'G'	Group 'W'	P- value
Baseline	28.7 ± 6.97	28.33 ± 7.5	0.85
Post-operative (At the end of surgery)	31.2 ± 5.98	32.47 ± 7.45	0.48
Post-operative (After 24 hrs)	28.2 ± 5.70	30.33 ± 7.73	0.24

Mean Serum Creatinine (mg/ dL)	Group 'G'	Group 'W'	P- value
Baseline	0.88 ± 0.16	0.89 ± 0.14	0.73
Post-operative (At the end of surgery)	0.86 ± 0.12	0.89 ± 0.14	0.45
Post-operative (After 24 hrs)	0.82 ± 0.11	0.86 ± 0.1	0.14

In both groups, there was no significant difference in baseline mean serum sodium and mean serum potassium concentration. The serum sodium concentration was decreased significantly after TURP surgery in both the groups. Immediately after TURP, the decrease in serum sodium was significantly more in sterile water group as compared to glycine group.

In post-operative period, the changes in serum sodium amongst the two groups were again insignificant at 24 hrs. Postoperatively, serum potassium concentration was increased in both the groups. The increase in serum potassium was significant in both groups as compared to baseline serum potassium level. This increase in serum potassium was greater in sterile water group as compared to glycine group, but the increase was not statistically significant. Immediately and at 24 hours after TURP surgery, statistically the change in serum K^+ values in between the two groups was insignificant. (Table 3)

Table- 3 Changes in Mean Serum Sodium and Potassium Concentration

Mean Serum Na^+ (mEq/ L)	Group 'G'	Group 'W'	P- Value
Baseline	140.63 ± 3.60	139.00 ± 3.00	0.06
Post-operative (At the end of surgery)	134.33 ± 3.65	131.87 ± 2.43	0.004
Post-operative (After 24 hrs)	133.17±18.22	136.10 ± 2.59	0.398

Mean Serum K^+ (mEq/ L)	Group 'G'	Group 'W'	P- Value
Baseline	4.13 ± 0.35	4.03 ± 0.36	0.26
Post-operative (At the end of surgery)	4.34 ± 0.33	4.44 ± 0.36	0.28
Post-operative (After 24 hrs)	4.05 ± 0.24	4.20 ± 0.34	0.06

Only in one patient of group 'G' required blood transfusion. The mean resected prostate mass in group 'G' and in group 'W' was 38.1± 8.4 gm and 40.6 ± 9 gm respectively. Ease of resection of prostate& endoscopy view was graded by operating surgeon & it was found to be excellent in maximum number of cases in both groups.

Incidence of perioperative complications was comparable in both the groups & statistically insignificant. In the present study, no patient developed TURP syndrome or other major complications related to irrigation fluids, (Table-4).

Table- 4 Peri-operative Complications

Incidence of Perioperative Complications	Group 'G'	Group 'W'	P Value
Bradycardia	2	3	0.64
Hypotension	2	2	1
Nausea & vomiting	2	2	1
ECG changes (ST elevation)	1	1	1
Change in mental status	0	1	0.31
Visual disturbance	0	0	-
TURP syndrome	0	0	-

Discussion

There have been very few studies comparing haemodynamic parameters in TURP surgery where 1.5% glycine and sterile water were studied as irrigation fluids. However, serum electrolyte changes and intravascular changes in TURP with sterile water have been studied by many authors.

Sterile water has been compared with glycine 1.5% in TURP by Moorthy et al [15], who studied changes in serum electrolytes and their correlation with various other parameters namely duration of procedure, weight of prostate gland resected, volume of irrigating fluid used and height of irrigating fluid column.

Comparison of haematocrit changes in TURP or assessment of intravascular hemolysis with sterile water and 1.5% glycine has not been done yet. Moharari et al [16] and Menon et al [17] have reported statistically insignificant changes in haematocrit and free plasma haemoglobin levels respectively, in TURP with sterile water used as irrigation fluid. We were aware that intravascular hemolysis is not usually associated with TURP syndrome and haemoglobin level may not precisely reflect the degree of fluid absorption, as massive volume absorption can trigger hemolysis as well as haemo-dilution. Haemodilution has been demonstrated in previous studies in patients who had lower free plasma haemoglobin postoperatively [18].

Dissayabutra et al [19] found increased free plasma hemoglobin in the sterile water group (n = 21), which was higher than in the 5% dextrose in water group ($p < 0.001$). Thus, a negative aspect of using sterile water is an increase in intravascular hemolysis, the significance of which needs further studies. In current study, perioperative changes in mean blood urea and creatinine levels were found to be similar with both the irrigation fluids. Studies on sterile water by Moharari et al [16] and Menon et al [17] had shown no significant change in these variables after TURP procedure.

Our study data showed that mean serum sodium concentration was significantly reduced in the immediate postoperative period in both the groups. This reduction was higher in the sterile water group (5.1%) as compared to glycine group (4.5%). The difference was statistically signify-cant, this significant change in sodium levels due to independent of the type of irrigating fluid used for the procedure. However this could be accounted for by the greater hypotonicity of sterile water as compared to 1.5% glycine. After 24 hrs, serum sodium levels in two groups were again comparable. Severe hyponatremia did not occur in any patient in either of the two groups and no incidence of TURP syndrome was reported.

The safety of distilled water had been confirmed by Shih et al [20], when these authors used supra-pubic cystostomy drainage during TURP. In their study, variation in sodium levels had been correlated with the volume of fluid used and height of irrigating fluid column and to a lesser extent to the duration of procedure and the weight

of gland resected. Norlen et al [21] have also shown that more the height of fluid column, larger is the variation of sodium levels. In present study, statistically significant rise in serum K^+ concentration was noted post-operatively with both irrigation fluids. With 1.5% Glycine, there was a 5.08% increase in serum potassium value after TURP surgery. A 10.17% increase in the corresponding mean serum potassium concentration was seen with sterile water group. Immediately after surgery and after 24 hours of TURP, comparison of change in serum potassium values between two groups was statistically insignificant. Severe hyperkalemia was not seen in any patient. Changes in serum potassium values were more than the changes observed in serum sodium values. Similar changes were reported by Moorthy et al [15] and Moskovitz et.al [22]. Clinical manifestations of hyperkalemia occur when the plasma level of K+ rise above 6.00 meq/L. The ECG will show tall, peaked T waves, PR prolongation, decrease in amplitude of P wave, QRS widening and arrhythmias. Flaccid paralysis and respiratory arrest occur when potassium level rises above 7 mEq/ L. Hyperkalemic cardiotoxicity is increased by hyponatremia and acidosis. Therefore, it is possible that the cardiovascular changes occurring in TURP syndrome can be due to a combination of both hyponatremia and hyperkalemia. We observed that both 1.5% glycine and sterile water produced significant plasma potassium changes during TURP surgery. It might be due to haemolysis during absorption of fluid into circulation. This was supported by the fact that studies have found no significant alteration in potassium levels when normal saline was used as irrigating fluid. This hemolysis has also been seen with 1.5% glycine in many studies, as normal saline is hypotonic as compared to plasma. Hyperkalemia may also be due to transient acidosis which transiently displaces potassium from the intracellular space and diffusion of potassium released from the injured prostatic cells.

One patient in group 'G' had significant intra-operative blood loss and had decrease in hemoglobin concentration to <7 g/ dl. ST elevation was noted in one patient in each group. Changes in mental status were seen in one patient in group 'W'. In these cases, the procedure was abandoned and patients were shifted to ICU care for one day. Intraoperatively, hypotension was noted in two patients in each group. It was managed with Inj. Mephentermine 6 mg IV. Two patients of group 'G' and three patients of group 'W' had intra-operative bradycardia. It was managed with Inj. Atropine 0.6 mg IV. Two patients in each group had post-operative nausea and vomiting. We have not come across the TURP syndrome cases in our study. None of the patients had complaints of visual disturbances. We have not observed ECG changes of hyperkalemia in any patient. All the cases were performed under regional anaesthesia (subarachnoid block) without any supplementation with sedation or general anaesthesia drugs.

Summary

We hypothesized that sterile water as an irrigant fluid has similar vital parameter changes, electrolyte changes, safety profile and incidence of complications as that of Glycine 1.5%. Most of participants of present study were between 61-70 (56.67%) years of age group. Duration of TURP varied from 25 - 65 minutes with mean surgery duration of 47 ± 12.2 min. in group 'G' and 44.5 ± 10.2 min in group 'W'. Mean irrigation fluid volume used was 10.7 ± 3.63 L in group 'G' and 9.9 ± 4.21 L in group 'W'. ???? Total irrigation fluid used ranged from 2.5 L - 22 L. Mean prostate mass resected in group 'G' was 38.1 ± 8.4 gm and in group 'W' was 40.6 ± 9 gm. All these variables were comparable amongst the two groups. In our study, we found no much change in intra-operative pulse rate, systolic and diastolic blood pressure changes during TURP surgery. Haemoglobin levels were measured pre-operatively, post-operatively and 24 hrs after TURP surgery in the two groups. In both groups,

post-operative mean haemoglobin was lower than the baseline mean haemoglobin. These decreases in haemoglobin levels were similar in both groups. After 24 hours, mean haemoglobin level had increased, but was lower than the baseline value in both groups. These changes were also similar in both groups.

Conclusion

As per observations of present study, it was concluded that,

1) Sterile water when compared to Glycine (1.5%) was safe and economical irrigation fluid for 'Trans-urethral resection of prostate' surgery.
2) As irrigant fluid, Sterile water and Glycine (1.5%) have similar safety profile. Sterile water did not cause extremes of hyponatremia or hyperkalemia if duration of surgery was restricted to 60 min or less.
3) Sample size of current study was too small to reach at a definitive conclusion about incidence of TURP syndrome with sterile water and glycine. (The prevalence of the TURP syndrome is ~0.5%).
4) The similar studies are planned in future on large sample size to confirm our observations regarding changes in vital parameters, change in electrolytes & haemoglobin and incidence of TURP syndrome.

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References

1. Moorthy H K, Philip S. TURP syndrome - current concepts in the patho-physiology and management. Indian J Urol 2001; 17:97-102.
2. Porter M, McCormick B. Anaesthesia for transurethral resection of prostate. WFSA Update in Anaesthesia 2003; 25(16): 21-6
3. Hahn RG: Fluid absorption in endoscopic surgery. Br J Anesthesia. 2006, 96: 8-20.
4. Hahn RG: Hallucination and visual disturbances in transurethral prostatic resection. Intensive Care Med. 1988, 14: 668-71.
5. Byard RW, Harrison R, Wells R, Gilbert JD. Glycine toxicity and unexpected intra-operative death. J Forensic Sci2001; 46: 1244–6.
6. Coppinger SW, Lewis CA, Milroy EJ. A method of measuring fluid balance during transurethral resection of the prostate. Br J Urol. 1995; 76:66–72.
7. Permi J: Serum acid phosphatase in TUR syndrome. Ann. Chir. Gynecol. Suppl. 1993; 206: 24-30.
8. Hahn RG. Acid phosphatase levels in serum during transurethral prostatectomy. Br J Urol. 1989; 64:500–3.
9. Hultén JO, Tran VT, Pettersson G. The control of haemolysis during transurethral resection of the prostate when water is used for irrigation: monitoring absorption by the ethanol method. BJU Int. 2000; 86: 989–92.
10. Hahn RG, Olssen J: Ethanol monitoring of the transurethral resection syndrome. J Clin Anesth. 1996, 8: 652-5.
11. Bender DA, Coppinger SW. Estimation of irrigant absorption during transurethral resection of the prostate-assessment of fluorescein as a marker. Urol Res. 1992; 20:67–9.
12. Hahn RG. Smoking increases the risk of large-scale fluid absorption during

transurethral prostatic resection. J Urol. 2001; 166:162–5.
13. Agarwal R, Emmett M. The post transurethral resection of prostate syndrome- therapeutic proposals. Am J Kidney Dis. 1994; 24:108–11.
14. Hahn RG: Irrigating fluids in endoscopic surgery. Br J Urol. 1997, 79: 669-80.
15. Moorthy K, Philip S. Serum electrolytes in TURP syndrome- Is the role of potassium under-estimated? Indian J. Anaesth. 2002; 46(6): 441-4.
16. Moharari RS, Khajavi MR, Khademhosseini P, Hosseini SR, Najafi A. Sterile water as an irrigating fluid for transurethral resection of the prostate: anesthetical view of the records of 1600 cases. South 2008 Apr; 101(4):373-5.
17. Memon A, Buchholz N-P, Salahuddin S. Water as an irrigant in transurethral resection of the prostate: a cost-effective alternative. Arch Ital Urol Androl 1999; LXXI: 131–4.
18. Aghamir SM, Alizadeh F, Meysamie A, Assefi Rad S, Edrisi L. Sterile water versus isotonic saline solution as irrigation fluid in percutaneous nephro-lithotomy. Urol J. 2009; 6:249-53.
19. Dissayabutraa T. Irrigation with water during transurethral resection of the prostate (TURP) induces intravascular hemolysis. Asian Biomed. 2014 Feb 21; 7(6):795.
20. Shih HC, Kang HM, Yang CR, Ho WM. Safety of distilled water as an irrigating fluid for transurethral resection of the prostate. J Chin Med 1999 Aug; 62(8):503-8.
21. Norlen H, Allegen LG: A comparison between intermittent and continuous transurethral resection of the prostate. Scand. J. Urol. Nephrol. 1993; 27(1): 21-5.
22. Moskovitz B, Ross M, Bolkier M, Rosenberg B, Levin DR: The use of distilled water as an irrigating fluid in patients undergoing transurethral resection of the prostate. Eur. Urol. 1989; 16(4): 267-70.