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The effect of bipolar and monopolar resectoscope use on optic nerve diameter in transurethral resection of the prostate

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Abstract

Aim: The aim of this study was to investigate the effects of monopolar and bipolar techniques of TURP under spinal anesthesia on serum electrolytes and changes in hemodynamic parameters, and to determine intracranial pressure changes by measuring optic nerve diameter with ultrasonography.

Material and Method: Eighty ASA II-III patients who included in the study. The patients were divided into two groups as the monopolar and bipolar according to the resectoscope technique used by the surgeon. All patients underwent surgery under spinal anesthesia. Optic nerve sheath diameter was measured with ultrasound and the levels of Na+, K+, Hb were measured before and after the operation. In addition, the mean arterial pressure, heart rate and peripheral oxygen saturation of the patients were recorded at regular time intervals, and the amount of irrigation solutions used, the amount of intravenous volume administered and duration of operation were recorded.

Results: In this study including 80 patients, the MAP and heart rate of patients at all perioperative time points and postoperative measurements were significantly lower when compared to baseline values ($p < 0.001$). The volume of irrigation fluid used was significantly higher in group monopolar ($p = 0.004$), and the duration of operation was also significantly longer in group monoplar compared to group bipolar ($p = 0.035$). The decrease observed in postoperative Na+ values of group monoplar was significant compared to baseline value ($p = 0.01$). In addition, a significant difference was found between the groups in terms of mean postoperative Na+ values ($p < 0.001$). While the change in preoperative and postoperative hemoglobin values in both groups was statistically significant, no difference was observed between the groups ($p < 0.001$ and $p = 0.02$, respectively). The change in optic nerve sheath diameter was significant in both groups ($p < 0.001$ for both).

Conclusion: In TUR-P surgery, ICP changes in patients can be followed by ONSD measurement using ultrasound.

Introduction

Bladder outlet obstruction due to benign prostatic hyperplasia (BPH) is one of the most common urological pathologies in men [1]. Although various new minimally invasive treatments have gained popularity in recent years, transurethral resection of the prostate (TURP) is still considered the gold standard treatment for BPH [2]. The operation is performed using monopolar and/or bipolar resectoscope techniques. In the traditional monopolar TURP method, high-voltage electric currents are applied and irrigation solutions do not contain electrolytes (containing glycine, sorbitol or mannitol). The bipolar resectoscope technique, on the other hand, allows resection and cauterization at the same time by using isotonic saline (0.9% NaCl) solution as the irrigation fluid and applies low-voltage electric current. In addition to electrolyte disorders due to excessive absorption of irrigation fluids during the operation, patients may develop clinical symptoms such as postoperative headache, restlessness, confusion, cyanosis, hypotension, dyspnea, arrhythmia, and convulsions due to changes in hemodynamics and intracranial pressure (ICP) [3]. Since optic nerve sheath diameter (ONSD) responds to changes in hemodynamic parameters and ICP, we hypothesized that the effects of the fluid and electrolyte imbalances caused by TURP could be evalu-

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ated by measuring ONSD. No such study was found in our literature review.

Because it is a non-invasive, fast and easily applicable method, ONSD measurement has been used in the diagnosis of intracranial pressure changes, with studies utilizing ultrasonography (USG) measurement showing a sensitivity of 95.6% and a specificity of 92.3% [4].

In this study, we aimed to investigate the monopolar and bipolar TURP operations performed under spinal anesthesia with respect to their effects on serum electrolytes and hemodynamic parameters in the perioperative period, and to determine the related ICP changes by measuring ONSD with USG.

Material and Methods

Study Design

After obtaining the approval from our hospital's ethics committee (SBU Bursa Yüksek Ihtisas Training and Research Hospital) (2011-KAEK-25 2108/05-28), registering the study with a clinical trial number (NCT04765397), and permission of patients via informed consent, a total of 80 patients with ASA II-III, aged 50-80, who were scheduled for TURP operation due to BPH, were included in the study. Patients with heart failure, respiratory failure, bleeding diathesis, ocular disorders and those who did not accept spinal anesthesia were excluded from the study. Patients were prospectively grouped into two groups, the monopolar or bipolar groups, according to the surgeon's preference for the resectoscope technique. The operations were performed by the same surgical team.

During the operations, noninvasive monitoring was perfomed for electrocardiogram (derivation II), pulse oximetry and blood pressure, and 3 L/min oxygen was administered via a face mask. Besides the demographic data of patients, we recorded the following data: mean arterial pressure (MAP), pulse rate, peripheral oxygen saturation (SpO2) (preoperative, perioperative every five minutes until 60 minutes, and during recovery room stay), the volume of irrigation and intravenous fluids, duration of operation, and the preoperative and postoperative levels of serum electrolytes (Na+, K+) and hemoglobin (Hb). Hypotension was defined as a 20% decrease in systolic blood pressure from baseline values and was planned to be treated with increased fluid. If hypotension persisted, 5 mg IV ephedrine was administered. Bradycardia was defined as a heart rate of < 50 beats/min and was treated with 0.5 mg IV atropine sulfate. Intraoperative and postoperative complications (respiratory distress, hypotension, hypertension, bradycardia, tachycardia, vomiting, headache, agitation, seizure, rhythm disturbance, and visual disturbance) were recorded.

Anesthesia Technique

Sterilization was achieved by applying 10% povidone iodine solution to the skin area where spinal anesthesia was to be applied in the sitting position. The subarachnoid space was entered using a 25G Quincke-tipped spinal needle (Spinocan, Braun Melsungen AG, Germany) with a median approach from the L4 – L5 space. A solution containing 10–12.5 mg 5% hyperbaric bupivacaine was applied. Sensory block level was tested with the loss of cold sensation at the T8 – T10 level. Surgery was begin after the block occurred.

Surgical Technique

Monopolar or bipolar resectoscope technique was used according to the preference of the same surgical team. In the monopolar patient group, a 26Ch Karl Storz monopolar resectoscope and a 30-degree optical lens were used. With Valleylab Force FX as the energy source, 130 watts for cutting and 80 watts for coagulation were applied. 5% mannitol was used as irrigation fluid (Resectisol, Eczacıbaşı-Baxter). In the bipolar patient group, 26Ch Karl Storz bipolar resectoscope and 30-degree optical lens were used. Karl StorzAutocon II 400 was chosen as the power source and 300 watts was preferred for cutting and coagulation. 0.9% NaCl was used as irrigation fluid.

Optic nerve sheath diameter measurement

With regard to ONSD measurement, in the vast majority of published studies, ONSD is defined as the distance between the external borders of the hyperechogenic area surrounding the optic nerve, which represents the subarachnoidal space including the arachnoid mater. During the measurement of the optic nerve diameter, a layer of water-soluble sterile gel was applied on the upper eyelid which was closed. A linear 10-15 MHz ultrasound probe (GE Healthcare Logiqe Series) was gently applied on the upper eyelid. Part of the optical nerve that enters the orbital globe was monitorized in the 2D mode without exerting much pressure. Diameter of the optic nerve sheath was measured 3 mm behind the optic disk using an electronic caliper after the right contrast was found between the retrobulber echogenic fatty tissue and the vertical hypoechogenic band. All ONSD measurements were performed by the same experienced anaesthesiologist. The ONSD was measured before anesthesia induction and during stay in the postoperative care unit.

Statistical Analysis

Statistical analysis was performed using the SPSS 23.0 program. Descriptive statistics for numerical variables were expressed as mean ± standard deviation, while categorical data were expressed with numbers (n) and percentages (%). The compliance of numerical variables with normal distribution was evaluated with the Shapiro- Wilk test. The Student's t-test was used to compare variables with normal distribution, the Mann-Whitney U test was used to compared those with non-normal distribution. The paired-samples t-test was used for paired analyses, and the two-way ANOVA test was used for repeated measurements. The results were evaluated within the 95% confidence interval and p-values of 0.05 or lower were considered to show significance.

Results

Eighty out of the 96 patients who underwent TURP surgery were included in the study. Ten patients who did not meet the inclusion/exclusion criteria, 2 patients who did not give consent for participation in the study, 3 patients who underwent general anesthesia after unsuccessful

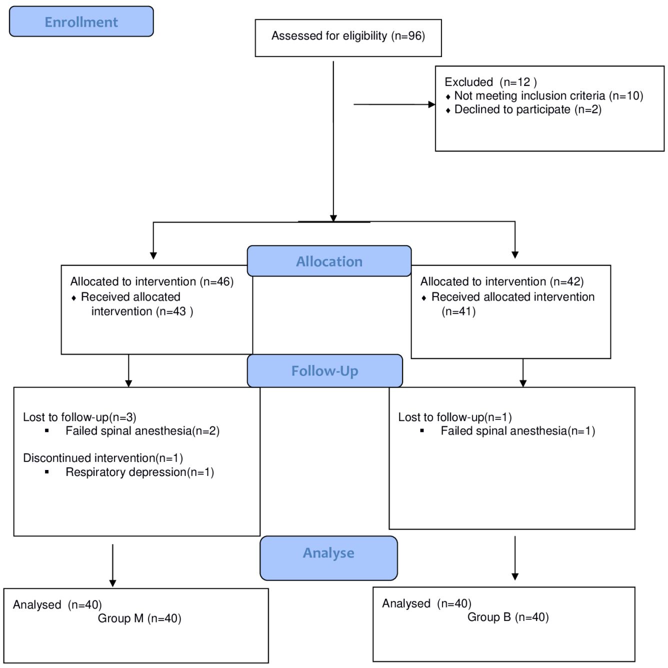

Figure 1. Flow chart

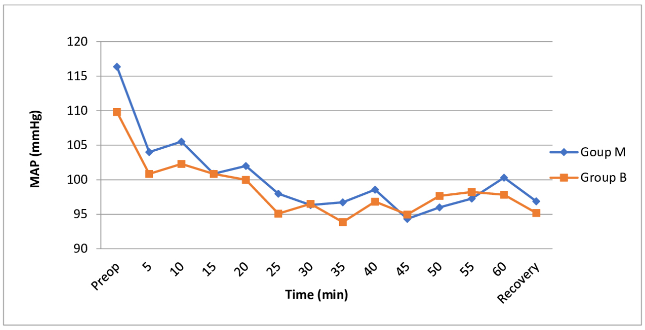

Figure 2. The temporal trend of mean arterial pressure in both groups

spinal anesthesia, and 1 patient who developed respiratory depression during the operation were excluded from the study (Figure 1). There was no significant difference between the two groups in terms of age, weight, height, and ASA (Table 1). The MAP and heart rate of patients at all perioperative time points and postoperative measurements were significantly lower when compared to baseline value (pre-operative measurement ($p < 0.001$) (Figures 2 and 3). However, the difference in the amount of decrease was not significant between groups.

In postoperative measurements, the Na+ values of group monopolar were found to be significantly lower than baseline value ($p = 0.05$). In addition, a significant difference was found in terms of mean postoperative Na+ levels between the two groups ($p < 0.001$). The time-bound decrease in Hb values were significant in both group monopolar and group bipolar ($p < 0.001$ and $p = 0.02$, respectively), but there were no differences between the groups at either time-point ($p < 0.001$, p=0.02). The change in ONSD was also significant in both groups ($p < 0.001$ and p

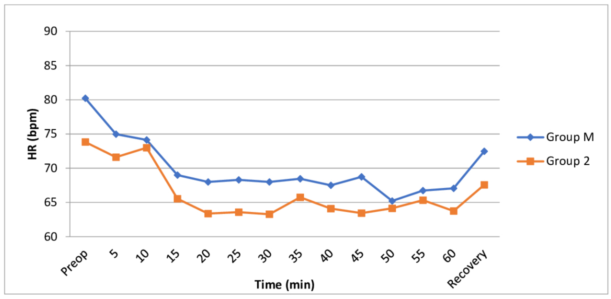

Figure 3. The temporal trend of heart rate in both groups

Table 1. Demographic data (mean ± SD)

	Group M (n= 40)	Group B (n= 40)	P
Age (years)	69.95 ± 7.40	69.02 ± 9.915	0. 624*
Weight (kg)	79.91 ± 13.48	76.18 ± 9.91	0. 135*
Height (cm)	170.16 ± 4.35	169.02 ± 4.93	0. 254*
ASA II/III	32/8	28/12	0. 362**

ASA: American Society of Anesthesiologists, Student t-test *, chi-square test**

< 0.001, respectively); however, no difference was observed between the groups (Table 2).

No patients required blood transfusion. The volume of irrigation fluid used was significantly higher in group monopolar ($p = 0.004$), and the duration of operation was also significantly longer in group monoplar compared to group bipolar ($p = 0.035$) (Table 3).

Discussion

In our study, in which we measured the effects of different methods of TURP on various parameters and ICP (as measured by ONSD), significant changes were observed in preoperative and postoperative ONSD and Hb values in both groups. The decrease in the postoperative Na+ values of the groups was found to be significant in group monopar, and there was a difference between the groups in terms of mean postoperative Na+. In addition, the amount of irrigation fluid used in the monopolar method was higher and the duration of operation was longer.

It is known that the optic nerve diameter decreases immediately after a decrease in cerebrovascular fluid pressure, and therefore, it is accepted that ONSD responds to ICP in real time [5]. Studies have shown that ONSD measurement is a non-invasive and reliable method for dynamic, real-time monitoring of ICP changes, especially in the early stages, and there is a significant correlation between ultrasound measurement of ONSD and ICP [6].

In transurethral prostate resection surgeries, circulatory overload due to significant absorption of irrigation solutions (e.g., glycine, mannitol, saline) is generally accompanied by hyponatremia and hypoosmolality. The movement of fluid between chambers occurs due to the osmotic pressure gradient as a result of the dissolved charge. Hyponatremia and the effective osmolality difference between the brain and plasma cause fluid movement from

Table 2. Comparison of preoperative and postoperative electrolyte, urea, creatinine, Hb values and ONSD measurements of the groups (mean ± SD)

	Group M (n= 40)	Group B (n= 40)	P
Na+(mmol/L)			
1st measure	139.10 ± 2.55	140.08 ± 2.61	0.095
2nd measure	135.86 ± 4.47	139.18 ± 3.76	p < 0.001 *
p	0.01	0.10	
K +(mmol/L)			
1st measure	4.35± 0.51	4.50 ± 0.48	0.167
2nd measure	4.40 ± 0.49	4.39 ± 0.53	0.952
p	0.40	0.23	
Hb (g / dL)			
1st measure	13.84 ± 1.94	13.30 ± 1.40	
2nd measure	11.80 ± 1.73	11.59 ± 1.78	
p	p < 0.001	0.02	0.272
ONSD			
1st measure	4.35 ± 0.49	4.28 ± 0.65	0.432
2nd measure	4.75 ± 0.45	4.63 ± 0.69	0.322
p	p < 0.001	p < 0.001	0.322

ONSD: Optic Nerve Sheath Diamater, *Paired Sample test, Student's t- test

Table 3. Comparison of intraoperative mai, irrigation fluid and duration of operation of the groups

	Group M	Group B	P
IV-administed volume (ml)	1080.56 ± 308.82	960.63 ± 362.34	0.520
Irrigation fluid (ml)	18.233 ± 9.170	12.883 ± 7.635	0.004 *
Prostate volume (cm3)	45.27 ± 4.43	43.95 ± 2.68	0.110
Duration of operation (mins)	77.56 ± 27.13	65.70 ± 23.96	0.035 *

Student's t-test, *p < 0.05

the extracellular compartment to the intracellular compartment. Brain cells begin to swell, which may result in an increase in ICP [7]. Tang et al., in their meta-analysis comparing both methods, reported that bipolar TURP is a safer method for patients because of acute dilutional hyponatremia, less electrolyte change, shorter duration of operation, lower complication rates, better coagulation and surgical exposure, less incidence of TUR syndrome and less risk of clot retention [8]. Although studies have shown a reduced risk of blood transfusion and clot retention with bipolar TURP, the evidence is not considered to be strong enough to make conclusive recommendation in this regard [9]. It is known that 0.9% NaCl solution also greatly reduces the risk of acute dilutional hyponatremia and TUR syndrome, and this is important especially for large prostates that require long-term surgery. In addition, there are studies stating that there is no difference between the two methods in terms of electrolyte changes and complications [10, 11].

Hyponatremia is frequently observed after TURP operations. There are studies showing that hyponatremia may cause brain edema and different degrees of neural damage [12, 13]. In their study, Demir et al. evaluated hyponatremia-related increase in ICP among patients who applied to the emergency department by measuring ONSD [14]. They found that the main reason for this finding was brain edema due to hyponatremia, and in the ultrasonic imaging of ONSD measurement in the emergency department, changes in ICP were consistent with changes in serum Na+. They measured the mean Na+ value as 125.9 ± 6.7 mmol/l. In our study, although there was a significant difference in postoperative Na+ values between the groups, the mean Na+ values of the groups were 135.8 ± 4.4 (group M) and 139.1 ± 3.7 (group B).

Along with the absorption of irrigation fluids used during the operation, IV-administered volume may cause hemodynamic load in patients. In a study evaluating volume load by measuring ONSD in patients with severe preeclampsia, the authors concluded that this approach was an easy, non-invasive method that could be used to evaluate general fluid status [15]. Since additional fluid intake may cause pulmonary edema or other complications related to fluid overload in preeclamptic patients, it was thought that ONSD measurement may be useful with respect to other factors as well. In a study investigating the relationship between volume status and ONSD after cardiac surgery, central venous pressure (CVP), 72-hour net fluid balance, ONSD and inferior vena cava (IVC) diameter measured by ultrasound were followed. A significant correlation of optic nerve diameter with CVP, IVC diameter, and 72-hour fluid balance has been demonstrated [16]. In patients who underwent cardiac surgery, the change in ONSD was found to be associated with the change in volume status. They concluded that ONSD could help predict cerebral edema, and that ONSD result was not only a potential index for assessing volume status, but also a guiding parameter to improve prognosis after cardiac surgery.

In our study, no difference was observed between the two groups in terms of IV-administered volume and prostate volume. Although the prostate volume was similar between the groups, we can attribute the longer duration of operation and higher volume of irrigation fluid used in the monopolar group to the differences in the surgeons performing the procedure. The increase in irrigation fluid used and hyponatremia in the monopolar group were not reflected in the clinical picture. Therefore, TUR syndrome was not found in any of the patients. Significant changes in ONSD and Hb values were observed in both groups. Dilution as a result of absorption of irrigation fluids in the methods used, and bleeding during the procedure may cause an increase in ICP. The patients did not need blood transfusion due to bleeding and no peroperative symptoms were observed.

Anesthesia method is also important for the observation of fluid absorption or the negative findings that may occur in electrolyte changes in routine TURP surgeries. Prolonged hemodynamic changes that develop after spinal anesthesia may also result in ICP changes by causing cerebral perfusion disorder. Since transurethral resection procedures are generally applied to geriatric patients, is spinal anesthesia considered primarily [17]. Stabilization of hemodynamics in these patients is a sensitive matter, and therefore, volume replacement and electrolyte changes are important characteristics. Neurological findings, such as nausea, vomiting, confusion and irritability, are noticed early in cases under spinal anesthesia. In geriatric patients, obtaining blockade extending to the T10 level is sufficient for anesthesia, and also has the advantages of causing lower risk for hypotension and bradycardia. For this purpose, the anesthetic dosage should be carefully optimized. Most experienced anesthesiologists can reduce the dosage of intrathecal anesthetics to avoid high blockage. Marty et al. stated that the dose of bupivacaine should be 10 mg or less to avoid hypotension [18]. In our study, the dose of bubivacaine was used at a range of 10-12.5 mg, similar to this suggestion. After spinal anesthesia, MAP and ONSD measurements were found to be significantly lower than the initial measurements. This decrease was not significant between groups. Since the patients were intervened when hypotension and bradycardia developed, long-term hemodynamic changes were prevented. In our study, only 3 patients had nausea, but recovered without the need for drug treatment.

Limitations

The limitations of our study include the fact that this was a single-centered study. In addition, the amount of bleeding and postoperative osmolarity of the patients were not measured.

Conclusion

We concluded that hemodilution due to fluid absorption and low Hb in both methods used in TURP surgery patients caused an increase in ICP. We think that ONSD measurement using ultrasound during TURP surgeries may be an alternative monitoring method for early diagnosis and treatment of complications.

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