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Original Research Article

COMPARISON OF EFFICACY AND CLINICAL OUTCOMES OF BIPOLAR TURP AND MONOPOLAR-TURP IN BENIGN PROSTATIC HYPERPLASIA

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ABSTRACT

Background: Benign Prostatic Hyperplasia (BPH) is a prevalent condition in elderly males, leading to lower urinary tract symptoms (LUTS) that impact the quality of life. Transurethral resection of the prostate (TURP) is the gold standard surgical intervention for BPH. Monopolar TURP (M-TURP) has traditionally been used, but Bipolar TURP (B-TURP) has emerged as a safer alternative, potentially reducing complications such as TUR syndrome, blood loss, and postoperative strictures. This study aims to compare the efficacy and clinical outcomes of B-TURP versus M-TURP. **Objectives:** To compare the efficacy, safety, and clinical outcomes of B-TURP and M-TURP in patients with BPH in terms of symptom relief, perioperative parameters, and postoperative complications.

Materials and Methods: This prospective, comparative study was conducted at Adichunchanagiri Institute of Medical Sciences from November 2023 to November 2024. A total of 86 patients diagnosed with BPH were randomized into two groups: 43 undergoing M-TURP and 43 undergoing B-TURP. Preoperative parameters including IPSS, QoL index, Qmax, hemoglobin, and sodium levels were recorded. Intraoperative and postoperative parameters such as resection time, prostate volume resected, hemoglobin drop, sodium changes, IPSS improvement, and complications were analyzed using statistical tests, considering a p-value <0.05 as significant.

Results: Both groups showed significant improvement in IPSS, QoL index, and Qmax postoperatively, with no significant difference between M-TURP and B-TURP. The mean prostate volume resected and resection time were similar in both groups. However, B-TURP demonstrated significantly lower sodium depletion ($p<0.001$), indicating a reduced risk of TUR syndrome. B-TURP had higher rates of clot retention (14% vs. 7%) and failure to void (23.3% vs. 10%), which were statistically significant ($p<0.001$). No TUR syndrome was reported in either group.

Conclusion: B-TURP offers similar efficacy to M-TURP in terms of symptom relief and uroflowmetry outcomes. It provides a safer alternative by significantly reducing the risk of dilutional hyponatremia, making it preferable for patients with cardiac comorbidities or electrolyte imbalances. Future larger-scale studies with longer follow-ups are recommended to assess long-term functional outcomes and complications.

Keywords: Benign Prostatic Hyperplasia, Bipolar TURP, Monopolar TURP, LUTS, TUR Syndrome, Uroflowmetry, IPSS, Quality of Life.

INTRODUCTION

Prostate is a pyramidal shaped major accessory sex gland of male reproductive system. It surrounds the prostatic urethra from base of bladder to external urethral sphincter. Prostate is accessory sex gland in males which secretes prostatic fluid, which constitutes about one sixth of total seminal secretion. As the age increases prostate continues to enlarge under the influence of testosterone and dihydrotestosterone which produces urinary bladder outlet obstruction. Benign prostatic hyperplasia (BPH) is one of the most common problems in elderly male. BPH produce variety of symptoms which can even disturb the quality of life.

The development of BPH starts as early as 40 years of age. BPH prevalence is as high as 50% by age of 60 years and approaches to 90% by the age of 85 years.[1] Hesitancy, poor flow, frequency, urgency, nocturia and terminal dribbling are symptoms of prostate enlargement [Lower urinary tract symptoms (LUTS)]. These symptoms can be measured using symptom index. Most widely used symptom index is International prostate symptom score (IPSS) and American Urological Association Symptom Index (AUA-SI). The objective assessment of LUTS can be done using uroflowmetry and urodynamic study. Management of BPH ranges from medical management, minimal invasive approach like Transurethral resection of prostate (TURP), Transurethral needle ablation of prostate (TUNA), transurethral vaporisation of prostate (TUVP), Transurethral enucleation of prostate using Holmium LASER (HoLEP), open prostatectomy.

Surgical intervention for BPH is required for patients who have severe symptoms secondary to BPH and who do not respond to medical therapy, and those who develop BPH related complications. Trans urethral resection of prostate (TURP) using monopolar cautery (M-TURP) is the most commonly used method for management of BPH. TURP using Bipolar cautery (B-TURP) is one of the newer methods with less complication rates like reduced blood loss, lower incidence of TUR syndrome, less collateral damage to tissue and less post-operative stricture rate. It allows larger gland resection, early recovery, early removal of catheter and it is also safe in patients with cardiac pacemakers, when compared to monopolar TURP. We studied the efficacy, advantages and disadvantages of B-TURP in comparison with M-TURP.[2,3] Hence this study was conducted with the objective to compare the efficacy and clinical outcomes of bipolar TURP (B-TURP) over monopolar-TURP (M-TURP).

MATERIALS AND METHODS

This study was a prospective comparative study conducted using simple random sampling. It was carried out at AIMS, BG Nagara (a tertiary care centre) from Nov 2023 to Nov 2024. The study included all patients who underwent Transurethral Resection of Prostate (TURP) at our hospital and met the inclusion and exclusion criteria. The sample size was estimated by N-MASTER software developed by CMC Vellore for calculating sample size for two groups with finite population correction, based on previous studies. Sample of 43 subjects were included in each group. Patients diagnosed with Benign Prostatic Hyperplasia (BPH) requiring TURP were included in the study and Patients with carcinoma of the prostate, Previous history of prostatic or urethral surgery, Presence of urethral stricture, BPH associated with bladder calculus greater than 2 cm were excluded.

Method of Study: Approval was obtained from the Institutional Ethics Committee, and informed consent was taken from all patients prior to the surgery. Patients were randomly assigned to either the Monopolar TURP (M-TURP) group or the Bipolar TURP (B-TURP) group using a closed envelope method. Patient details were recorded in the study proforma.

In the M-TURP group, glycine was used as the irrigating fluid, whereas in the B-TURP group, saline was used. The Alan bipolar system was used for resection in the B-TURP group, with power settings of 190W for cutting and 100W for coagulation. The Covidien monopolar cautery system was used in the M-TURP group, with power settings of 110W for cutting and 70W for coagulation.

The instrument setup for monopolar TURP included a 26-Fr Karl Storz continuous flow rotating sheath with a visual obturator, resectoscope, monopolar loop, high-frequency cord, 30-degree Karl Storz telescope, and diathermy. The setup for bipolar TURP was similar, with modifications. The bipolar working element had no shaft, a modified slot for engaging the bipolar loop, and an adapter to fit into the resectoscope sheath used for monopolar TURP. The high-frequency cable was integrated into the loop, preventing separation from the cable, unlike in the monopolar loop system. A leak-proof visor was also present in the shaft of the bipolar loop.

Peri-operative Workup: All patients underwent detailed demographic evaluation, history-taking, and physical examination. International Prostate Symptom Score (IPSS) and Quality of Life (QoL) index scores were recorded. Comorbidities such as hypertension, diabetes mellitus, and coronary artery disease were documented, along with drug history, especially regarding anticoagulants or antiplatelet therapy. Physical examination was conducted, including genital and digital rectal examination with grading of the prostate. Preoperative investigations included complete urine analysis, urine culture and sensitivity, with appropriate antibiotic treatment for positive cultures. Laboratory investigations included complete blood count, serum creatinine, serum electrolytes (sodium and potassium), and blood grouping and typing. Serum PSA levels were

measured in selected patients. Ultrasonography (USG) of the kidneys, ureters, and bladder (KUB region) was performed by a radiologist to assess prostate size. Uroflowmetry was conducted for non-catheterized patients, and urodynamic evaluation was performed for selected cases.

After obtaining patient consent, individuals were randomized into two groups—Group A (M-TURP) and Group B (B-TURP)—using the random chit-picking method on the day of surgery. The TURP procedures were performed by four senior consultants at our hospital. Anesthesia consent was obtained, and the type of anesthesia was determined by the anesthetist based on the patient's condition.

A preliminary cysto-urethroscopy was performed to evaluate the anterior urethra, verumontanum, prostate gland, bladder mucosa, and ureteric orifices. A 26-Fr continuous flow resectoscope was used for resection, with 1.5% glycine as the irrigant in M-TURP (Group A) and 0.9% saline as the irrigant in B-TURP (Group B). The resection was performed using standard techniques.

At the end of the procedure, a 20-Fr or 22-Fr three-way Foley catheter was inserted, and continuous bladder irrigation was initiated postoperatively. Resected prostate specimens were weighed in the operating theater and sent for histopathological examination. Resection time was calculated from the initiation of resection to the removal of the resectoscope sheath, and perioperative complications, such as capsular perforation, were documented.

Postoperative Monitoring; All patients were monitored postoperatively for hematuria, altered sensorium, and changes in vital parameters. At 24 hours post-surgery, hemoglobin and serum sodium levels were measured. Continuous bladder irrigation was maintained overnight as per protocol and was continued further if required, as decided by the consultant. Patients were followed up at one month postoperatively and assessed using IPSS, QoL scores, and uroflowmetry.

Statistical Analysis: Data was entered into Microsoft Excel and analysed using Epi-info version 7.2.1 (CDC Atlanta) software. Descriptive statistics were used to summarize the study population. Statistical tests, including Levene's test, T-test, Fisher's exact test, Pearson's Chi-square test and students t test were used to analyse the data and a p-value of <0.05 was considered statistically significant.

RESULTS

Table 1: Baseline Characteristics comparison between two groups

		M-TURP (n =43)	B-TURP (n =43)	P value
Age (Years) [Mean ± SD]		67.32 ± 11.15	70.30 ± 5.90	0.125
Comorbdities	Diabetes Mellitus	4 (9.3%)	6 (14%)	0.501
	Hypertension	5 (11.6%)	7 (16.3%)	0.534
	DM+HTN	6 (14%)	11 (25.6%)	0.176
	Coronary Artery Diasease	5 (11.6%)	7 (16.3%)	0.534
Indication for surgery	Retention	22 (51.2%)	23 (53.5%)	0.829
	Symptomatic and others	21 (48.8%)	20 (46.5%)	

The mean age of the study population was 68.81 years, ranging from 44 to 84 years. The mean age in the M-TURP group was 67.32 ± 11.15 years, while in the B-TURP group, it was 70.30 ± 5.90 years. There was no statistically significant difference between the two groups (p = 0.125).

Regarding comorbidities, the prevalence of diabetes mellitus was 9.3% in the M-TURP group and 14% in the B-TURP group (p = 0.501). Hypertension was present in 11.6% of patients in the M-TURP group and 16.3% in the B-TURP group (p = 0.534). Patients with both diabetes mellitus and hypertension constituted 14% of the M-TURP group and 25.6% of the B-TURP group, with no significant difference (p = 0.176). Coronary artery disease was observed in 11.6% of M-TURP patients and 16.3% of B-TURP patients (p = 0.534).

Regarding the indication for surgery, 51.2% of M-TURP patients and 53.5% of B-TURP patients underwent TURP due to retention of urine, while 48.8% of M-TURP patients and 46.5% of B-TURP patients underwent the procedure due to symptomatic or other indications. This difference was not statistically significant (p = 0.829). [Table 1]

Table 2: Comparison of Prostate Volume, Volume of Prostate Resected and Resection Time between two groups

	M-TURP (n =43)	B-TURP (n =43)	P value
Prostate volume (in cc)	50 ± 30.43	49.97 ± 24.59	0.996
Mean volume of prostate resected (gms)	19.30 ± 13.62	18.30 ± 8.50	0.684
Resection Time (mins)	40.65 ± 15.83	42.55 ± 11.33	0.524

The mean prostate volume was 50.0 ± 30.43 cc in the M-TURP group and 49.97 ± 24.59 cc in the B-TURP group, with no statistically significant difference (p = 0.996). The overall prostate volume resected ranged from 4 gms to 66 gms, with a mean resected volume of 18.8 gms. In the M-TURP group, the mean prostate volume resected was 19.30 ± 13.62 gms, whereas in the B-TURP group, it was

18.30 ± 8.50 gms. There was no statistically significant difference in the volume of tissue resected between the two groups (p = 0.684).

The mean intraoperative resection time was 41.6 minutes, ranging from 15 to 80 minutes. The mean resection time in the M-TURP group was 40.65 ± 15.83 minutes, whereas in the B-TURP group, it was 42.55 ± 11.33 minutes. Even though the B-TURP group had a slightly longer mean resection time, the difference was not statistically significant (p = 0.524). This indicates that both techniques were equally efficacious in terms of resection time. [Table 2]

Table 3: Comparison Parameters pre and post procedure between two groups

		M-TURP (n =43)	B-TURP (n =43)	P value
Hemoglobin (gms)	Pre Op	12.99	12.28	0.067
	Post Op	12.29	11.67	
	Mean Difference	0.7	0.061	0.571
	% difference pre and post intervention	5.26%	4.64%	
Sodium (mq/dl)	Pre Op	138.74	137.86	0.260
	Post Op	135.62	136.30	
	Mean Difference	3.12	1.56	<0.001*
	% difference pre and post intervention	2.24%	1.11%	
IPSS	Pre Op	17.32	17.76	0.257
	Post Op	9.65	10.02	
	Mean Difference	7.67	7.74	0.752
	% difference pre and post intervention	43.48%	42.56%	
QOL	Pre Op	3.46	3.4	0.257
	Post Op	1.51	1.53	
	Mean Difference	1.95	1.95	0.752
	% difference pre and post intervention	57.36%	56.58%	
Qmax (mi/sec)	Pre Op	7.15	7.70	0.287
	Post Op	16.87	17	
	Mean Difference	9.72	9.3	0.562
	% difference pre and post intervention	57.6%	54.7%	

The mean preoperative hemoglobin level was 12.99 gms in the M-TURP group and 12.28 gms in the B-TURP group (p = 0.067). Postoperatively, the mean hemoglobin level was 12.29 gms and 11.67 gms in the M-TURP and B-TURP groups, respectively. The mean hemoglobin difference postoperatively was 0.7 gms in the M-TURP group and 0.061 gms in the B-TURP group, with no significant difference (p = 0.571).

The mean preoperative sodium level was 138.74 mEq/L in the M-TURP group and 137.86 mEq/L in the B-TURP group (p = 0.260). Postoperatively, sodium levels dropped to 135.62 mEq/L in the M-TURP group and 136.30 mEq/L in the B-TURP group. The mean sodium difference was 3.12 mEq/L in the M-TURP group and 1.56 mEq/L in the B-TURP group, showing a statistically significant difference (p < 0.001).

The preoperative IPSS score ranged from 14 to 24. A majority of patients had a moderate IPSS score, with 86.04% of M-TURP patients and 83.72% of B-TURP patients classified in this category. Severe IPSS scores were observed in 13.96% of M-TURP patients and 16.28% of B-TURP patients. No patients were classified in the mild category. [Table 3]

The mean preoperative International Prostate Symptom Score (IPSS) was 17.32 in the M-TURP group and 17.76 in the B-TURP group (p = 0.257). Postoperatively, the scores improved to 9.65 and 10.02, respectively. The mean reduction in IPSS was 7.67 points in the M-TURP group and 7.74 points in the B-TURP group, with no significant difference (p = 0.752).

The mean preoperative Quality of Life (QoL) score was 3.46 in the M-TURP group and 3.4 in the B-TURP group (p = 0.257). Postoperatively, the QoL score improved to 1.51 and 1.53, respectively. The mean QoL improvement was 1.95 points in both groups, showing no statistically significant difference (p = 0.752).

The mean preoperative Qmax (maximum urinary flow rate) was 7.15 ml/sec in the M-TURP group and 7.70 ml/sec in the B-TURP group (p = 0.287). Postoperatively, Qmax improved to 16.87 ml/sec and 17.00 ml/sec, respectively. The mean improvement in Qmax was 9.72 ml/sec in the M-TURP group and 9.3 ml/sec in the B-TURP group, with no statistically significant difference (p = 0.562). [Table 3]

Table 4: Complications comparison between two groups

	M-TURP (n =43)	B-TURP (n =43)	P value
Clot Retension	3 (7%)	6 (14%)	<0.001*
Failure To Void	6 (10%)	10 (23.3%)	<0.001*
TUR Syndrome	0	0	-

The incidence of clot retention was 7% in the M-TURP group and 14% in the B-TURP group, showing a statistically significant difference ($p < 0.001$). Failure to void was reported in 10% of M-TURP patients and 23.3% of B-TURP patients, which was also statistically significant ($p < 0.001$). TUR syndrome was not observed in either group. [Table 4]

DISCUSSIONS

Benign prostatic hyperplasia (BPH) was one of the most common conditions observed in elderly male patients. Surgical intervention for BPH was required in patients who had symptoms secondary to BPH, those who did not respond to medical therapy, and those who developed BPH-related complications.

Transurethral resection of the prostate (TURP) using monopolar cautery (M-TURP) had been the most commonly utilized method for BPH management. TURP using bipolar cautery (B-TURP) emerged as a newer technique with lower complication rates, including reduced blood loss, lower incidence of TUR syndrome, less collateral tissue damage, and a lower postoperative stricture rate. It allowed for the resection of larger glands, promoted early recovery and catheter removal, and was safer in patients with cardiac pacemakers when compared to monopolar TURP.

This study compared the efficacy and clinical outcomes of B-TURP with M-TURP. A total of 86 patients were randomized, with 43 patients undergoing M-TURP and 43 patients undergoing B-TURP. The demographic characteristics and baseline parameters were comparable between the two groups.

The mean volume of prostate resected in this study was 18.8 gms, with 19.3 gms in the M-TURP group and 18.3 gms in the B-TURP group. There was no statistically significant difference ($p = 0.684$) in the volume of tissue resected between the two techniques. The mean prostate volume resected was similar to the findings in the study by Singla Mamta et al,[3] where the mean resected volume was 22.68 gms in M-TURP and 21.09 gms in B-TURP. However, some larger randomized controlled trials (RCTs), such as the study by Alexander CE et al.4, reported a slightly larger mean prostate volume resected. Thus, the findings in this study were comparable to existing literature in terms of resected prostate tissue.

The mean resection time in the present study was 41.6 minutes, with 40.65 minutes in the M-TURP group and 42.55 minutes in the B-TURP group. Although the resection time was slightly longer in the B-TURP group, the difference was not statistically significant ($p = 0.524$). Similar findings were reported by Charlampos Mamoulakis et al,[5] and Singla Mamta et al,[3] where resection times were nearly identical between B-TURP and M-TURP. However, Dirk P. Michielsen et al,[6] reported longer resection times in the B-TURP group, which could be attributed to the larger mean prostatic tissue resected in their study and the technically slower resection process in B-TURP. This suggested that the resection time for B-TURP increased significantly with larger prostate volumes.

There was a decline in serum hemoglobin levels postoperatively in both groups. The mean hemoglobin drop was 0.7 gms in the M-TURP group and 0.61 gms in the B-TURP group, though the difference was not statistically significant. These findings were consistent with those of Dirk PJ Michielsen et al.6, who also reported insignificant hemoglobin drops between the two techniques. However, studies by Singla Mamta et al.[3] and Piyush Singhania et al,[7] demonstrated a significantly lower hemoglobin drop in the B-TURP group. The difference in hemoglobin reduction observed across studies may be attributable to variations in surgical technique, surgeon experience, and the volume of tissue resected.

The mean postoperative sodium reduction was 3.12 mEq/L in the M-TURP group and 1.56 mEq/L in the B-TURP group, demonstrating a statistically significant difference ($p < 0.001$). This indicated that M-TURP was associated with a greater drop in serum sodium levels. The findings in this study were consistent with Meltem Savran Karadeniz et al., Henry S.S. Ho et al,[8] Singh H et al,[9] and Piyush Singhania et al.7, all of whom reported greater sodium depletion in M-TURP compared to B-TURP. The reduced sodium loss in B-TURP could be explained by the use of normal saline as an irrigating fluid, unlike M-TURP, which utilized glycine, thereby making B-TURP a safer option for preventing TUR syndrome.

Most patients in this study presented with moderate or severe IPSS scores (ranging from 14 to 24). The mean improvement in IPSS scores postoperatively was 7.67 points in the M-TURP group and 7.74 points in the B-TURP group, with no significant difference between the two techniques. Similarly, the mean improvement in QoL scores was 1.95 points in both groups, demonstrating no statistical difference. Qmax also improved significantly postoperatively, with a mean increase of 9.72 ml/sec in M-TURP and 9.3 ml/sec in B-TURP, though this difference was also statistically insignificant. These findings were comparable to studies by Alexander CE et al,[4] Burke et al,[10] Omar et al,[11] and Yang et al,[12] all of which found no significant difference between M-TURP and B-TURP in terms of IPSS improvement, QoL enhancement, or Qmax increase. This confirmed that both techniques were equally effective in relieving LUTS symptoms.

However, B-TURP was associated with a higher incidence of clot retention and a greater number of failed trial voids in the postoperative period, which was statistically significant in this study. These findings were contrary to the studies by Omar et al,[11] Yang et al,[13] and Charlampos Mamoulakis et al,[5] where B-TURP was linked to a lower incidence

of postoperative clot retention and failed trial voids. The discrepancy in results could be explained by variations in preoperative bladder function among the study populations.

None of the patients in this study developed TUR syndrome in either group. However, studies by Omar et al,[11] and Sameer Fathi Al Rawashdah et al,[14] reported a significantly lower incidence of TUR syndrome in the B-TURP group. The difference in findings may be due to the smaller sample size and shorter resection times in this study.

This study had several limitations. Sample size was relatively small, which may have limited the statistical power and generalizability of the findings. A larger multicentric study would be beneficial to validate these results. Secondly, the follow-up period was limited to one month, which may not be sufficient to assess long-term complications such as stricture formation, late urinary dysfunction, or recurrence of symptoms. A longer follow-up period would provide better insights into the durability of clinical outcomes. Thirdly, while this study evaluated perioperative and short-term postoperative outcomes, it did not include a cost-effectiveness analysis comparing M-TURP and B-TURP. Economic factors, including hospital stay duration, need for additional interventions, and equipment costs, play a crucial role in clinical decision-making and should be considered in future studies.

CONCLUSION

Bipolar TURP demonstrates comparable efficacy to Monopolar TURP in symptom improvement, as measured subjectively by IPSS and QoL scores and objectively by uroflowmetry. It offers a safer alternative by significantly reducing the risk of dilutional hyponatremia, enhancing perioperative safety. Given its efficacy and improved safety profile, Bipolar TURP may emerge as the preferred standard technique for transurethral prostate resection in the future.

Recommendations: Given these benefits, B-TURP should be considered as the preferred technique for TURP, particularly in patients with cardiac comorbidities or those at risk for electrolyte imbalances, while M-TURP may still be a viable alternative in settings where bipolar technology is not available. Further long-term follow-up studies with larger sample sizes are recommended to evaluate long-term functional outcomes and complication rates between the two techniques.

REFERENCES

1. Randall A. Surgical Pathology of Prostatic Obstruction. Baltimore, MD: Williams & Wilkins Co; 1931.
2. Hirik E, Altunkol A, Seyitoglu H, Sefik E, Arslan B, Tepeler A, et al. Safety and efficacy of bipolar versus monopolar transurethral resection of the prostate: a comparative study. Urol J. 2015;12(6):2454.
3. Singla M, Singh S, Gupta A. Comparative study to evaluate efficacy of bipolar electrosurgical unit versus monopolar electrosurgical unit in transurethral resection of prostate. Int J Contemp Med Res. 2017;4(2):565-568.
4. Alexander CE, Scullion MMF, Omar MI, Yuan Y, Mamoulakis C, N'Dow JMO, et al. Bipolar versus monopolar transurethral resection of the prostate for lower urinary tract symptoms secondary to benign prostatic obstruction. Cochrane Database Syst Rev. 2019;12:CD009629.
5. Mamoulakis C, Ubbink DT, de la Rosette JJ. Bipolar versus monopolar transurethral resection of the prostate: a systematic review and meta-analysis of randomized controlled trials. Eur Urol. 2009; 56:798-809.
6. Michielsen DPJ, Coomans D, Van Lersberghe C, Braeckman JG. Comparison of the haemostatic properties of conventional monopolar and bipolar transurethral resection of the prostate in patients on oral anticoagulants. Arch Med Sci. 2011; 5:764-71.
7. Singhania P, Dave N, Fernandes S, Pathak H, Iyer H. Transurethral resection of prostate: a comparison of standard monopolar versus bipolar saline resection. Int Braz J Urol. 2010; 36:183-9.
8. Ho HSS, Yip SKH, Lim KB, Fook S, Foo KT, Cheng CWS. A prospective randomized study comparing monopolar and bipolar transurethral resection of prostate using transurethral resection in saline (TURIS) system. Eur Urol. 2007; 52:517-24.
9. Singh H, Desai MR, Shrivastav P, Vani K. Bipolar versus monopolar transurethral resection of prostate: randomized controlled study. J Endourol. 2005; 19:333-8.
10. Burke N, Whelan JP, Goeree L, Hopkins RB, Campbell K, Goeree R, et al. Systematic review and meta-analysis of transurethral resection of the prostate versus minimally invasive procedures for the treatment of benign prostatic obstruction. Urology. 2010; 75:1015-22.
11. Omar MI, Lam TB, Alexander CE, Graham J, Mamoulakis C, Imamura M, et al. Systematic review and meta-analysis of the clinical effectiveness of bipolar compared with monopolar transurethral resection of the prostate (TURP). BJU Int. 2014; 113:24-35.
12. Yang S, Lin WC, Chang HK, Hsu JM, Lin WR, Chow YC, et al. Gyrus plasmasect: Is it better than monopolar transurethral resection of the prostate? Urol Int. 2004; 73:258-61.
13. Yang EJ, Li H, Sun XB, Huang L, Wang L, Gong XX, et al. Bipolar versus monopolar transurethral resection of the prostate for benign prostatic hyperplasia: safe in patients with high surgical risk. Sci Rep. 2016; 6:21494.
14. Al Rawashdah SF, Alghazo MA, Al-Taani MI, Abdel-Rahman S, Elmuhtaseb MS. Prospective randomized study comparing monopolar with bipolar transurethral resection of prostate in benign prostatic obstruction: 36-month outcomes. World J Urol. 2017; 35:1595-1601.