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Transurethral Resection of Bladder Tumour: Safe Implementation of Bipolar Technique

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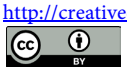

Abstract

Background: Traditionally, monopolar transurethral resection was the standard surgery for bladder tumors. After developing the bipolar technique, it was noticed that patients' morbidity was reduced. We aim to compare bipolar and monopolar transurethral resection of bladder tumors in terms of efficacy, safety, and oncological outcomes. **Patients and Methods:** Clinical records of sixty patients with newly diagnosed bladder cancer who underwent either monopolar or bipolar transurethral resection between March 2019 and April 2021 were prospectively reviewed. **Results:** Thirty patients were included in each group. The mean age in monopolar and bipolar arms was 59.9 and 57.5 years, respectively. The obturator reflex occurred in 13.33% and 36.66% of the bipolar and monopolar arms, respectively ($p = 0.032$). Bladder perforation was reported in 2 cases in the monopolar arm. The resection time was significantly longer for the monopolar arm (25.45 Vs 22.85 minutes). Also, the monopolar arm reported longer mean irrigation (23.34 Vs 20.11, $p = 0.039$), with 1 TUR syndrome reported in the monopolar arm. The mean hemoglobin drop was more in the monopolar arm (0.9 Vs 0.5 gm/dl, $p = 0.041$). No statistical significance was reported regarding the histopathology results, and one patient in the monopolar group did not have muscle in his specimen. There was no statistically significant difference in recurrence and prognosis between both groups. **Conclusions:** The bipolar technique has demonstrated its reliability and efficiency as a surgical procedure, providing various advantages while minimizing the risk of complications.

Keywords

Bladder Cancer, TURBT, Monopolar and Bipolar

1. Introduction

Non-muscle invasive bladder cancer (NMIBC) accounts for 80% of bladder cancers. The most common presenting symptom of bladder cancer is painless hematuria, which occurs in about 85% of patients. Also, the symptom complex of bladder irritability and urinary frequency, urgency, and dysuria is the second most common presentation of bladder cancer and is usually associated with diffuse carcinoma *in situ* (CIS) or invasive bladder cancer. The majority of bladder tumors are transitional cell carcinoma (TCC) (around 90%) and the rest are squamous cell carcinomas, adenocarcinomas, and rare varieties like small cell carcinoma. NMIBC represents about 75% - 85% of bladder cancers with disease limited to the mucosa (stage Ta and CIS) or submucosa (T1) [1] [2] [3].

Since its introduction in 1926, the resectoscope was used for transurethral resection of bladder tumors (TURBT), which has become the gold standard procedure for the management of NMIBC. It has been proven that the presence of detrusor muscle is crucial for the quality and completeness of resection while the absence of detrusor muscle in the specimen is associated with a significantly high risk of residual disease, tumor understating, and early recurrence [4] [5].

For many years, the standard treatment for NMIBC was Conventional Monopolar TURBT (mTURBT) which has been predominantly used for accurate diagnosis, staging, and initial management of NMIBC. Monopolar energy depends on the current traveling through the patient's body to complete the circuit while the resecting loop and a pad placed on the patient's skin represent both the active and the return electrodes respectively. On the other hand, both the active and return electrodes in bipolar TURBT (bTURBT) are in close proximity to the target tissue, thus the distance the current travels in the body is limited. Moreover, the limited distance of the current travels in the body in bTURBT reduces patient morbidity, especially in pregnant women and cardiac patients with an implanted pacemaker or cardioverter defibrillator which cannot be deactivated [1] [6] [7] [8] [9].

In our study, we evaluate and compare bipolar versus monopolar TURBT procedures in terms of efficacy and safety as well as oncological outcomes in the management of solitary bladder mass not exceeding 4 cm in the largest dimension or two masses each of them is not more than 2 cm in maximum diameter suspected to be NMIBC.

2. Patients and Methods

The study was approved by the local Research Ethical Committee and Quality Assurance Unit of the Faculty of Medicine at Tanta University, Egypt. Informed consent was taken from all participants, which included the aim of the research. All data would be kept confidential through a coding system, as well as all the data would be used in the research only. Additionally, a person, to whom the participants and the relatives could return at any time for any explanation, was identified. Moreover, unexpected risks that appear during the course of the re-

search were declared to the participant and to the ethical committee on time.

Between March 2019 and April 2021, a total of 60 patients newly diagnosed with bladder cancer were randomly selected to undergo TURBT. The odd-numbered patients underwent TURBT using monopolar electrocautery, while the even-numbered patients underwent TURBT using bipolar electrocautery. Specifically, 30 patients underwent mTURBT, and the remaining 30 patients underwent bTURBT. All surgical procedures were performed at the urology department of Tanta University Hospital.

The patients' clinical records, imaging studies, operative notes, and histopathology results were thoroughly reviewed. We prospectively recorded baseline demographics as well as tumor size, location, and number for each patient. Intraoperative variables, such as resection time, irrigation time, and complications (e.g., obturator reflex, bladder perforation, TUR syndrome, and blood loss), were also recorded. Outcomes, including histopathology results, the presence of muscle in the specimen, the need for a second-look procedure, recurrence, and prognosis, were documented as well.

Our study included patients with solitary bladder masses that were not more than 4 cm in size or two masses, each not more than 2 cm. Patients with muscle-invasive bladder cancer, restaging, or recurrent/residual bladder tumors were excluded.

For mTURBT, we used the Martin ME MB3 (Germany) generator, with 100 to 150 W for cutting and 80 to 100 W for cautery. For bTURBT, we used the Karl Storz-AUTOCON® II 400 ESU (Germany) generator, with 160 W for resection and 100 to 120 W for coagulation. A 26Fr continuous-flow resectoscope with a 30˚ telescope was used for all procedures.

Spinal anesthesia was used in all cases. 1.5% glycine and normal saline were used for mTURBT and bTURBT, respectively, at a height of 60 cm from the level of the operating table. The bladder mass was resected from the edge to the center. A further deep muscle biopsy was taken from the tumor bed. Elik's evacuator was used, and adequate hemostasis was obtained. A 22Fr three-way catheter with saline irrigation was placed, which was removed once urine had been clear for 24 hours. Patients were discharged on the first postoperative day. All patients received a single dose of 40 mg Mitomycin C within 6 hours after surgery.

We used SPSS-20 software for descriptive statistical analysis. Qualitative data were described using numbers and percentages, while quantitative data were described using the range, median, and mean ± standard deviation (SD). Significance was determined using the independent t-test for quantitative variables and the chi-square test for qualitative variables. P-values less than 0.05 were considered statistically significant.

3. Results

3.1. Baseline Demographics and Tumor Characteristics

In the mTURBT group, the mean age of the patients was 60 years, while in the

bTURBT group, it was 57 years. The majority of patients in both groups were male, with 25 patients in the mTURBT group and 23 patients in the bTURBT group. Additionally, 23 patients in the mTURBT group and 21 patients in the bTURBT group were either current or ex-smokers. The mean tumor size was 27 mm in the mTURBT group and 29 mm in the bTURBT group. The most common tumor site was found to be on the lateral walls, with 19 cases in the mTURBT group and 20 cases in the bTURBT group (Table 1 and Table 2).

3.2. Intraoperative Variables and Complications

Table 3 summarizes the intraoperative variables and complications observed in the study. The resection time, which was calculated from resection beginning to

Table 1. Baseline demographics.

Age	mTURBT (n = 30)		bTURBT (n = 30)		p value
Range	40.0 - 77.0		37.0 - 74.0		0.632
Mean ± SD.	59.85 ± 10.07		57.35 ± 9.53		
	n	%	n	%	
Male	25	83.33	23	76.66	0.580
Female	5	16.66	7	23.33	
Smoking	23	76.66	21	70	
Active smoker	16	53.33	13	43.33	0.825
Ex-smoker	7	23.33	8	26.66	

mTURBT: monopolar transurethral resection of bladder tumor. bTURBT: bipolar transurethral resection of bladder tumor. n: number. SD: Standard deviation.

Table 2. Tumour characteristics.

Tumour Size (mm)		mTURBT (n = 30)		bTURBT (n = 30)		p value
Range		17 - 40 mm		18 - 38 mm		0.932
Mean ± SD.		27 ±4.4		29 ± 3.8		
Location		**n**	**%**	**n**	**%**	
Left lateral wall		11	36.66	13	43.33	0.721
Right lateral wall		8	26.66	7	23.33	
Trigone		4	13.33	6	20.00	
Posterior wall		5	16.66	3	10.00	
Dome		2	6.66	1	3.33	
Multiplicity	Single	24	80.00	22	73.33	0.957
	Multiple	6	20.00	8	26.66	

mTURBT: monopolar transurethral resection of bladder tumor. bTURBT: bipolar transurethral resection of bladder tumor. n: number. SD: Standard deviation.

Table 3. Intraoperative variables and complications.

Operation time (minutes)	mTURBT (n = 30)		bTURBT (n = 30)		p value
Range	20.0 - 30.0		17.0 - 28.0		0.03*
Mean ± SD	25.45 ± 5.73		22.85 ± 7.52		
Irrigation time (minutes)					
Range	17.0 - 25.0		15.0 - 22.0		0.039*
Mean ± SD	23.34 ± 4.52		20.11 ± 3.32		
Blood loss (Hemoglobin drop = gm/dl)					
Range	0.5 - 1.3		0.4 - 0.6		0.041*
Mean ± SD	0.9 ± 0.12		0.5 ± 0.1		
	n	**%**	**n**	**%**	**p value**
Obturator reflex	11	36.66	4	13.33	0.032*
Bladder perforation	2	6.6%	0	0	0.071
TUR syndrome	1	3.3%	0	0	0.093

mTURBT: monopolar transurethral resection of bladder tumor. bTURBT: bipolar transurethral resection of bladder tumor. n: number. SD: Standard deviation. TUR syndrome: transurethral resection syndrome. *: Statistically significant at $p \leq 0.05$.

resectoscope sheath removal, was longer for mTURBT (25.45 minutes) than for bTURBT (22.85 minutes) ($p = 0.03$). Also, the monopolar arm reported longer mean irrigation time than bTURBT (23.34 Vs 20.11, $p = 0.039$), with 1 TUR syndrome reported in the monopolar arm.

Regarding the obturator reflex, the study reported a statistically significant difference between the two groups. The bTURBT group had 4 cases (13.33%), while the mTURBT group had 11 cases (36.66%) ($p = 0.032$). Bladder perforation was reported in 2 cases in the monopolar arm.

Blood loss was estimated by the difference between pre-and post-operative haemoglobin concentration. The mean haemoglobin drop was more in the mTURBT group than bTURBT (0.9 and 0.5 gm/dl, respectively. $p = 0.041$). However, blood transfusion was not required in any of the cases.

3.3. Postoperative Outcomes

Table 4 showed no statistical differences between the two groups regarding histopathology results. Regarding cautery artifact, it was more common in the mTURBT group, with 11 cases (36.66%) compared to 5 cases (16.66%) in the bTURBT group. This difference was statistically significant ($P = 0.041$) (Figure 1).

In terms of the presence of muscle in the specimen, the bipolar resection group had all patients with muscle in their specimens without the need for a second look. In contrast, one patient (3.33%) in the monopolar resection group, who had a domal mass, did not have muscle in his specimen due to incomplete

Table 4. Histopathology and cautery artifact results.

	mTURBT (n = 30)		bTURBT (n = 30)		P value
	n	%	n	%	
Pathology T stage and grade					
Low-grade TCC	14	46.66	17	56.66	0.892
High-grade TCC	16	53.33	13	43.33	
Pathological T Stage					
Ta	14	46.66	12	40.00	
T1	12	40.00	13	43.33	0.847
T2	4	13.33	5	16.66	
Cautery artefact	11	36.66	5	16.66	0.041*

mTURBT: monopolar transurethral resection of bladder tumor. bTURBT: bipolar transurethral resection of bladder tumor. TCC: transitional cell carcinoma. n: number. *: Statistically significant at $p \leq 0.05$.

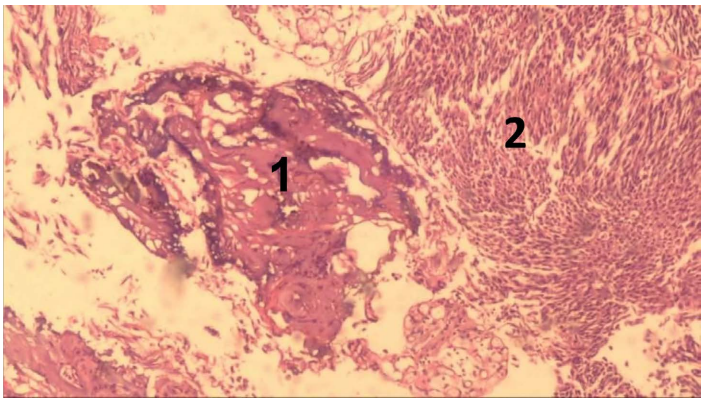

Figure 1. Cautery artifact (by monopolar technique). (1) The cautery artifact. (2) The malignant cells.

resection because of difficult resectoscope access. This patient required a second look one month later. The difference between the two groups in this regard was not statistically significant (p value = 0.889).

The study also evaluated the recurrence and prognosis of patients who underwent either mTURBT or bTURBT. None of the patients with pTaLG tumors in either arm experienced recurrence ($\chi^2 = 1.106$, p = 1). In patients with pTaHG tumors, one case (3.33%) in each arm showed recurrence, and they were advised to undergo an induction course of intravesical BCG followed by maintenance for one year ($\chi^2 = 1.003$, p = 1) (Table 5).

Regarding patients with pT1 tumors, one case in mTURBT (3.33%) and two cases in bTURBT (6.66%) showed recurrence, which was pT1LG. They were also advised to undergo an induction course of intravesical BCG followed by maintenance for one year ($\chi^2 = 2.753$, p = 0.097). Additionally, two cases (6.66%) in mTURBT and three cases (10.00%) in bTURBT showed recurrence, which was

Table 5. Tumor recurrence.

	mTURBT (n = 30)		bTURBT (n = 30)	
	n	**%**	**n**	**%**
pTa LG TCC	0	0	0	0
pTa HG TCC	1	3.33%	1	3.33%
pT1 TCC	3	10%	5	16.66%

mTURBT: monopolar transurethral resection of bladder tumor. bTURBT: bipolar transurethral resection of bladder tumor. TCC: transitional cell carcinoma. LG: low grade. HG: high grade. n: number.

pT1HG. They were advised for radical cystectomy or bladder-preservation strategies ($\chi^2 = 1.583$, p = 0.903) (**Table 5**).

4. Discussion

The successful treatment of urinary bladder tumors relies on two crucial factors: performing an adequate initial resection and obtaining an accurate histopathological diagnosis. Traditionally, TURBT has been predominantly conducted using monopolar electrocautery. However, recently, urologists have started utilizing bipolar energy for TURBT procedures. This shift in technique is driven by the aim to enhance patient outcomes and improve the effectiveness of tumor removal during the surgical procedure. By incorporating bipolar energy into TURBT, urologists strive to optimize the quality of resection and enhance the accuracy of histopathological evaluation, ultimately leading to improved treatment outcomes for patients with bladder tumors [6].

During mTURBT, the current passes from the cutting loop at the tissue interface through the patient to a proportionately larger indifferent electrode located on the skin and subsequently back to the generator. Thus, the patient is part of the system. A non-conductive, hypotonic fluid such as glycine is required for irrigation [9] [10].

In bTURBT, energy is transmitted from the loop electrode into the surrounding saline solution, causing it to evaporate and form a layer of gas around the loop. This gas layer then forms a plasma around the loop, giving it an orange-glowing appearance [8], which showed in **Figure 2**. Plasma consists of freely moving charged molecules, which create a disruption of the tissue at a molecular level, allowing the relatively low voltage to separate tissue [8] [11].

During coagulation, the voltage is maintained at a low level to prevent plasma formation, so only tissue heating occurs, allowing tissue and blood to form a coagulum that seals the bleeders. The tissue will appear white, indicating the formation of a coagulum [12] (**Figure 3**).

Unlike the high voltage and high temperatures used in monopolar coagulation, the lower voltage and temperatures used in the bipolar system minimize charring and blackening of the tissue that is seen during monopolar electrocautery [12] (**Figure 4**).

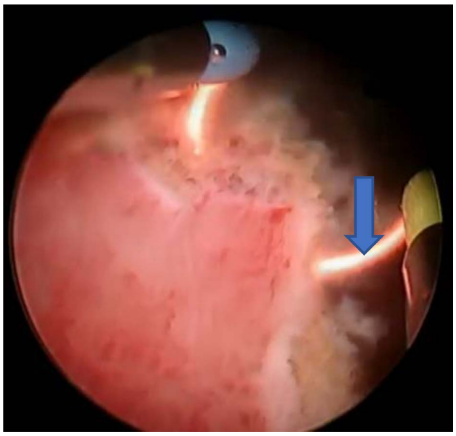

Figure 2. Bipolar piecemeal resection from the edge to the center, the arrow shows the orange glowing appearance of the energized plasma layer surrounding the active bipolar electrode resection loop.

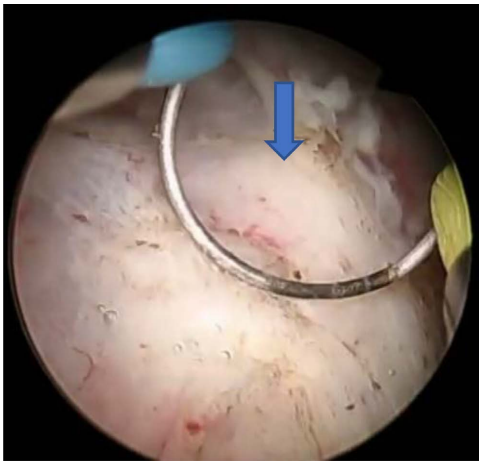

Figure 3. Bipolar hemostasis of the ground tumor and surrounding mucosa, the arrow shows white coagulum.

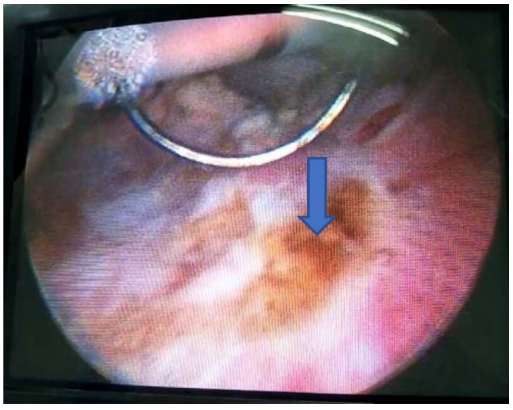

Figure 4. Monopolar hemostasis of the ground tumor and surrounding mucosa, the arrow shows charring and blackening of the tissue.

In our study, we demonstrated a notable statistical significance in relation to the obturator reflex. The incidence of this reflex can be influenced by several

factors, including the tumor's location primarily on the lateral wall, the power setting used, and the administration of general anesthesia with muscle relaxation or obturator block. Consequently, determining the precise occurrence of the obturator reflex becomes challenging. To mitigate these influences in our study, we took measures to avoid bladder over-distension. Notably, two cases in the monopolar arm reported bladder perforation. Subsequently, these two patients required urethral catheters for a period of 3 to 4 weeks.

Gupta and colleagues reported a significant occurrence of obturator reflexes in their first 10 patients when the bipolar power setting was adjusted to 160 and 80 W for cutting and coagulation, respectively. They found that these complications were eliminated by utilizing a lower power setting of 50 and 40 W for cutting and coagulation, respectively [7]. In our study, we used 100 to 150 W for cutting and 80 to 100 W for coagulation during mTURBT and 160 W for resection, and 100 to 120 W for coagulation during bTURBT. But we recommend fixing the power setting in both arms to the limit known to be safe and associated with a lower incidence of the obturator reflex.

Similarly, Zhao and colleagues conducted a meta-analysis and reported a higher incidence of obturator jerk in the monopolar arm and, subsequently, a higher incidence of bladder perforation [5]. Also, the study of Mashni *et al.* favored bipolar TURBT in eliminating the obturator reflex in a statistically significant way compared with monopolar TURBT [13].

The shorter operative time observed in bTURBT in our study was clinically and statistically significant. In bTURBT, a shorter operative time allows for shorter irrigation and less risk of TUR syndrome. Additionally, residual debris adhering to the resectoscope is quickly removed without the need for manual removal, which can be a time-consuming process in mTURBT.

Yang and colleagues conducted a randomized study that yielded comparable results to our study. They reported a longer operation time in mTURBT than in bTURBT (29.5 min vs 28 min) [12]. Also, Xu J and colleagues reported shorter operative time in the bTURBT group at 2 - 3 minute intervals, which was statistically significant [14]. Additionally, the longer irrigation time reported by Zhao and colleagues in the monopolar arm resulted in a higher risk of TUR syndrome [5].

Significant differences in terms of blood loss were observed between the monopolar and bipolar techniques, with the former exhibiting greater clinical significance. This disparity can be attributed to the superior hemostatic capacity of bipolar current, enabling effective deep coagulation and a cut-and-seal effect. Supporting this notion, Yang *et al.* discovered significantly lower postoperative hemoglobin changes in the bipolar group compared to the monopolar group, despite no patients in either group requiring transfusions [12].

Both approaches yielded comparable outcomes concerning the presence of muscle in the specimen. Nevertheless, it is crucial to acknowledge that in cases where resectoscope access poses challenges and leads to incomplete resection, a follow-up examination may be necessary, regardless of the technique employed

for resection.

The recurrence rate observed in our study did not exhibit any significant difference between the two groups. This finding aligns with the results of a meta-analysis conducted by Xie and colleagues, which similarly reported no significant distinction between the two groups [15]. In terms of the presence of cautery artifacts in the specimen, our study yielded results consistent with Venkatramani *et al.*, who conducted a randomized study and demonstrated that bTURBT exhibited a significant lower incidence of cautery artifacts compared to mTURBT. Yang *et al.* and Cui *et al.* also reported lower occurrences of cautery artifacts in bTURBT, although without a significant difference between the two groups [12] [16].

Our study possesses several strengths that contribute to its validity. Firstly, the cases were randomly assigned to the two groups, minimizing selectivity bias and enhancing comparability between the monopolar and bipolar TURBT techniques. Additionally, being a prospective study, it reduces the potential for missing data bias by ensuring comprehensive data collection. However, we do recognize certain limitations in our study. One of these limitations is the relatively small sample size, which may affect the generalizability of the findings. A larger sample size would provide more robust and reliable results. Furthermore, we acknowledge the importance of fixing the power settings in both arms of the study to a known safe limit associated with a lower incidence of obturator jerk. This consideration ensures standardized and consistent energy settings during surgical procedures, reducing the risk of complications and allowing for more accurate comparisons between the two techniques.

5. Conclusion

The bipolar technique is a safe and effective surgery for NMIBC. It reduces the risk of obturator reflex, bladder perforation, TUR syndrome, and blood loss. Additionally, the operation time is shorter, and there is less need for irrigation. Furthermore, it provides better hemostasis.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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