



# Safety and efficacy of bipolar energy for transurethral resection of bladder tumours: a prospective quasi-randomized study

*Mesane tümörlerinin transüretal rezeksiyonunda bipolar enerjinin güvenilirlik ve etkinliği: prospektif yarı-randomize bir çalışma*

Vasudevan Thirugnanasambandam<sup>1</sup>, Jeyaraman Ramanathan<sup>2</sup>

## ABSTRACT

**Objective:** The primary aim of the study was to evaluate the safety and efficacy of bipolar energy in resecting bladder tumors.

**Material and methods:** The study was done between March 2012 and February 2013. This is a prospective quasi-randomized study evaluating the safety and efficacy of bipolar energy in transurethral resection of bladder tumours (TURBT). Institutional Ethics Committee approval was obtained. Informed consent was taken from all patients. Patients were randomized into two groups of 50 each to undergo either monopolar TURBT or bipolar TURBT using glycine and saline irrigation solutions, respectively.

**Results:** Most important of all, the means of variables were compared between the two energy sources to know the difference between them and its significance. Hematocrit level, resection time and obturator jerks had significant values.

**Conclusion:** The results of this study indicated that bipolar resection of bladder tumours have lower incidence of complications especially bleeding, TUR syndrome, obturator jerks and bladder perforation. Bipolar TURBT is safe and efficacious in managing bladder tumours.

**Keywords:** Bipolar; bladder tumor; plasma; saline; transurethral resection.

## ÖZ

**Amaç:** Çalışmanın birincil amacı mesane tümörlerinin rezeksiyonunda bipolar enerjinin güvenilirlik ve etkinliğini değerlendirmektir.

**Gereç ve yöntemler:** Çalışma Mart 2012 ile Şubat 2013 tarihleri arasında gerçekleştirilmiştir. Bu çalışma, mesane tümörlerinin transüretal rezeksiyonunda (TURMT) bipolar enerjisi değerlendiren yarı-randomize prospektif bir çalışmadır. Kurumsal etik komite onayı ve hastaların hepsinden bilgilendirilmiş onam formu alınmıştır. Hastalar monopolar TURMT (n=50) veya bipolar TURMT (n=50) olmak üzere iki gruba randomize edilmiştir. Hastalara glisin kullanılarak monopolar TURMT veya salin kullanılarak bipolar TURMT uygulanmıştır.

**Bulgular:** Her şeyden önemlisi, aradaki farklılığı ve bu farklılığın anlamını bilmek için iki enerji kaynağı değişkenlerinin ortalamaları karşılaştırılmıştır. Hematokrit düzeyi, rezeksiyon süresi ve obturator refleksi açısından anlamlı değerler elde edilmiştir.

**Sonuç:** Bu çalışmanın sonuçlarına göre mesane tümörlerinin bipolar enerjiyle rezeksiyonu özellikle kanama, TUR sendromu, obturator refleksi ve mesane perforasyonu dahil olmak üzere daha düşük komplikasyon insidansına sahiptir. Bipolar TURMT mesane tümörlerinin tedavisinde güvenli ve etkindir.

**Anahtar Kelimeler:** Bipolar; mesane tümörü; plazma; salin; transüretal rezeksiyon.

<sup>1</sup>Department of Urology,  
Mahatma Gandhi Medical  
College and Research Institute,  
Puducherry, India

<sup>2</sup>Department of Urology, Sri  
Balaji Medical College and  
Research Institute, Chennai,  
India

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**Correspondence:**  
Vasudevan  
Thirugnanasambandam  
E-mail:  
akashlaya@gmail.com

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## Introduction

In 1910 Beer was the first to perform endoscopic resection of bladder tumour.<sup>[1]</sup> Since then transurethral resection of bladder tumours

(TURBT) has remained the basic diagnostic and often therapeutic tool for bladder tumours. Conventionally, monopolar loop resection of the bladder tumours have been and are being done using non-conducting irrigation solutions

such as sterile water, 1.5% glycine and other alternative fluids. As an optimal irrigant sterile water is a cheap, and non-conducting solution with many advantages as better field of vision. However intravasation of some amount of water into blood circulation can lead to osmotic lysis of red cells and dilutional hyponatraemia.<sup>[2]</sup> So to reduce this effect but not exclude, non-hemolytic solutions are being used. However even these irrigants are not isotonic, so the incidence of hyponatremia still exists. Besides these irrigants used for monopolar resection are expensive.

Saline is safer than water in many aspects such as it is physiological, has equivalent visibility comparable to water, less expensive, isosmotic with plasma and is considered as the irrigant of choice for endoscopic procedures. But this irrigant cannot be used during monopolar resections as the current will be carried by the saline without any tissue effect.<sup>[3]</sup> With technological advance, invention of bipolar electrosurgery, it has become possible to use physiologic solution such as saline during resection.

For the above-mentioned reasons, bipolar electroresection in saline avoids the risk of TUR syndrome. Mainly because even if large amounts of saline are absorbed, since it is an isotonic solution it does not lead to dilutional hyponatremia.<sup>[4]</sup> Secondly, the incidence of obturator reflex and consequent complications like bladder injury is considered one of the dreaddest complications of monopolar TURBT. Theoretically, the path of electrocurrent in monopolar circuit passes through the patient body and via the patient plate to the generator thereby increasing the chance of stimulating the obturator nerve. Whereas bipolar circuit negates this effect as the current is shunted from active electrode to indifferant electrode within the loop itself.<sup>[5,6]</sup>

There is little evidence in literature as most of the comparative studies are done for prostate and only few for bladder malignancies. With this background we conducted a prospective quasi-randomised study comparing monopolar TURBT with bipolar TURBT.

## Material and methods

The study was conducted between March 2012 and February 2013 in a tertiary care centre in South India. This was a prospective quasi-randomized study evaluating the safety and efficacy of bipolar energy in TURBT. The sample size was calculated from the previous five-year operative record of the patients undergoing TURBT in our centre as there was no accurate prevalence record in the region. On an average, about 120 cases have been operated in the previous five year and following exclusion the sample size was fixed at 100 (50 for monopolar and 50 for bipolar resections). Randomization was done by closed-envelope method on the day of surgery.

Successful complete resection of the tumour with consequent placement of urinary catheter was considered as primary endpoint. Bladder perforation and uncontrolled bleeding were considered as secondary endpoints. All patients diagnosed to have bladder tumour by using ultrasonography, contrast-enhanced computed tomography (CECT) and cystoscopy. Patients with coagulopathy, seriously ill patients, tumours with perivesical extension and metastases and patients with elevated renal parameters were excluded from the study. Institutional Ethics Committee approval was obtained, and informed consent was taken from all patients. Patients were randomized into two groups of 50 each to undergo either monopolar or bipolar using glycine, and saline solutions, respectively.

We used the Gyrus American cystoscope makers Inc. (ACMI) plasma kinetic (PK) system and PK thin loop for resection. The settings we employed for bipolar resection were 160W, and 80W for cutting and coagulation, respectively. Martin ME MB2 (Model) monopolar system was used for monopolar resection at the settings of 120W for cutting and 60W for coagulation. The setup of instruments for Monopolar TUR resection is well known. But the setup for bipolar transurethral resection (TUR) is essentially the same with certain modifications. The working element is modified and has no shaft. There is a modified slot for engaging the Bipolar loop. The working element is provided with an adaptor so that it can fit into the regular resectoscope sheath. The bipolar loop is also modified from the conventional monopolar loop. It is much sturdier to compensate for the shaft which is absent in working element. The high frequency cable is integrated into the loop. So loop cannot be separated from the cable. There is also a Leak-Proof rubber stopper present in the shaft of the loop. All the resections were performed by a single surgeon who was very experienced in performing TURBT. A 26 Fr Karl Storz continuous flow resectoscope was used with either glycine or saline irrigation for both monopolar, and bipolar TURBT.

Following exclusion of ineligible patients, all eligible patients were subjected to either monopolar or bipolar TURBT. Spinal anaesthesia without any nerve block was used and patients underwent the procedure in lithotomy position. Preliminary cystoscopy was done to assess the urethra, prostate gland, and the nature, size, location and multiplicity of bladder tumour. Using a 26 Fr Karl Storz continuous resectoscope sheath and Baumberger type active working element, TURBT was performed in both groups. Tumour resection was done in a step by step manner starting from the summit of the tumour reaching the stalk or the base. Once the base was resected, the underlying muscle was resected separately. The two specimens resected from superficial and deep layers were put in separate containers and sent for histopathological examination. After completion of the procedure all the bleeding points were coagulated and hemostasis secured. We routinely used a 22 Fr three-way Foley catheter for drainage

and irrigation. Irrigation with saline was given for the first 12 hours or till clear urinary drainage was seen.

The resection time was calculated from the period of initiation of resection to the removal of resectoscope sheath. For every patient, resection time, volume of irrigation, obturator jerks, perforation, TUR syndrome, postoperative hemoglobin, hematocrit and sodium levels, weight of the specimen and catheterization period were recorded. Patients were discharged on the day of catheter removal.

**Statistical analysis**

Statistical analysis of the data obtained were analyzed using Statistical Package for the Social Sciences software (version 16) (SPSS Inc., Chicago, IL, USA). The comparison of mean values of continuous and categorical variables was done using Student’s t-test and the chi-square test, respectively. If the p value was <0.05, the result was considered statistically significant and taken as power to reject null hypothesis. Kolmogorov-Smirnov test was applied for data with normal distribution.

**Results**

A total of 145 patients underwent TURBT for bladder tumour during the study period. Out of these 145 patients, 45 patients were excluded from the analysis for various reasons like locally advanced disease (n=18), azotemia (n=12), anticoagulant use which could not be withdrawn for medical reasons (n=8), patient’s desire for bipolar resection (n=5) and also refusal to participate in the study (n=2). So, after excluding these 45 patients, the remaining patients underwent TURBT using either monopolar or bipolar energy (Figure 1).

Preoperative parameters of both monopolar TURBT and bipolar TURBT are presented in Table 1.

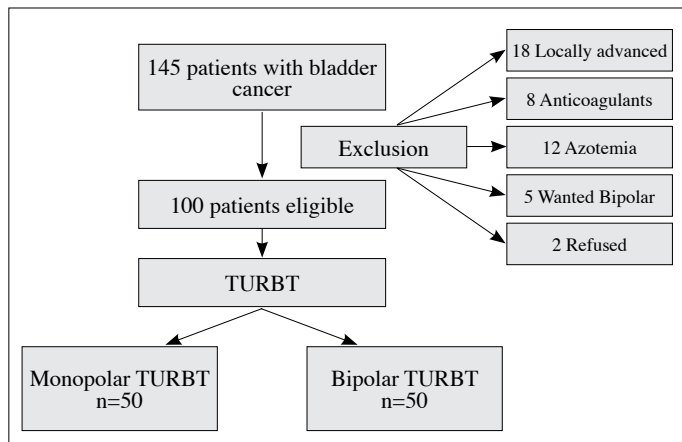


Figure 1. Patient randomization  
TURBT: Transurethral resection of bladder tumour

A total of 50 patients (men, n=45, and women, n=5) with bladder tumours were subjected to monopolar resection. Mean±SD tumour size was 20.6±7.5 mm. The mean drop in hematocrit level after the procedure was 2.38±0.83. The mean drop in sodium concentration after the procedure was 3.2±1.76 mEq/L, with no patient developing TUR syndrome. The mean resection time of the tumours was 24.84±4.75 mins. Perforation of the bladder was noted in 3 cases. Among 50 cases 10 patients had obturator jerks, either occurring singly or multiple times in the same patient (20%) with an average frequency of 0.32. The mean weight of the specimens was 1.52±0.47 gr. We discharged the patient once the hematuria via Foley catheter was not seen and on the day of catheter removal. So the mean hospital stay after the procedure was 2.56±1.88 days (Table 2).

Histopathological examination of the tissue specimens yielded the diagnosis of urothelial carcinoma in 48 patients. Histopathological types of these cases with 48 urothelial carcinoma had papillary (n=17), low-grade T1 (n=16), high-grade T1 (n=12), and muscle invasive (n=3) types. The histopathology of two specimens turned out to be adenocarcinoma and squamous cell carcinoma, respectively. Forty-eight patients received instillation of mitomycin-c within 6 postoperative hours. Twelve

**Table 1. Demographic characteristics of patient and tumour**

Variable	Monopolar TURBT	Bipolar TURBT
Number of patients	50	50
Male	45 (90%)	44 (88%)
Female	05 (10%)	06 (12%)
Age (years)		
Mean+SD	58.2+8.45	56.5+10.4
Range	40-76	32-80
Smoking, n (%)	37 (74%)	35 (70%)
Co-morbidities, n		
Diabetes	14 (28%)	15 (30%)
Hypertension	17 (34%)	18 (36%)
Tumour		
Single	46 (92%)	45 (90%)
Multiple	4 (8%)	5 (10%)
Location		
Lateral wall	29 (58%)	39 (78%)
Posterior wall	2 (4%)	3 (6%)
Anterior wall	1 (2%)	2 (4%)
Trigone	14 (28%)	10 (20%)
Dome	7 (14%)	4 (8%)

TURBT: Transurethral resection of bladder tumour

**Table 2. Comparative evaluation of intra-, and post-operative parameters in monopolar and bipolar TURBT**

	Monopolar (n=50)	Bipolar (n=50)	p
Difference in mean hematocrit (%)	2.38	1.22	0.001
Mean hemoglobin deficit (gr %)	0.42	0.37	0.12
Mean sodium deficit (meq/L)	3.20	3.02	0.601
Mean resection time (mins)	24.84	33.72	0.001
Mean number of obturator jerks	0.32	0.08	0.029
Mean specimen weight (gr)	1.52	1.69	0.46

TURBT: Transurethral resection of bladder tumour

**Table 3. Histopathological characteristics of the patients**

Variable	Monopolar TURBT	Bipolar TURBT
Stage	50	50
Ta	17 (34%)	23 (46%)
T1 low grade	16 (32%)	16 (32%)
T1 high grade	12 (24%)	8 (16%)
T2	3 (6%)	2 (4%)
Histopathology		
Urothelial carcinoma	48 (96%)	49 (98%)
Adenocarcinoma	1 (2%)	00
SCC	1 (2%)	1 (2%)
Intravesical therapy		
Mitomycin-C	48	49
BCG	12	8
Radical cystectomy	5	3

TURBT: Transurethral resection of bladder tumour; SCC: Squamous cell carcinoma;  
BCG: Bacille-calmette-Guerin

patients received induction dose of intravesical Bacille-Calmette-Guerin (BCG) and five patients were subjected to radical cystectomy. These five patients, had detrusor invasion (n=3), squamous cell carcinoma (n=1) and adenocarcinoma (n=1) (Table 3).

A total of 50 patients (men, n=44, and women, n=6) with bladder tumours were subjected to bipolar resection. Mean ( $\pm$  SD) tumour size was 21.68 $\pm$ 7.64 mm. Mean drop in hematocrit level after the procedure was 1.22 $\pm$ 0.46. Mean drop in sodium concentration after the procedure was 3.02 $\pm$ 1.67 mEq/L, with no patients developing TUR syndrome. No perforation of the bladder was noted. The mean resection time was 33.72 $\pm$ 2.36 mins. In a total of 50 patients 4 (8%) cases had obturator jerks at an average frequency of 0.08 times. The mean weight of the resected specimen was 1.69 $\pm$ 0.60 gr. We discharged the patient once the hematuria via Foley catheter was not seen and on the day of

catheter removal. So the mean hospital stay after the procedure was 2.1 $\pm$ 0.36 days (Table 2).

Histopathological examination of the tissue specimens established the diagnosis of urothelial carcinoma in 49 patients. Out of this 49 urothelial carcinomas papillary histology (n=23), low-grade T1 (n=16), high-grade T1 (n=8) and muscle invasive (n=2) were detected. The histopathology of one specimen turned out to be squamous cell carcinoma. Forty-nine patients received post operative instillation of mitomycin-c within postoperative 6 hours. Eight patients received induction dose of intravesical BCG and three patients were subjected to radical cystectomy. These three patients had detrusor invasion (n=2), and squamous cell carcinoma (n=1) (Table 3).

Three patients in the monopolar group had bladder perforation. Two of them were extra-peritoneal and were managed by prolonged catheter drainage. One patient underwent exploratory laparotomy and closure of the perforation. None of the patients in the bipolar group had perforation and no patient in either group required blood transfusion or developed TUR syndrome.

The mean age of the patients in both groups was comparable and intergroup difference did not reach statistical significance (p=0.474). Both groups were comparable in the distribution of sexes and analysis did not reveal any statistical difference (p=0.538). The association of smoking with bladder cancer was also assessed. Even though there was high incidence of tobacco abuse within each group there was no statistically significant difference between the two groups (p=0.656). The comorbidities associated with bladder cancer were also studied and both groups were comparably matched without any statistical difference. The mean packed cell volume was much lesser in the bipolar group than the monopolar group (p=0.001). The resection time between groups also reached significance with prolonged time in the bipolar group (p=0.001). The obturator jerks were more frequent in the monopolar group with statistically significant values (p=0.029). The intergroup differences regarding hemoglobin, and sodium deficit and weight of the resected specimen did not reach statistical significance. Any intergroup difference was not found as for the location of the tumours (p=0.435).

## Discussion

When cystoscopy is performed for bladder cancer, it is prudent to record the location, size, number, and nature of the tumors. Contrast imaging is done to stage the disease and to survey the upper tracts since one of the theories behind the pathology of urothelial carcinoma is "Field change cancerisation".<sup>[7]</sup> The primary treatment for visible lesion is TURBT.

Whenever TUR is being done, venous and lymphatic channels of the tissues are opened up and since the irrigation is done under positive pressure it is understood that irrigant is bound to enter into these channels, thereby leading to aforementioned complications. The degree of absorption of fluid is dependent upon many factors. The height from which the irrigant is delivered, surface area of the resected area, resection time, type of the irrigant used and of course the number of venous channels opened.

In a study conducted by Hahn et al.<sup>[8]</sup> regarding endoscopic resection of bladder tumours using monopolar energy the researchers first reported the incidence of TUR syndrome in four patients. Subsequently, there are few published literature reporting the syndrome with an average incidence of 2% in monopolar TURBT. But when it comes to bipolar TURBT there is even lesser number of studies reporting the incidence of TUR syndrome.

In our study if we take the incidence of TUR syndrome, even though there was a biochemical evidence of minor drop in the level of sodium in monopolar TURBT, none of the patients had symptoms of dilutional hyponatremia. Moreover the statistical analysis of the difference in the sodium levels did not reach significance. In bipolar TURBT, even though there were minor alterations in the sodium levels, none of the patients developed symptomatic TUR syndrome. When we compared the mean sodium drop between monopolar and bipolar TURBT, intergroup difference did not reach statistical significance. This seems to be due to the lesser number of venous channels opened during resection in comparison to TURP and the resection time is much shorter relative to TURP. So whatever energy source is used, the incidence of TUR syndrome seems to be negligible.

When it comes to the incidence of obturator jerks, it is much lesser in bipolar resections compared to monopolar resections. In a study comprising of 160 resections, Kihl et al.<sup>[5]</sup> reported obturator jerks in 10.6% of the cases receiving monopolar energy. Another similar study by McKiernan et al.<sup>[9]</sup> notified obturator reflex in 11% of their patients receiving monopolar energy.

In our study, the incidence rates of obturator jerks in monopolar, and bipolar TURBT were 20%, and 8%, respectively. A statistically significantly higher incidence of jerks was observed in the monopolar TURBT group. On the other hand, multiple number of jerks occurred patients in the monopolar group. In a study conducted by Wuand et al.<sup>[10]</sup> on 121 patients using bipolar TURBT at a power setting of 160 watts for cutting and 80 watts for coagulation mode, the authors reported an overall complication rate of 13.2%, including significant hematuria mandating blood transfusion in 2.5%, bladder perforation in 1.7%, and obturator jerks in 4.9% of their patients.

None of our patients needed transfusion, none had bladder perforation and we noticed obturator jerks in 8% of the patients. We noticed that the jerks were common when the tumour was located on the lateral walls and all of them occurred during the initial activation of the loop. None of the jerks occurred during the actual resection process. Similarly, a study conducted by Gupta et al.<sup>[6]</sup> using low power settings; have noticed a decrease number of jerks and also the jerks were noticed during the activation of the loop. When operating on high risk group like patients with pacemakers, cardiac diseases, unstable angina and patients with decreased pulmonary reserve it is shown that bipolar resection is much safer than monopolar resection.<sup>[6]</sup>

When the resection time was considered, the mean resection time was prolonged with the use of bipolar energy which was statistically significant. This may be explained by the fact that the formation of plasma on activation of the loop has a lag period of few milliseconds, which is experienced by the surgeon in reality. Secondly, slower the loop is moved, better is the hemostasis. To gain on the hemostatic effect of the bipolar energy, it is accepted to lose time during resection. Third factor is that, the surgeon has the tendency to go easy during resection since he is already aware that saline is being used.

The tissue specimens resected by both methods did not interfere in histopathological interpretation by the pathologists. A few studies have shown that due to deep thermal damage produced by monopolar TURBT which imparts artefacts and hence difficulty in histopathological examination.<sup>[11]</sup> But we did not find difficulty in interpreting any of our specimens.

The conclusions that can be drawn from our present study are that bipolar resection of bladder tumours have lower incidence of complications including especially bleeding, TUR syndrome, obturator jerks and bladder perforation. Bipolar TURBT is safe and efficacious in managing bladder tumours.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the ethics committee of Madars Medical College.

**Informed Consent:** Written informed consent was obtained from patients who participated in this study.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept – V.T., J.R.; Design – V.T., J.R.; Supervision – V.T., J.R.; Resources – V.T., J.R.; Materials – V.T., J.R.; Data Collection and/or Processing – V.T., J.R.; Analysis and/or Interpretation – V.T., J.R.; Literature Search – V.T., J.R.; Writing Manuscript – V.T., J.R.; Critical Review – V.T., J.R.

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