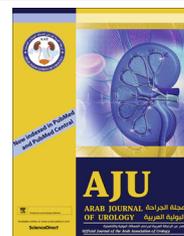




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# Bipolar plasma kinetic enucleation of non-muscle-invasive bladder cancer: Initial experience with a novel technique



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## KEYWORDS

NMIBC, non-invasive muscle bladder cancer; PKEBT, plasma kinetic enucleation of bladder tumour; TUR, transurethral resection

## ABBREVIATIONS

NMIBC, non-muscle-invasive bladder cancer; PK, plasma kinetic; PKEBT, PK enucleation of bladder

**Abstract Objective:** To assess the effectiveness and safety of bipolar plasma kinetic energy for *en bloc* enucleation of non-muscle-invasive bladder cancer (NMIBC).

**Patients and methods:** In all, 46 patients diagnosed with suspected NMIBC were included. All patients were diagnosed using ultrasonography, computed tomography, and diagnostic cystoscopy, and then underwent bipolar plasma kinetic enucleation of bladder tumour (PKEBT). At the end of the procedure, all patients had a single-dose (40 mg in 40 mL saline) intravesical installation of mitomycin C (< 6 h after bipolar PKEBT). Follow-up diagnostic cystoscopy was performed at 3, 6, and 12 months.

**Results:** The mean (SD) enucleation time was 17 (5.4) min, operative time was 27.9 (11.4) min, haemoglobin drop was 1.3 (0.9) g/dL, postoperative irrigation time was 1.7 (2.3) h, and hospital stay was 35.4 (13) h. There was intraoperative bleeding in three patients, with one requiring blood transfusion. There were no other perioperative complications. At the 1-month follow-up, six (13%) patients were diagnosed with residual tumour and underwent repeat bipolar PKEBT. The overall recurrence rate at 12 months' follow-up was 15.2%.

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tumour;  
(b)(m)TURBT, (bipo-  
lar) (monopolar)  
transurethral resection  
of bladder tumour

**Conclusion:** Bipolar PKEBT is an effective procedure for managing NMIBC, as it preserves the entire lamina propria and detrusor muscle in well-intact specimens, with negligible perioperative complications.

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## Introduction

The resectoscope was developed by Maximilian Stern in 1926. Since then conventional transurethral resection of bladder tumour (TURBT), using monopolar electro-resection, has become the ‘gold standard’ procedure for accurate diagnosis, staging, and initial management of non-muscle-invasive bladder cancer (NMIBC) [1].

In recent decades, the bipolar resectoscope has been successfully utilised for urology procedures, particularly for TURP. The main difference between the monopolar and bipolar devices is the configuration of the current pathway. An advantage of bipolar devices is that they can be used with a conductive irrigant (normal saline) rather than the conventional non-conductive irrigant (glycine, sorbitol, and mannitol) required for monopolar electro-resection [2,3]. Bipolar TURBT (bTURBT) has several advantages and benefits compared with monopolar TURBT (mTURBT), e.g. good haemostasis due to deep cutting and coagulation, no dilutional hyponatraemia, a lower incidence of obturator nerve jerk, and less damage to the resection site [4].

The plasma kinetic (PK) resectoscope, is a bipolar resectoscope, recently introduced and has mainly been used for TURP. In this technique, energy is transmitted from the loop electrode into the saline solution, to evaporate and form an interface gas layer around the loop. As result of the addition of voltage to the gas, the excitation of the sodium ions forms plasma, a highly energised state of matter [5].

An *en bloc* tumour enucleation technique can also avoid the most serious disadvantage of the well-established ‘incise and scatter’ resection technique, which is used in conventional TURBT [6].

The aim of the present study was to assess the effectiveness and safety of a novel technique using bipolar plasma kinetic energy for *en bloc* enucleation of NMIBC.

## Patients and methods

This study was carried out at the Department of Urology, Benha University Hospital, Egypt, from February 2012 to June 2013. The study was approved by the Ethical Scientific Committee of Benha University and was in accordance with the principles of the Helsinki Declaration II. A written informed consent was obtained from each participant.

In all, 46 patients diagnosed with suspected NMIBC in a tertiary referral centre and planned for TUR with a new diagnosis of bladder tumour were included in the study. The patients were prospectively recruited for a novel technique of transurethral bipolar plasma kinetic enucleation of bladder tumour (PKEBT). Ultrasonography, CT and diagnostic cystoscopy were used for the diagnosis of bladder tumour. Patients with tumours of > 30 mm and those with more than two masses were excluded.

The effectiveness and safety of the technique were assessed using the following criteria:

- Efficacy of complete tumour removal was tested by detecting the percentage of residual disease by re-staging TUR at 3-, 6- and 12-months follow-up.
- Proper muscle sampling was assessed by histological examination.
- Safety of the procedure was assessed by reporting the total operating time, enucleation time, serum haemoglobin drop, catheterisation time, postoperative hospital stay, and complications.

The bipolar PKEBT was performed using a mushroom loop and the HF Unit UES-40 Surgmaster (Olympus, Tokyo, Japan) as follows:

- Step 1: Coagulate (vaporise) 0.5–1 cm all around the tumour with the mushroom loop to mark the starting point of the resection and for haemostasis.
- Step 2: An incision is made starting at the marked line using the sharp edge of the mushroom loop by tilting the resectoscope to prevent the vaporisation effect of the loop.
- Step 3: The incision is made deeply to reach the muscle layer and continued to complete the *en bloc* resection of the tumour to free it from the bladder wall.
- Step 4: If the tumour is large, we divide it into smaller parts for easy passage into the Ellik evacuator.
- Step 5: Vaporisation of the edges of the bladder wall and the base is repeated to eradicate residual tumour.
- Step 6: Biopsies are taken from the edges and bases to ensure a free surgical margin using the resection bipolar loop.

At the end of the procedure, all patients had a single-dose ((40 mg in 40 mL saline) intravesical installation of mitomycin C (< 6 h after the bipolar PKEBT) via the three-way indwelling urethral catheter. Continuous saline bladder irrigation was used until the efflux became clear, when it became clear the catheter was removed

and the patient was discharged. At 1-month postoperatively, repeat bipolar PKEBT was performed for resection of any residual tumour, and intravesical immunotherapy was introduced if indicated by the pathology results. Follow-up diagnostic cystoscopy was performed at 3, 6, and 12 months. Baseline demographic characteristics and perioperative data including: total operating time, enucleation time, serum haemoglobin drop, catheterisation time, postoperative hospital stay, histological examination results, and complications, were recorded.

## Results

In all, 46 patients underwent transurethral bipolar PKEBT and all the procedures were successfully completed.

In all, 78% of the patients were male (36 patients) and 21.7% (10) were female, with a mean (SD, range) age of 62.7 (8.5, 33–81) years. The mean (SD, range) tumour diameter was 17.8 (6.1, 7–30) mm, with most of tumours located on the lateral wall (56.6%, 26 patients of 46), 21.7% (10 patients) located in the posterior wall, 8.7% (four) located in the anterior wall, and 13% (six) located in the trigone (Table 1).

The mean (SD, range) enucleation time was 17 (5.4, 11–28) min, operative time was 27.9 (11.4, 14–57) min, haemoglobin drop was 1.3 (0.9, 0–4.3) g/dL, postoperative irrigation time was 1.7 (2.3, 0–8) h, and hospital stay was 35.4 (13, 24–72) h (Table 2).

Histology revealed TCC in all patients: low grade in 52.2% (24 patients) and high grade in 47.8% (22). Histopathological classification and the depth of tumour infiltration (pT) were determined by the Pathology Department. All the specimens contained muscle layers, and the pathological staging was pTa in 30.4% (14 patients), pT1 in 54.3% (25), and pT2a in 15.2% (seven) (Table 3).

There was intraoperative bleeding in three patients, with only one requiring blood transfusion. There were no other reported perioperative complications. At 1-month postoperatively, six (13%) patients were diag-

**Table 2** Intra- and postoperative variables.

Variable	Mean (SD, range)
Enucleation time, min	17 (5.4, 11–28)
Operative time, min	27.9 (11.4, 14–57)
Haemoglobin drop, g/dL	1.3 (0.9, 0–4.3)
Postoperative irrigation time, h	1.7 (2.3, 0–8)
Hospital stay, h	35.4 (13, 24–72)

**Table 3** Histological and histopathological classification.

Variable	N (%)
Histological analyses of TCC:	
Low grade	24 (52.2)
High grade	2 (47.8)
Histopathological classification:	
pTa	14 (30.4)
pT1	25 (54.3)
pT2a	7 (15.2)

nosed with residual tumour and underwent repeat bipolar PKEBT. The overall recurrence rate at the 12-month follow-up was 15.2%.

## Discussion

Cystoscopy and standard TURBT are still the ‘gold standard’ technique for the diagnosis and initial treatment of NMIBC, which has predominantly been carried out using monopolar resectoscopes. Recently, with the introduction of the bipolar resectoscope and its successful application in TURP, bipolar resectoscopes are now being used for the treatment of bladder cancer. The bipolar resectoscope has several advantages including using saline for irrigation, which reduces morbidity from TUR syndrome, especially in procedures of long duration (>90 min). Furthermore, in conventional mTURBT, the resecting loop is the active electrode and the return electrode is a pad placed on the patient’s skin, which means that the current travels a considerable distance through the body to complete the circuit [1,3,7]. In the bipolar system (bTURBT), both the active and return electrodes are in close proximity in the target tissue, thus limiting the distance the current travels in the body, which reduces patient morbidity, especially in cardiac patients with an implanted pacemaker or cardioverter defibrillator that consequently does not need to be deactivated [8,9].

The PK generator and specific instruments are designed as a system, which uses high-powered pulsed bipolar energy to produce a PK field around the working elements and is designed to produce a temperature that allows effective tissue dissection but result in minimal collateral damage and adherence to tissue. PK

**Table 1** Patients’ characteristics.

Variable	Value
Sex, n (%)	
Male	36 (78.0)
Female	10 (21.7)
Age, years, mean (SD, range)	62.7 (8.5, 33–81)
Tumour diameter, mm, mean (SD, range)	17.8 (6.1, 7–30)
Tumour location, n (%)	
Lateral wall	26 (56.6)
Posterior wall	10 (21.7)
Anterior wall	4 (8.7)
Trigone	6 (13)

energy has been widely and safely used for TURP, as one of the newly developed procedures [10–12].

Additionally, unlike the conventional fragmentary resection pieces left from the TURBT procedure, with PKEBT the tumour can be resected *en bloc*, providing an intact specimen, where the specimen edges are well preserved for further histopathological examination and which decreases the incidence of re-implantation of the tumour [13].

In our present study, the mean (SD, range) tumour diameter was 17.8 (6.1, 7–30) mm. Most of the tumours were located on the lateral wall (56.6%, 26 patients of 46), 21.7% (10 patients) were located in the posterior wall, 8.7% (four) were located in the anterior wall, and 13% (six) were located in the trigone. All the procedures were successfully completed.

In a study by He et al. [6], green-light potassium tityl phosphate (KTP) laser was used for *en bloc* enucleation in 45 patients with NMIBC. They found that most of the bladder tumours were located on the lateral wall; only seven tumours were on the posterior bladder wall or trigone. Their mean (range) operative time was 21 (12–38) min and the enucleation time was 12 (4–23) min, and the haemoglobin drop was 1.1 (0.1–2.4) g/dL. They also found that postoperative irrigation was unnecessary for most patients, and only some required intermittent irrigation. The mean (range) catheterisation time was 2.0 (1.0–3.0) days; with a mean (range) postoperative hospital stay of 2.5 (1.5–4.0) days.

In our present study, the mean (SD) enucleation time was 17 (5.4) min, operative time was 27.9 (11.4) min, haemoglobin drop was 1.3 (0.9) g/dL, postoperative irrigation time was 1.7 (2.3) h, and the mean (SD, range) hospital stay was 35.4 (13, 24–72) h.

Del Rosso et al. [14] compared the safety and efficacy of PK bTURBT to conventional mTURBT for primary NMIBC. They found that the mean catheterisation time was 1.3 days in the PK bTURBT group and 2.3 days in the mTURBT group ( $P < 0.05$ ). The mean hospital stay was also significantly shorter for PK bTURBT compared with mTURBT (2.2 vs 3.5 days).

In the present study, histology confirmed that all the patients had TCC, which was low grade in 52.2% (24 patients) and high-grade in 47.8% (22). Histopathological classification and the depth of tumour infiltration (pT) were determined by the Pathology Department. All the specimens contained muscle layers, therefore with our novel *en bloc* PKEBT the overall histological structures, including specimen edges, are well preserved, thus the adequacy of the resection can be appropriately assessed by examining the base and lateral margins. This also helped to minimise unnecessary re-TURBTs or intravesical instillation therapy, reducing the bother for patients and economic burden. Conversely, in conventional mTURBT specimens are often shrunken and

fragmented, making histological assessment more difficult.

There was intraoperative bleeding in three patients, with only one requiring blood transfusion. There were no other reported perioperative complications. At 1-month postoperatively, six patients (13%) were diagnosed with residual tumour and underwent repeat PKEBT. The overall recurrence rate at the 12-month follow-up was 15.2%.

Pu et al. [7] reviewed 121 patients with NMIBC treated with bTURBT, they reported a mean postoperative hospitalisation of 3 days, with haematuria in 2.5% of the patients, who required blood transfusion, and 1.7% had bladder perforation. They concluded that PK energy is safe for the treatment of NMIBC.

Also, Xishuang et al. [8] in their study of 173 patients comparing mTURBT, bTURBT and holmium laser-TURBT, reported that for the bTURBT and holmium laser-TURBT arms there were fewer intraoperative and postoperative complications, including bladder perforation, obturator nerve reflex, as well as bleeding and postoperative bladder irritation.

Another study by Venkatramani et al. [15], including 147 patients (75 mTURBT and 72 bTURBT), found that both were similar for the occurrence of obturator jerk, bladder perforation and haemostasis, and they concluded that the bTURBT was only superior for the low incidence of severe cautery artefacts compared with mTURBT (25% vs 46.7%,  $P = 0.001$ ).

Also, Mashni et al. [16] reported on 83 patients (38 mTURBT and 45 bTURBT) and found that, in bTURBT there was less bleeding during and after resection, whilst there were no significant differences for postoperative recovery time or complication rates between the two techniques.

Based on our initial experience with this novel technique, we found that the bipolar PKEBT for *en bloc* resection was an effective procedure for managing NMIBC. Particularly, as *en bloc* enucleation of the tumour preserves the entire lamina propria and detrusor muscle in well-intact specimens, with negligible perioperative complications.

#### Conflict of interest

None.

#### References

- [1] Williams SK, Hoenig DM, Ghavamian R, Soloway M. Intravesical therapy for bladder cancer. *Expert Opin Pharmacother* 2010;11:947–58.
- [2] Mamoulakis C, Ubbink DT, De La Rosette J. Bipolar versus monopolar transurethral resection of the prostate: a systematic review and meta-analysis of randomized controlled trials. *Eur Urol* 2009;56:798–809.

- [3] Michielsen D, Debacker T, De Boe V, Van Lersberghe C, Kaufman L, Braeckman JG, et al. Bipolar transurethral resection in saline – an alternative surgical treatment for bladder outlet obstruction? *J Urol* 2007;**178**:2035–9.
- [4] Poh BK, Mancer K, Goh D, Lim T, Ng V, Ng KK, et al. Plasma Kinetic™ (bipolar) transurethral resection of prostate: a prospective trial to study pathological artefacts, surgical parameters and clinical outcomes. *Singapore Med J* 2011;**52**:336–9.
- [5] Issa MM. Technological advances in transurethral resection of the prostate: bipolar versus monopolar turp. *J Endourol* 2008;**22**:1587–95.
- [6] He D, Fan J, Wu K, Wang X, Wu D, Li L, et al. Novel green-light KTP laser en bloc enucleation for nonmuscle-invasive bladder cancer: technique and initial clinical experience. *J Endourol* 2014;**28**:975–9.
- [7] Pu XY, Wang HP, Wu YL, Wang XH. Use of bipolar energy for transurethral resection of superficial bladder tumors: long-term results. *J Endourol* 2008;**22**:545–9.
- [8] Xishuang S, Deyong Y, Xiangyu C, Tao J, Quanlin L, Hongwei G, et al. Comparing the safety and efficiency of conventional monopolar, plasma kinetic and holmium laser transurethral resection of primary non-muscle invasive bladder cancer. *J Endourol* 2010;**24**:69–73.
- [9] Akgül KT, Ayyıldız A, Nuhuğlu B, Çaydere M, Üstün H, Germiyanoglu C. Comparison of transurethral prostate resection and plasma kinetic prostate resection according to cautery artefacts in tissue specimens. *Int Urol Nephrol* 2007;**39**:1091–6.
- [10] Geavlete B, Multescu R, Dragutescu M, Jecu M, Georgescu D, Geavlete P. Transurethral resection (TUR) in saline plasma vaporization of the prostate vs standard TUR of the prostate: 'the better choice' in benign prostatic hyperplasia? *BJU Int* 2010;**106**:1695–9.
- [11] Oelke M, Alivizatos G, Emberton M, Gravas S, Madersbacher S, Michel M, et al. Guidelines on benign prostatic hyperplasia. In: Parsons KF, Irani J, Chapple CR, Fall M, Hanus J, Llorente Abarca C, et al., editors. *European Association of Urology Pocket Guidelines*. Arnhem: European Association of Urology; 2009. p. 90–7.
- [12] Puppo P, Bertolotto F, Introini C, Germinale F, Timossi L, Naselli A. Bipolar Transurethral resection in saline (TURis): outcome and complication rates after the first 1000 cases. *J Endourol* 2009;**23**:1145–9.
- [13] El-Tabey M, Abo-Taleb A, Abdelal A, Khalil MM. Outcome of transurethral plasma kinetic vaporization for benign prostatic hyperplasia. *Int Braz J Urol* 2015;**41**:239–44.
- [14] Del Rosso A, Pace G, Masciovecchio S, Saldutto P, Galatioto C, Vicentini C. Plasma kinetic bipolar versus monopolar transurethral resection of non-muscle invasive bladder cancer: a single center randomized controlled trial. *Int J Urol* 2013;**20**:399–403.
- [15] Venkatramani V, Panda A, Manojkumar R, Kekre NS. Monopolar versus bipolar transurethral resection of bladder tumors: a single center, parallel arm, randomized, controlled trial. *J Urol* 2014;**191**:1703–7.
- [16] Mashni J, Godoy G, Haarer C, Dalbagni G, Reuter VE, Al Ahmadie H, et al. Prospective evaluation of plasma kinetic bipolar resection of bladder cancer: comparison to monopolar resection and pathologic findings. *Int Urol Nephrol* 2014;**46**:1699–705.