PlasmaKinetic™ (bipolar) transurethral resection of prostate: a prospective trial to study pathological artefacts, surgical parameters and clinical outcomes

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ABSTRACT

Introduction: The aims of the study were to compare the degree of cautery artefacts in prostatic chips between monopolar and PlasmaKinetic™ transurethral resection of prostate (TURP), and to determine if there is any difference in the intraoperative and post surgical parameters between them.

Methods: After institutional review board approval, patients were prospectively enrolled to undergo PlasmaKinetic™ TURP. Their parameters were compared with those of the historical monopolar TURP controls. All histological specimens were reviewed by a single senior pathologist.

Results: 46 patients were recruited to undergo PlasmaKinetic™ TURP. The resection time was significantly longer for the bipolar group compared to the monopolar group (50.2 versus 36.7 min, p-value is 0.001). The speed of resection (resection weight/time) was lower for the bipolar group (0.45 versus 0.56 g/min, p-value is 0.017). More irrigant was used for the bipolar group (21.2 versus 15.6 litres, p-value is 0.001) intraoperatively. There was no statistically significant difference in terms of intraoperative drop in haemoglobin and serum sodium change between the two groups. There seems to be a lesser degree of cautery artefacts in the PlasmaKinetic™ group than the monopolar group (42.17 versus 45.07 microns); however, this was not statistically significant (p-value is 0.452).

Conclusion: Bipolar TURP seems to result in a lesser degree of cautery artefacts when compared to conventional monopolar TURP, albeit statistically insignificant, compared to monopolar TURP. TURP also resulted in a longer resection time and increased irrigant use, but no difference in blood loss and serum sodium levels.

Keywords: bipolar, cautery artefacts, monopolar, PlasmaKinetic™, transurethral resection of prostate

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INTRODUCTION

Since its introduction, bipolar transurethral resection of prostate (TURP) has gained much popularity among urologists worldwide. The bipolar technology allows for resection of the prostate gland in saline solution. A proposed advantage of bipolar resection is improved haemostasis, resulting in better intraoperative visualisation.[1] With the use of saline as the irrigant, bipolar TURP also reduces the risk of TURP syndrome.[1] Some studies also reported a shorter catheterisation time, with reduced hospital stay for bipolar TURP compared to monopolar resection.[2]

There are, however, concerns about the bipolar current causing increased incidence of urethral stricture.[3] This observation contradicts the electrophysical principle of the bipolar current, with its lower peak voltage (as compared to monopolar resection) and higher frequency, resulting in a smaller depth of tissue penetration.[4] The electrophysical behaviour of the bipolar current is also important in the histological analysis of prostatic chips. More cautery artefacts would translate into difficult histopathological evaluation of prostatic chips. This would be of importance in the case of subtle changes such as a small, low-grade prostate cancer focus, or in bipolar transurethral resection of bladder tumour (TURBT) where the histological status of the tumour base will have great impact on the management plan. It has been reported that cautery artefacts between bipolar and monopolar resections are similar.[5]

METHODS

Patients were prospectively enrolled to undergo bipolar

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TURP after informed consent was obtained. The protocol of the study was approved by the institutional review board. All patients who satisfied the clinical indications for TURP were included in the study. The indications for resection were failed medical therapy for benign prostatic hyperplasia (BPH), inability to tolerate medical therapy for BPH due to side effects, acute retention of urine and other complications of bladder outlet obstruction, e.g. bladder calculi.

All patients were subjected to bipolar resection using the Gyrus PlasmaKinetic™ System (Gyrus Medical, Maple Grove, MN, USA). Preoperative work-up included International Prostate Symptom Score (IPSS) and Quality of Life (QOL) score, mean maximum voiding velocity (Qmax) and post void residual urine, as well as haemoglobin and serum sodium levels. Intraoperative parameters measured included resection time, weight of prostate chips, intraoperative irrigation fluid usage and the presence of intraoperative events.

All prostatic chips were reviewed by a single senior pathologist who was blinded to the origin of the specimen, i.e. whether it was from a bipolar resection patient or a monopolar historical control. Bipolar prostatic tissue specimens were evaluated with haematoxylin-eosin staining under a light microscope. Tissue specimens from the historical monopolar control group had previously been retrieved from the archive and re-evaluated by the same blinded pathologist. For each prostatic chip, the greatest depth of cautery artefact was measured in microns with the aid of a micrometer under the light microscope. The mean for each arm was then calculated.

All resections were performed with a 26F, continuous flow resectoscope with a 30° telescopic lens. In monopolar resections, 1.5% glycine solution was used. Monopolar energy output was 180 W for cutting and 80 W for coagulation. In the bipolar group, a plasma sect electrode (Gyrus PlasmaKinetic™ System) was the cutting element and saline was the irrigant of choice. During bipolar resections, PK3 mode at 340 V2 was used, attaining an incident power of 160 W during cutting and 80 W during coagulation.

After surgery, all patients had an indwelling urinary catheter and continuous bladder irrigation. They were monitored in a high dependency ward. A review was conducted at 4–6 hours post surgery. If the wash-out was clear, continuous irrigation was stopped; otherwise, further reviews were conducted. The urinary catheter was removed on postoperative Day 1 and the patient was given a trial-off catheter. If successful, the patient was discharged on the same day. If the patient failed trial-off catheter, he was discharged with an indwelling catheter and scheduled to return to the outpatient clinic within one week for another attempt at trial-off catheter. Postsurgical parameters measured included haemoglobin and serum sodium level, duration and total volume of continuous bladder irrigation, duration of indwelling catheter and length of hospital stay. Patients were given standard follow-up appointments in the postoperative period at six weeks, three months, six months and one year, with assessment of the following parameters: Qmax and post void residual urine as well as IPSS and QOL scores.

Table I. Baseline parameters of the two groups.

Parameter	Mean ± SD	p-value
Age (yrs)		
PK	71.67 ± 8.06	0.881
Mono	71.76 ± 8.23	
PSA		
PK	10.07 ± 7.74	0.182
Mono	13.64 ± 12.74	
IPSS		
PK	14.27 ± 7.31	0.173
Mono	17.60 ± 8.24	
QOL		
PK	3.71 ± 1.68	0.816
Mono	3.83 ± 1.47	
Qmax (ml/sec)		
PK	6.44 ± 2.46	0.890
Mono	6.53 ± 3.39	

SD: standard deviation; PK: PlasmaKinetic™; Mono: monopolar; PSA: prostate specific antigen; IPSS: international prostate symptoms score; QOL: quality of life score; Qmax: maximum uroflowmetry

In the production of the bipolar current using the Gyrus PlasmaKinetic™ System, the generator produces a high initialising voltage spike that creates a voltage gradient in a gap between the neutral and 'live' electrode (the cutting loop). This high voltage gradient creates a vaporised 'plasma' layer containing charged particles as it traverses the conductive irrigation solution, thus the term 'plasmakinetic'.[6] Once formed, this interface can be maintained at lower voltages. Cutting and coagulation occur when there is tissue contact with the loop, causing a disintegration of tissue via molecular dissociation as the current flows to the return electrode. The energy-charged ions in the 'plasma' cause disruption of the carbon-carbon and carbon-nitrogen bonds as well as electron impact dissociation of water molecules into excited H^+ and OH^- ions. The end result is the rupture of cell membranes, which translates into visible cutting.[7]

Data analysis was performed using the Statistical Package for the Social Sciences version 13.0 (SPSS Inc, Chicago, IL, USA). All values were expressed as mean ± standard deviation. Significant difference between the two groups was evaluated using the nonparametric Mann-Whitney U test. Associations between categorical

Table II. Differences in intraoperative blood loss, serum sodium change and cautery artefacts between the two groups.

Parameter	Mean ± SD	p-value
Change in Hb (g%)		
PK	0.76 ± 0.79	0.168
Mono	1.13 ± 1.02	
Change in Na (mmol/L)		
PK	1.76 ± 2.93	0.504
Mono	2.40 ± 3.52	
Depth of cautery artefacts (microns)		
PK	42.17 ± 16.49	0.452
Mono	45.07 ± 19.29	

SD: standard deviation; PK: PlasmaKinetic™; Mono: monopolar; Hb: haemoglobin; Na: sodium

Table III. Resection efficiency and intraoperative irrigant use in the two groups.

Parameter	Mean ± SD	p-value
Resected weight (g)		
PK	23.03 ± 14.60	0.420
Mono	20.63 ± 12.84	
Resection time (min)		
PK	50.22 ± 20.83	0.001*
Mono	36.71 ± 16.11	
Resection speed (g/min)		
PK	0.45 ± 0.19	0.017*
Mono	0.56 ± 0.25	
Irrigation intra-op (l)		
PK	21.20 ± 8.17	0.001*
Mono	15.59 ± 6.82	

* Denotes statistical significance.
SD: standard deviation; PK: PlasmaKinetic™; Mono: monopolar

variables were analysed using the Pearson's chi-square test. A p-value ≤ 0.05 was considered to be statistically significant.

RESULTS

Baseline parameters were similar in both groups (Table I). There was no statistical difference in intraoperative blood loss and serum sodium change between the two groups. A lesser degree of cautery artefacts was noted in the PlasmaKinetic™ group (42.17 microns) compared to the monopolar group (45.07 microns); however, this difference was not statistically significant (p = 0.452) (Table II). Resection time was significantly longer in the bipolar vs. monopolar group ((50.2 vs. 36.7 min, p = 0.001), while the speed of resection (resection weight/resection time) was lower for the bipolar vs. the monopolar group (0.45 vs. 0.56 g/min, p = 0.017). A greater volume of irrigant was used intraoperatively for the bipolar group (21.2 vs. 15.6 litres, p = 0.001) (Table III). Length of hospitalisation stay was shorter in the bipolar group (2.5 vs. 3.2 days, p < 0.001). However, a greater amount of irrigant was used postoperatively for the monopolar group (72.7 vs. 45.2 litres, p < 0.001). Postoperative catheter time, as well as changes in IPSS, QOL and Qmax were similar in both groups.

DISCUSSION

With its many proposed advantages, bipolar TURP has gained increasing acceptance among urologists over the past few years. Bipolar current, however, has very different electrophysical behaviour compared to its monopolar counterpart; as a result, its effect on tissues and tissue margins may differ from what we know about monopolar current. The extent of cautery artefacts may have an impact on cases in which a small focus of prostatic cancer may be present in the prostatic chips. This may, in turn, result in underdiagnosis or understaging of prostate cancer. Understanding the effects of monopolar current on tissues is also important in the realm of TURBT, where the histological status of the tumour base often has a great impact on subsequent management as well as the prognosis of the disease.

Studies have shown that cautery artefacts occur in TURP due to high temperatures, resulting in various problems during the pathological evaluation of prostatic chips.[8] There is, however, a paucity of studies addressing this important issue. Akgül et al, in a retrospective review, attempted to compare the histological features after TURP between monopolar and bipolar resections, and found no difference in the total number of cautery artefacts between the two groups, with bipolar TURP appearing to result in fewer instances of severe artefacts.[5]

In our study, patients were prospectively enrolled to undergo surgery with bipolar TURP, and their eventual histopathological cautery margins were compared with those of the monopolar controls retrieved from our archive. The entire process of pathological review was blinded and performed by a single senior histopathologist. We measured the greatest cautery artefact depth with respect to the resection margin under a light microscope and objectively measured it with a micrometer. As such, we were able to provide objective evidence of the thermal effects each type of current has on prostatic tissues.

Since McLean's pioneering work on the effects of electrosurgery on prostatic tissue in 1929, the efficiency and power output of monopolar machines have undergone considerable changes.[9] Tissue desiccation and coagulation take place at a much lower peak voltage of up to 120 V with bipolar systems compared with monopolar systems, which can reach peak voltages of up to 800 V, resulting in resection and coagulation with a smaller depth of penetration.[10]

As shown in our study, bipolar resection seemed to produce less cautery artefacts on the resected prostatic chips; however, this difference did not reach statistical significance. This could be a direct result of the small sample size. With this study, we aimed to develop a standardised, objective way to quantify cautery artefacts in both TURP and TURBT specimens, which will aid in histopathological evaluation of tissue specimens and enable uropathologists to compare results objectively. We look forward to the results from future randomised trials with a larger sample size so as to further address this issue.

In conclusion, PlasmaKinetic™ bipolar TURP, as demonstrated in our study, seemed to result in smaller degrees of cautery artefacts when compared to conventional monopolar TURP, but this difference was not statistically significant. It is our hope that this method of evaluating cautery artefacts in prostatic tissue would provide a standardised and objective platform for future randomised trials comparing tissue effects between the two currents. As for intraoperative and postoperative parameters, PlasmaKinetic™ TURP has a significantly longer resection time, higher irrigation fluid volume and slower resection speed. There was no difference in the overall clinical outcome between the two TURP techniques.

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