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Determination of prostate adenoma weight reduction due to vaporisation process occurring during transurethral resection of the prostate

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Abstract

Introduction: *Transurethral resection of the prostate (TURP) is regarded as the gold standard surgical treatment for benign prostatic hyperplasia (BPH). The completeness of TURP may be assessed indirectly by estimation of the weight of glandular tissue removed. This parameter is often lower than expected. Tissue vaporisation in the course of TURP could be a contributory cause.*
Aim: *To quantitatively evaluate tissue vaporisation occurring in the course of transurethral resection of the prostate and electrovaporisation of the prostate (EVAP) performed under experimental conditions.*
Material and methods: *The study was performed on 26 prostate glands removed during retropubic prostatectomy. Immediately following surgery all adenomas were halved and TURP or EVAP were carried out on both halves of each gland for period of 5 min. The amount of prostate tissue which vaporised during EVAP and TURP were calculated.*
Results: *The mean weight (± standard deviation) of the adenoma lost due to resection and vaporisation in the TURP group was 10.00 ±2.92 g and 4.26 ±1.59 g, respectively. The latter accounted for 30.10 ±7.71% of total prostate weight reduction. The mean prostate weight lost in the course of EVAP was 5.03 ±1.58 g.*
Conclusions: *The vaporisation significantly contributes to the prostate tissue loss occurring during transurethral resection of the prostate.*

Key words: *vaporisation, transurethral resection of the prostate, adenoma.*

Introduction

Transurethral resection of the prostate has been the gold-standard therapy for lower urinary tract symptoms (LUTS) caused by benign prostatic enlargement (BPE) and benign prostatic obstruction (BPO) throughout the world [1–4]. However, during last two decades its role has been increasingly challenged by the development of several minimally invasive treatment options, including transurethral electrovaporisation of the prostate [5, 6]. Since its introduction by Kramkowsky and Tucker in 1991 and the first reports published in 1994, it has been described as a safe and effective treatment for benign prostatic hyperplasia (BPH) [6, 7]. However, several studies have shown that the long-term results of electrovaporisation of the prostate (EVAP) are worse than of transurethral resection of the prostate (TURP) [8, 9].

The efficacy of surgical treatment of BHP, including the efficacy of TURP and other transurethral methods, is evaluated on the basis of improvements in LUTS score and quality of life (QoL), as well

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as improved objective parameters of micturition, such as maximal flow rate (Qmax) and post-void residual urine volume (PVR) [10]. The completeness and efficacy of TURP can also be assessed indirectly by estimation of the weight of glandular tissue removed [11, 12]. However, the clinical significance of this measure, as well as its value as a predictor of the final response to treatment, has yet to be established.

Several authors have observed significant discrepancies between the amount of resected and expected tissue during the seemingly complete TURP [11, 13–15]. This divergence could likely be attributed to the process of tissue vaporisation which occurs during TURP, as the procedure involves a rapid rise in temperature within the area near the cutting electrode which could subsequently result in the tissue vaporisation or carbonisation [16].

A similar process of tissue vaporisation is involved in transurethral electrovapor resection of the prostate (TUVRP), which uses a thick wedge loop allowing for simultaneous vaporisation and resection of the gland, and is responsible for approximately 50% resected tissue weight reduction [17, 18], whereas the loss of glandular mass that occurs in EVAP is strictly due to tissue vaporisation.

So far, however, quantitative evaluation of the vaporisation process, involved in reduction of prostate adenoma during TURP, has not been performed.

Aim

The aim of the study was to quantitatively assess the amount of glandular tissue lost due to vaporisation during TURP and compare the efficacy of TURP and EVAP techniques under experimental conditions.

Material and methods

This study was approved by the local research ethics committee, and all the procedures have been carried out in accordance with the Helsinki Declaration of 1975, as revised in 1983. Twenty six prostate glands removed during open prostatectomy (Millin method), performed for histologically confirmed BPH were included in the study. Immediately following surgery all adenomas were halved into two relatively equal parts (left and right lobes) and each of them was then weighed. Next, electroresection (ER) of one lobe (group 1), and electrovaporisation (EV) of the other were carried out for 5 min.

The procedures were performed after the lobes of the adenoma had been placed in a 5 l container exclusively designed for the purpose of the study (Photo 1). The dish was equipped with a passive electrode and was filled with 4 l of fluid, obtained from a Medsys 20 HP water filter system routinely used for transurethral procedures, heated to a temperature of 37°C. The ER was performed using a loop electrode from Storz-cutting loop nr. 27040G, while EV was done with a cylindrical electrode (Vapotrode, Circon-ACMI Corporation, Stamford CT). Diathermic current was generated by the ERBE ICC350 apparatus – model 3245. For electroresection, a current of 120 W was used for cutting and 80 W for coagulation, whereas vaporesection was performed with cutting current of 230 W. Both ER and EV lasted 5 min each (accuracy of time measurement within 2 s). In the course of the procedures, the temperature of the water was monitored.

To prevent drying out of the prostate tissue, the resected fragments of the gland, as well as residual adenoma, were weighed immediately after ER. Similarly, immediate weight of the remaining tissue was taken following EV. For this purpose a laboratory scale was used, with accuracy to 0.01 g. On the basis of these measurements, the total tissue lost during ER and EV was determined. After the study, the remaining prostate fragments underwent a routine histopathological examination.

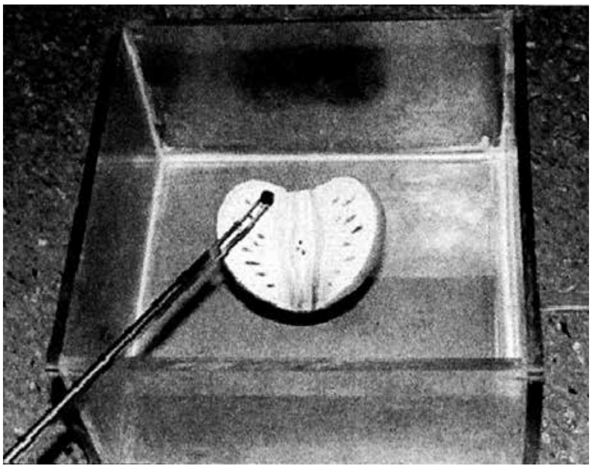

Photo 1. A container designed for the purpose of this study with a passive electrode at its bottom and an active electrode connected to the resectoscope loop. The walls of the container are made of plexiglass (isolator). The vaporisation electrode is also visible

Statistical analysis

Statistical analysis was performed using software, the Statistical Package for the Social Sciences (SPSS) 12.0 for Windows. Since data in the studied groups was distributed in a Gaussian manner, the paired student *t*-test was applied. A *p* value of < 0.05 was considered statistically significant.

Results

In all of the samples, BPH has been histologically confirmed. Relative to the baseline, an average increase of 0.5°C in the water temperature after 2.5 min and 5 min of ER and EV was observed.

The mean ± standard deviation initial weight of adenoma lobes in group 1 and group 2 was 40.61 ±14.48 g and 39.01 ±15.22 g, respectively. There was no significant difference between the initial weight of the adenomas in both groups (*p* = 0.759). The mean weight of the resected tissue chips in ER group was 10.00 ±2.92 g, whilst the mean weight of residual adenoma fragments after ER and after EV was 26.35 ±13.28 g and 33.98 ±14.60 g, respectively.

The mean prostate tissue weight lost resulting from vaporisation during ER was 4.26 ±1.59 g and accounted for 44.58 ±14.60% of the resected fragments' weight.

The average adenoma weight lost following EVAP was 5.03 ±1.58 g. While the mean total weight reduction with TURP was statistically greater than with EVAP (*p* < 0.0001, Figure 1), the mean weight of vaporised tissue during both TURP and EVAP was similar (*p* = 0.100, Figure 2). All measurements are shown in Table I. Table II presents comparison of selected measurements between the two groups under investigation.

Discussion

The significance of the vaporisation phenomenon in the course of classical transurethral resection of the prostate has not yet been thoroughly studied. This process is innately related to the cutting effect of diathermic current [16]. Narayan *et al.* who studied the effect of various physical parameters on vaporisation during EVAP and compared the procedure outcomes with those produced by TURP and neodymium : yttrium-aluminum-garnet laser fibers, reported that electrovaporisation under optimal conditions causes a vaporisation lesion comparable to

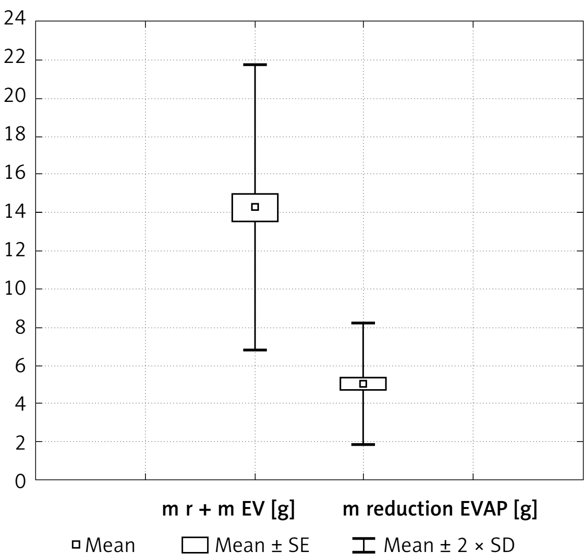

Figure 1. Comparison of total weight reduction in electoresection group (group 1) vs. total weight reduction in electrovaporisation group (m reduction EVAP) (group 2). In group 1, total weight loss is the sum of resected prostate chips weight (m r) and the weight of the adenoma lost due to vaporisation (m EV)

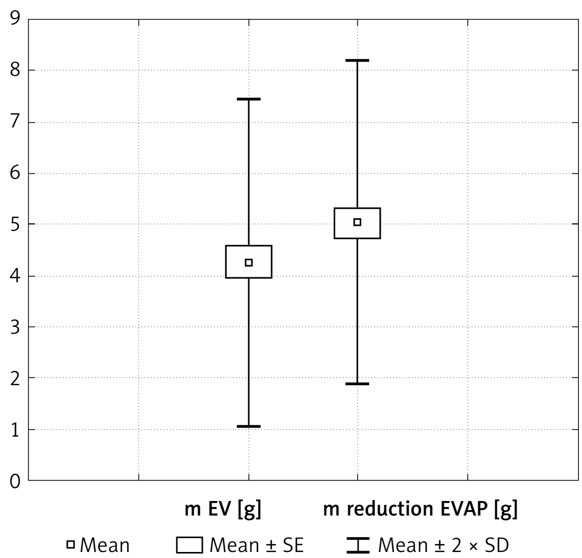

Figure 2. Comparison of adenoma weight lost due to vaporisation following electroresection (m EV) vs. total weight reduction after electrovaporisation (m reduction EVAP)

Table I. Measurements in electroresection (ER) and electrovaporisation (EVAP) groups

Variables	*N*	Mean ± standard deviation
m pre TURP [g]	26	40.61 ±14.48
m post TURP [g]	26	26.35 ±13.28
m r [g]	26	10.00 ±2.92
m EV [g]	26	4.26 ±1.59
m r + mEV [g]	26	14.26 ±3.75
m EV/m pre TURP × 100 [%]	26	11.24 ±4.15
m EV/m r × 100 [%]	26	44.58 ±14.60
m EV/(mr + mEV) × 100 [%]	26	30.10 ±7.71
m pre EVAP [g]	26	39.01 ±15.22
m post EVAP [g]	26	33.98 ±14.60
m reduction EVAP [g]	26	5.03 ±1.58
m reduction EVAP/m pre EVAP × 100 [%]	26	14.56 ±7.31

N – number of glands, m pre TURP – prostate tissue weight prior electroresection (group 1), m post TURP – prostate tissue weight after electroresection, m r – weight of resected tissue chips in ER group, m EV – prostate tissue weight reduction secondary to vaporisation occurring during electroresection (group 1), m r + mEV – total weight reduction following electroresection, m EV/m pre TURP × 100 (%) – prostate tissue weight reduction secondary to vaporisation occurring during electroresection expressed as the percent of pre-electroresection prostate tissue weight, m EV/m r × 100 (%) – prostate tissue weight reduction secondary to vaporisation occurring during electroresection expressed as the percent of resected tissue chips in ER group, m EV/(m r + mEV) × 100 (%) – prostate tissue weight reduction secondary to vaporisation occurring during electroresection expressed as the percent of total weight reduction following electroresection, m pre EVAP – prostate tissue weight prior electrovaporisation (group 2), m post EVAP – prostate tissue weight following electrovaporisation (group 2), m reduction EVAP – total weight reduction following electrovaporisation (group 2), m reduction EVAP/m pre EVAP × 100 % – total weight reduction following electrovaporisation in group 2 expressed as the percent of prostate tissue weight prior electrovaporisation.

that produced by higher power density laser prostatectomy [19]. In our study, the vaporisation effect during TURP resulted in a loss of tissue comprising approximately 30% of the total gland weight reduction. Thus, the vaporisation process seems to play a significant role in the reduction of prostate tissue during the classical transurethral resection of the prostate and should be taken into account while calculating the total amount of removed tissue.

However, the vaporisation effect depends on several factors including the technique of the procedure as well as various physical parameters of electrosurgical generators. The power of the diathermic current used in TURP could play a significant role. Presumably an increase in power would result in more intense vaporisation [20]. Moreover, the importance of the thickness and number of tissue fragments resected with the resectoscope loop should also be noted. With full-thickness cuts of tissue the number of fragments would be lower compared to when the fragments were thinner, and therefore the loss of tissue due to vaporisation would be relatively smaller. In our study, full-thickness tissue cuts were performed and thick fragments were obtained.

Table II. Comparison of pre- and post-procedure tissue measurements

Variables	*N*	Mean ± standard deviation	Value of *p*
m pre TURP	26	40.61 ±14.48	0.759
m pre EVAP	26	39.01 ±15.22	
m r + m EV	26	14.26 ±3.75	< 0.0001*
m reduction EVAP	26	5.03 ±1.58	
m EV	26	4.26 ±1.59	0.100
m reduction EVAP	26	5.03 ±1.58	

**Statistically significant, N – number of glands, m pre TURP – prostate tissue weight prior electroresection (group 1), m pre EVAP – prostate tissue weight prior electrovaporisation (group 2), m r – weight of resected tissue chips in ER group, m EV – prostate tissue weight reduction secondary to vaporisation occurring during electroresection (group 1), m r + m EV – total weight reduction following electroresection, m reduction EVAP – total weight reduction following electrovaporisation, m EV – prostate tissue weight reduction secondary to vaporisation occurring during electroresection*

Since the TURP procedure is performed in water solution, which under certain conditions can become an electrolyte solution, its chemical composition may also play a role. However, the significance of this effect for transurethral electrosurgery has not yet been fully investigated.

In this study, all procedures were performed in an environment without a continuous irrigation fluid flow. This could, theoretically, have resulted in ions' concentration changes in the solution, as well as in generation of other substances in the course of vaporisation, which would not occur during EVAP or TURP performed in a clinical setting. Hence, the lack of analysis, of the chemical composition of the solution in which the specimens were immersed during ER and EV, is a limitation of this study.

In order to achieve the maximal vaporisation effect in the course of EVAP, it is important to apply an adequate pressure with vaporisation electrode onto the tissue [21]. In addition, the speed at which the vaporisation electrode passes through the prostatic segment of the urethra plays a role, with maximal vaporisation effect occurring at a slow pass rate, not greater than 10 mm/s [21]. These parameters were not standardised during the EVAP performed under experimental conditions, which is another limitation of this study. However, continuous macroscopic evaluation of the vaporisation effect occurring during procedures made it possible to gauge the speed of the electrode, so that the measured effect would have been optimal.

Conclusions

This study demonstrates that the reduction of adenoma tissue due to vaporisation in the course of TURP could be significant, and should be accounted for in the total reduced weight calculation. The EVAP procedure causes a similar loss of adenoma tissue comparable to that obtained through vaporisation during TURP. Further research should assess impact of potentially modifiable factors on vaporisation effect occurring during transurethral resection of the prostate.

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