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ORIGINAL PAPER

The role of irrigation fluid in transurethral resection of the prostate outcomes and surgeon performance

Federico Romantini, Daniela Biferi, Guevar Maselli, Federico Narcisi, Maurizio Ranieri, Luca Topazio

Mazzini Hospital, Department of Urology, ASL Teramo, Teramo, Italy.

Summary

Introduction: Transurethral resection of the prostate (TURP) is the gold-standard for the treatment of benign prostate enlargement (BPE) associated with lower urinary tract symptoms (LUTS), after failure of conservative therapy. At present, only resection-rate (grams of prostate resected over time) is regarded as an efficiency parameter to evaluate the skill of the operator and to assess the outcome of the procedure.

Materials and methods: Five surgeons performed TURP using a Gyrus-type bipolar system in 123 patients with BPE/LUTS who came to our observation from June 2016 to December 2019. The amount of irrigation fluid used during the procedure was registered and correlated to the operating time, resection-rate, prostate adenoma weight, post-operative bladder irrigation time, intraoperative bleeding and days of catheterization.

Results: We found an inverse correlation between the amount of irrigation fluid used during TURP and the resection-rate recorded for all operators, according to Spearman's Correlation ($r = -0.78$, $p = 0.002$); a direct correlation was also found between the amount of irrigation fluid and the adenoma weight. Finally, we also found a direct correlation with intraoperative bleeding and the duration and amount of bladder irrigation during and after TURP.

Conclusions: The amount of irrigation fluid used is proposed as a reliable parameter to estimate the efficiency of the endoscopic procedure as well to assess the skill of the operator and short-term results. The observed data encourage the possibility of applying this new efficiency indicator to all endoscopic maneuvers.

KEY WORDS: Prostate; Benign Prostatic Hyperplasia; Obstruction.

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INTRODUCTION

Transurethral resection of the prostate (TURP) is the gold-standard for the treatment of *benign prostate enlargement* (BPE) associated with lower urinary tract symptoms LUTS after failure of conservative therapy (1). The choice for the most appropriate surgical therapy depends on the size of the prostate gland and the skills of the operator. The evolution of endoscopic surgical treatments has led to the introduction of bipolar plasma-kinetic energy for trans-urethral resection. In clinical practice, the only parameter used to evaluate the efficiency of a TURP is the "*resection-rate*", i.e., the ratio between the amount of prostatic tissue resected, expressed in grams, and the resection time, expressed in minutes (g/m) (2). Efficiency is defined as "*the ability to produce something with a minimum amount of effort*" (in this context, the best outcome for the patient *vs.* the minimum operating time) (3).
To calculate the resection rate as an efficiency parameter, the surgeon must weight all the resected tissue chips after the operation, or wait for the histopathological findings, when usually the weight of the tissue is recorded (typically, many days later); after that, it is then necessary to calculate the ratio between the amount of resected tissue and the duration of the operation. At present there is not unanimous consensus about the starting point in time of a TURP: from the introduction of the cutting device in the urethra or from the first cut chip, and this could lead to variable results in the resection-rate recorded in different centres.

MATERIALS AND METHODS

We enrolled 123 patients with BPE/LUTS who came to our observation from June 2016 to December 2019. Patients were evaluated preoperatively with medical history, symptom questionnaires (*IPSS and Bother Score*), digital rectal exploration, PSA assay, blood tests, serum electrolytes, complete urodynamic examination and transrectal, renal, bladder and prostate ultrasound. All patients underwent TURP. Patients with bladder stones and/or diverticula, stenosis of the urethra and patients with alterations in coagulation or platelet aggregation were excluded from our study. All patients taking antiplatelet or anticoagulant drugs discontinued therapy according to the guidelines. The procedures were performed under spinal anesthesia, in the lithotomy position, by 5 different operators. TURP was performed, in all patients, using a bipolar type resectoscope with a 27 Ch diameter liner, continuous flow, and a 'U' shaped cutting loop. The plasmakinetic device had a maximum power of 200 watts, a radiofrequency range of 320 to 450 kHz, and a voltage range of 350 to 450 volts. Once connected, the generator was programmed for a power of 160 W for shear and 80 W for hemostasis. The bipolar resectoscope used were from two different manufacturers. The main difference between the two types of resectoscopes, as far as the study is concerned, is the different caliber of the irrigation channels of the operating sheaths, which, however, although probably providing different flow rates, do not affect the final recording of the amount of fluid used during the interventions (Figure 1). The irri-

Figure 1.
Details of the different irrigation system of the two bipolar endoscopic resectoscopes used.

gation fluid used was 0.9% NaCl saline, in three-liter bags connected to a 6-mm-diameter outflow tube attached to the bipolar device. The solution was at room temperature (20°-22°) and placed at a height of 60 cm from the patient's pubic symphysis, at a continuous and constant washing rate. The drained washing fluid flowed into an aspirator (S.HO.W) equipped with a system that allows automatic digital measurement of drained fluid volumes. We measured the amount of irrigation fluid used, the amount of irrigation fluid in the aspirator at the end of the procedure, the surgical time (from insertion of the device into the urethra), and registered the operator. The amount of prostate tissue excised was weighed with a scale at the end of resection; a Dufour 20Ch catheter was placed in all patients, with continuous and constant irrigation with 9% NaCl saline. Once clear urine was obtained, bladder irrigation was stopped. In the postoperative period, we evaluated the difference in hemoglobin levels (preoperative vs postoperative), duration of bladder irrigation, and catheter dwell times.

Statistical analysis

All collected data was evaluated as *mean* (M) ± *standard deviation* (SD). The correlation between the parameters was calculated using Spearman's correlation coefficient. Values of $p < 0.05$ were considered statistically significant.

RESULTS

The median age of the patients was 70.13 years (SD ± 8.74), and the means and relative standard deviations of the preoperative characteristics of the study population are shown in Table 1.

Table 1.
Preoperative characteristics of the study population.

Patients characteristics	Mean + SD
Age	70.13 ± 8.74
IPSS	17.63 ± 4.58
BS	4.63 ± 1.03
Q_{max} (ml|/s)	7.66 ± 3.38
Voided volume (ml)	231.67 ± 101.09
Post-void Residual Volume (PVR)	98.03 ± 113.22
Prostate adenoma (g)	38.96 ± 13.56
Prostate volume (g)	52.20 ± 16.81

Table 2.
intraoperative variables recorded during TURP.

	Mean + SD
Operating time (minutes)	71.01 ± 31.52
Irrigation fluid (litres)	16.63 ± 5.52
Resection-rate (g/m)	0.548 ± 0.18

Intraoperative variables such as operation time, volume of irrigation fluid used and resection rate are shown in Table 2, with means and their standard deviations.
Figure 2 shows the inverse correlation between the amount of irrigation fluid used during TURP and the resection rate recorded for all operators, according to Spearman's correlation (r= -0.78, p = 0.002).

Figure 2.
Inverse correlation between the amount of fluid used and resection-rate according to Spearman's Correlation; (r = - 0.78, p = 0.002).

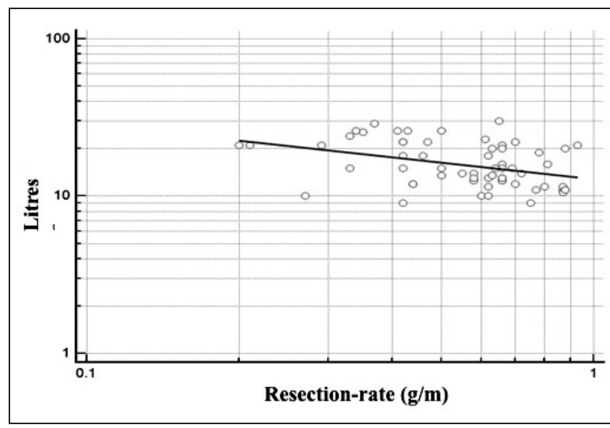


Figure 3 shows Spearman correlation between the amount of irrigation fluid (in liters) and adenoma weight (in grams), stratified by operator. The results for the cumulative data is statistically significant (p = 0.005) (r = 0.61575).

Figure 3.
Correlation between the amount of irrigation fluid and adenoma weight, stratified by operator.

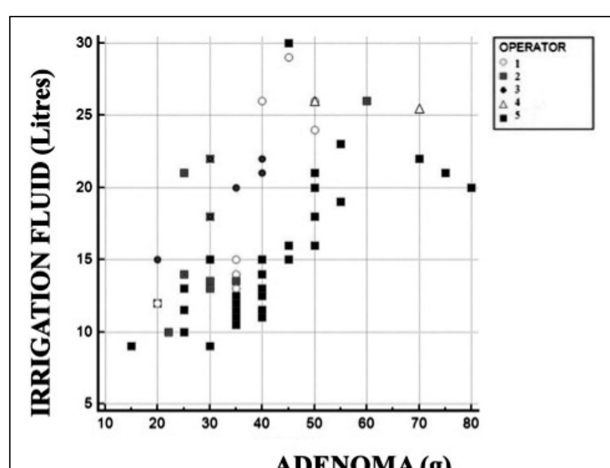
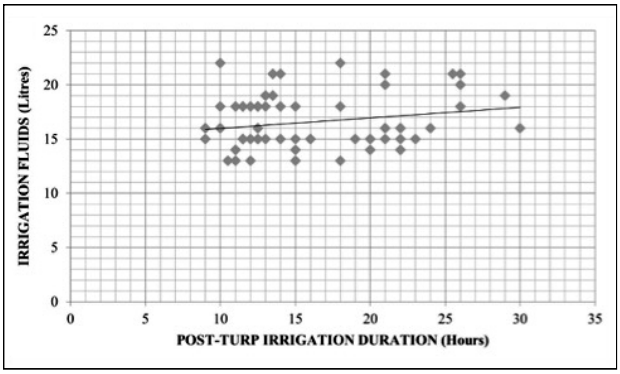


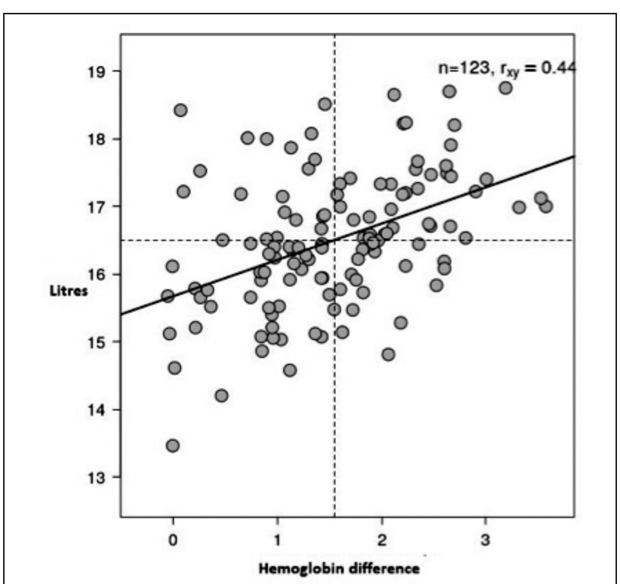
Figure 4 shows a direct, statistically significant correlation ($p = 0.004$) between the amount of irrigation fluid used and the duration of bladder irrigation after TURP ($r = 0.2498$).

Figure 4.
Correlation between the amount of irrigation fluid used and the duration of bladder irrigation after TURP, with r: 0.2498 and p = 0.004.



A change in hemoglobin concentration was observed within 48 hours after surgery ($p < 0.0001$), which was statistically significant, although this was clinically irrelevant in most patients, with no signs or symptoms of severe anemia. The postoperative blood transfusion rate was 0.81%. A direct link was observed between change in hemoglobin concentration and resected tissue weight ($p < 0.0001$) as well as the amount of irrigation fluid used (Figure 5).
Only one patient was given a blood transfusion on the third postoperative day for anemia.
The mean preoperative hemoglobin was 12.4 g/dl and the mean postoperative hemoglobin was 11.5 g/dl. The mean hemoglobin loss was 0.9 g/dl. This result proved not to be clinically relevant.

Figure 5.
Direct correlation between intraoperative blood loss (difference in pre and post operative hemoglobin concentration) and amount of irrigation fluid used.



Discussion

The main purpose of this study was to propose monitoring the amount of irrigation fluid used during a TURP procedure as a new parameter of resection efficiency. The efficacy and safety of TURP are often discussed in current literature, but there is a lack of quantitatively relevant data on efficiency (4). In clinical practice, resection-rate is described as the only parameter that can evaluate the efficiency of a trans-urethral prostate resection and is often used to compare the skills of different operators or as a benchmark parameter when new techniques or instrument are to be tested. The average resection-rate value during bipolar TURP reported in the literature is 0.65 (5). Our experience shows an average of 0.55 ± 0.18. Higher resection-rate values correspond to a more efficient resection, in terms of time and, most importantly, intraoperative bleeding. The cornerstone of all endoscopic procedures is vision, and an efficient and safe TURP requires a clear, blood-free surgical field; the medium through which we look is water, or rather different irrigation fluids containing H_2O. During TURP, bleeding hampers the procedure and forces the surgeon to use more irrigation fluid, both because resection is slowed and because the operator will increase flow to allow better vision, having to drain more blood from the visual field (6). It is reported in the literature how this type of issue is particularly important during resections with a monopolar instrument, and is less pronounced during resections with a bipolar instrument (6). Poorly controlled bleeding not only makes the procedure take longer, but also makes it less accurate, and ultimately, less efficient. Our data show a direct correlation between the amount of irrigation fluid used and intraoperative bleeding, which can be quantified as grams of hemoglobin lost during the procedure (difference between pre- and post-operative values). The correlation was statistically significant. Longer operative times are not only related to short-term complications, such as TUR syndrome, clot retention, and the need for blood transfusions (7, 8); longer operative time has also been linked to long-term complications, particularly urethral strictures (9).
We hypothesized that the amount of irrigation fluid used during bipolar TURP could be a valid parameter for estimating the efficiency of resection and predicting the likelihood of short- and long-term complications. Indeed, our data show a statistically significant inverse correlation between the resection rate and the amount of irrigation fluid; the correspondence was observed in all operators. A statistically significant direct correlation was observed between the amount of fluid used during surgery and the duration of postoperative bladder irrigation, which in turn is directly dependent on postoperative period hematuria.
A smaller amount of irrigation fluid used during TURP could be a direct indicator of the likelihood of less hematuria in the postoperative period and the possibility of using slow-flow bladder irrigation after surgery to control bleeding. An inverse correlation was found between irrigation fluid and duration of catheterization after TURP; this could allow more accurate prediction of early patient mobilization and shorter hospital stay. Follow-up at 40 days showed significant improvement in symptom scores and uroflowmetric parameters, regardless of resection efficiency estimated by resection rate and amount of irriga-

tion fluid. Aa mid- and long-term evaluation of patients at 6 and 12 months is needed to better understand the correlation between TURP efficiency (expressed by resection rate and irrigation fluid used) and surgery outcomes expressed in IPSS questionnaire score.

Conclusions

The present study shows that less irrigation fluid used during transurethral prostatic resection correlates significantly with less intra- and postoperative bleeding. Thus, a lower amount of fluid used correlates with a better visual field during surgery, which translates into better operating conditions for the operator. Postoperatively, this correlation is reflected in shorter catheterization time and hospital stay. The amount of irrigation fluid used is proposed as a reliable parameter for estimating the efficiency of the endoscopic procedure and the skill of the operator; its application may be particularly useful in the evaluation of physicians-in-training, measuring over time any improvement in the operational efficiency of surgeons in their professional training. Monitoring and measurement of irrigation fluids could also be used as predictive parameters of the clinical situation in the immediate postoperative period.

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Correspondence

Romantini Federico, MD (Corresponding author)
federomantini@gmail.com

Biferi Daniela, MD
daniela.biferi@aslteramo.it

Maselli Guevar, MD
gue.maselli@gmail.com

Narcisi Federico, MD
federico.narcisi@aslteramo.it

Ranieri Maurizio, MD
maurizio.ranieri@aslteramo.it

Topazio Luca, MD
luca.topazio@aslteramo.it

Mazzini Hospital, Department of Urology, ASL Teramo; Teramo, Italy

Conflict of interest: The authors declare no potential conflict of interest.