

ORIGINAL PAPER

Measurement and quantitative analysis of perioperative blood loss and associated clinical variables in patients undergoing transurethral resection of the prostate: A prospective observational study

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Summary

Introduction: Perioperative bleeding is a clinically important adverse outcome of transurethral resection of the prostate (TURP), the gold standard surgical procedure in the management of benign prostatic hyperplasia (BPH). The difficulty in quantifying blood loss is because there is constant irrigation in the procedure.

This research attempted to objectively estimate perioperative blood loss by hemoglobin and determine clinical and procedural predictors of elevated perioperative blood loss.

Methods: It is a prospective observational cohort study that includes at least 60 male patients who were ≥ 50 years old undergoing elective TURP in two urology centers in Sulaymaniyah, Iraq. The preoperative and 24-hour postoperative hemoglobin were measured and the clinical variables were registered, such as age, comorbidities, PSA, prostate volume, and operative time. Paired t-tests, Pearson correlation and multivariate logistic regression were used as statistical analysis.

Results: Mean hemoglobin decreased markedly from 13.8 to 13.2 g/dL, ($p < 0.001$) with an approximate median blood loss of 5.7%. PSA level was the most correlated with blood loss ($r = 0.307$, $p < 0.01$), then prostate size and operative duration. The risk of hemorrhage was also linked to comorbidity status. Multivariate analysis showed no individual predictor of high blood loss.

Conclusions: Hb-based quantification is a valid, clinically viable method for quantifying perioperative blood loss in TURP.

The process of bleeding is multifactorial with PSA, prostate size, and operative duration being the main correlates. Strong preoperative risk stratification is needed to optimize perioperative care and surgical safety.

KEY WORDS: Estimation of blood loss; Benign prostatic hyperplasia; Transurethral resection of the prostate; Prostate-specific antigen.

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INTRODUCTION

As most common urological maladies, benign prostatic hyperplasia (BPH) burdens aging men. Its prevalence increases dramatically with age. According to the litera-

ture, over 30% of men over 65 years old present with either irritative or obstructive urinary problems (1), and the prevalence reaches up to 70-80% in men over the age of 80 years (2). The progressive enlargement of the prostate results in lower urinary tract symptoms (LUTS) that can have a major impact on patients' quality of life, and in severe cases may develop into renal impairment or obstructive uropathy, accounting for approximately 38% of postrenal acute renal failure. As global populations mature, BPH-related morbidity and need for surgical management is increasing (3).

Transurethral resection of the prostate (TURP) has been described as the gold standard surgical treatment for symptomatic BPH since its inception. It has been affirmed that TURP is the gold standard for the surgical management of BPH (1) and is the reference standard procedure for prostates between 30 and 80 ml (4). Its general popularity is due to reproducibility and long-term efficacy. It can improve IPSS and Q_{max} score by up to 80% in nearly 80% of the treated subjects. Although laser and/or bipolar-based technologies have been developed, TURP continues to be the reference method for assessment against these newer methods (4).

Nevertheless, TURP is complicated by several hazards. One of the most clinically important risks is the perioperative bleeding. Transfusion requiring hemorrhage (1-4%) and clot retention (3%) are among the reported complications (3). In an Iraqi cohort, the monopolar TURP patients needed transfusion due to a mean drop of 5 g/dl in their hemoglobin, while no transfusions were necessary in the bipolar group (4). Likewise, perioperative bleeding is directly related to morbidity, recovery period, and length of stay in Pakistan. According to Pakistani data, excess bleeding leads to transfusion and increased hospital stay. Therefore, it is clinically significant to measure blood loss accurately before TURP surgery (5).

An additional methodological quandary is obtaining an accurate measurement of blood loss during TURP. Unlike open surgery, TURP entails continuous irrigation; blood is diluted in glycine or saline, and therefore, the estimation of visual or volumetric change is not reliable. Visual

or volumetric methods alone are not effective in isolating true blood loss in case of blood mixture with irrigant (1). This challenge seems to be reflected in several studies, which report that irrigation renders visual estimation unreliable and prone to substantial error (2) and that traditional methods have large errors and low accuracy (6). These limitations have led to an established field for laboratory-based quantification with serial hemoglobin or hematocrit measurement. This approach provides a reproducible and clinically meaningful index of perioperative blood loss (1), and also offers a more objective, reproducible, and validated approach (2). Hemoglobin-based approaches have become more commonly described in prospective studies, as they indicate that patient postoperative hemoglobin decrease is associated with the magnitude of hemorrhage (5). Methods including chromium 51 labeling that are technically sophisticated give good precision but are not suitable for routine clinical purposes. Therefore, we propose, on the whole, hemoglobin-based estimation as the most economically feasible and standardized approach for prospective observational studies (6).

A plethora of patient associated and procedural factors are assumed to be associated with bleeding at TURP, including prostate size, operative duration, vascularity, comorbidities, and baseline hematological status. Previous published studies have established that prostate volume and operative time are significantly associated with increased blood loss, with a strong association observed between blood loss and both prostate volume and surgery lasting time (6). A study identified operative time of greater than 90 minutes and prostate volume of greater than 45 ml as major risk factors for complications including TUR syndrome and hemorrhage (4). Health factors at the patient-level may also affect hemorrhagic risk including age, diabetes, hypertension, smoking and coagulation profile. Prostatitis has also been associated with higher blood loss, and three of eight of these patients required transfusion among a prospective cohort of patients who required transfusion in one study cohort (3).

Although TURP is a well-established and research validated procedure, there is still an important gap in research aiming to quantify perioperative blood loss with a standardized hemoglobin-based methodology. In fact, the vast majority of the literature reporting on intraoperative hemorrhage regards loss of blood as an indirect or secondary outcome or does not account for true hemorrhage in patients who fall below the transfusion threshold.

Several authors advocate for the development of prospective randomized studies with a higher number of patients to characterize perioperative outcomes (4) and promote research to better elucidate TURP-related bleeding determinants (7).

Blood loss should be accurately quantified for optimizing surgical plan, improving perioperative risk stratification and informing transfusion protocols. Predictors of hemorrhage like prostate size, operative duration and other patient morbidity should be identified to help clinicians determining the risks and customizing perioperative management to improve patient safety (8, 9).

The objective of this study is to accurately assess TURP-related perioperative blood loss in patients through

objective quantification based on hemoglobin. The main goal is to measure hemoglobin levels in preoperative and postoperative patients in order to establish a reliable estimate of blood loss. Secondary aims are to define transfusion rates and reveal clinical and procedural predictors of elevated hemorrhage such as prostate size and operative time as well as patient age and associated comorbidities. This observational prospective study aims to develop evidence to support the evidence that will be useful for safer surgical practice in TURP and improved perioperative management.

MATERIALS AND METHODS

Study design

This was a prospective observational cohort study that specifically aimed to quantify perioperative blood loss in patients during TURP and identify clinical and operative correlates of increased bleeding. The study was conducted in a prospective design to allow for systematic and standardized collection of data throughout time, thereby limiting recall and ascertainment bias. All procedures were performed by one surgeon, in order to ensure technical uniformity across the study population and to prevent inter-surgeon variability as a confounding factor.

Study Setting

The study took place in two urological centers located in Sulaymaniyah, Iraq, namely, the *Department of Urology, Sulaymaniyah Surgical Teaching Hospital* and *Department of Urology, Smart Health Tower*. Both institutions are referral centers for urological surgery within the Kurdistan Region and together provide access to a large enough number of acceptable patients to fulfill the study's requirement of a sample size in the planned study period.

Study duration

It was a 2-year study involving patient recruitment, perioperative records collection, laboratory analysis, statistical analysis, and reporting. This timing was determined to be appropriate for sufficient sample size so as to obtain a meaningful evaluation of clinical and operative predictors of perioperative blood loss.

Sample size

The target was at least 60 patients. The sample size was calculated by comparison to other published studies of perioperative hemorrhage in urological surgery according to the surgeon's training time. This sample size confers sufficient statistical strength to observe potentially clinically informative variance in hemoglobin levels and to conduct multivariate regression analyses for the detection of risk factors for increased blood loss (10). Inclusion criteria were being a male participant aged ≥ 50 years, positive diagnosis for BPH, elective TURP appointment and written informed consent. The exclusion criteria were patients with a known or suspected coagulopathy, current use of anticoagulant or antiplatelet therapy that could not be safely discontinued prior to surgery, histologically confirmed or clinically suspected prostate cancer, and lack of complete clinical, operative, or laboratory data for complete analysis.

Perioperative protocol and data collection

Preoperative assessment

Data were taken for the patient before the operation, such as age, comorbidities including diabetes mellitus, hypertension, and chronic kidney disease, and prostate volume defined by transrectal or transabdominal ultrasound, as well as classification of physical status based upon the *American Society of Anesthesiologists* (ASA), and baseline serum hemoglobin concentration from a full blood count taken within 72 hours of the time planned for surgery.

Intraoperative data

Operational variables were prospectively recorded during the procedure including operative time (from urethral instrumentation, until completion of resection and catheter insertion), irrigation fluid (glycine or normal saline), type of resection (monopolar or bipolar TURP), and resection of prostatic lobes. Before diagnostic pathologic detection, prostatic tissue was weighted and recorded.

Postoperative assessment

Normalized serum hemoglobin (as per perioperative protocol for all patients) was repeated in 24 hours postoperatively. The frequency of blood transfusion (defined as administration of 1 or more packed red blood cells intraoperatively or within the first 24 postoperative hours) was determined, along with any significant postoperative complications. The most important indicator of blood loss was the decrease in hemoglobin level from the preoperative baseline to 24-hour postoperative.

Ethical considerations

Prior to recruitment of patients, ethical approval for the study was obtained from the *Research Ethics Committee of the College of Medicine, University of Sulaimani*. The research was performed strictly according to the Declaration of Helsinki along with relevant local legislations. All participants gave written informed consent prior to participation. To maintain strict confidentiality, the patient identifiers were replaced with anonymized study codes in all data records and analysis files. In all cases, the study design and treatment of participants were completely voluntary, and withdrawal from the study at any point in time would not affect patient's clinical care, therefore the consent to take part was completely voluntary.

Statistical analysis

All data were entered and analyzed with IBM SPSS Statistics (version 26.0). Continuous variables are represented as mean $\pm$ SD, and categorical variables are reported as frequencies and percentages. The paired samples t-test was used to compare hemoglobin concentrations before and after surgery. A Pearson correlation coefficient was used to evaluate the association between continuous predictor variables (prostate volume, operative time, patient age, etc.) and hemoglobin decline severity. Independent predictors of perioperative blood loss were identified by means of multivariate linear regression analysis, and hemoglobin drop was considered as the dependent variable. Any testing was 2-tailed, a p score < 0.05 indicating statistical significance.

RESULTS

According to the values shown in Table 1, preoperative hemoglobin was 13.8 g/dL, reducing to 13.2 g/dL postoperative with a reduction median of 0.7 g/dL. Platelet count was not decreased, WBC increased to 10.9, median prostate size was 62 cc, PSA 2.5 ng/ml and the duration of the operation was 30 min. Quantification was done based on hemoglobin with an estimated median blood loss of 5.7% as per the objective of the study to quantitatively estimate perioperative loss.

Table 1.

Baseline characteristics of study population (n = 79).

Variable	Median (IQR)
Age (years)	70 (63-74)
Hb pre-op (g/dL)	13.8 (12.7-14.9)
Platelet pre-op	227 (200-250)
WBC pre-op	7.7 (6.5-9.5)
Prostate size (cc)	62 (42-89)
PSA (ng/mL)	2.5 (1.58-7.17)
PVRV (cc)	153 (59-300)
Duration (min)	30 (25-40)
Hb post-op (g/dL)	13.2 (11.7-14.3)
Platelet post-op	220 (193-258)
WBC post-op	10.9 (8.7-13.1)
Hb drop (g/dL)	0.7 (0.2-1.3)
Estimated blood loss (%)	5.7 (1.36-9.70)

Table 2 is a representation of data of this prospective observational study on perioperative blood loss in TURP patients. It displays some of the most important categorical distributions of the study that are related to the objective of quantifying the extent of hemorrhage in the study. The majority of the patients were between 70-79 years (45.6%), with the most prevalent comorbidities being hypertension (22.8%), and diabetes (7.6%). More than half (57.0%) had no drug history and 20.3% took anti-hypertensives and 8.9% antiplatelets. The complications were not very common, and 96.2% did not have any. The stratification based on hemoglobin revealed 58.2% and 41.8% in the low blood loss group (≤ 1.0 g/dL) and the high group (> 1.0 g/dL), respectively, which demonstrated the purpose of our study to determine clinical predictors of perioperative bleeding to manage TURP safely. Table 3 indicates that median hemoglobin decreased between pre- and postoperative values of 13.8 g/dL and 13.2 g/dL, respectively ($p < 0.001$), which validates quantifiable blood loss. There was no significant difference in platelet counts ($p = 0.164$) and WBC counts increased significantly ($p < 0.001$) from 7.7 to 10.9, indicating postoperative inflammatory reaction. Our results confirm the use of hemoglobin-based quantification as a valid measurement used to assess bleeding during perioperative settings and safer management of TURP.

Table 2.
Distribution of categorical variables.

Variable	Category	Frequency (%)
Age group (years)	50-59	12 (15.2)
	60-69	26 (32.9)
	70-79	36 (45.6)
	≥ 80	5 (6.3)
Past Medical History	None	38 (48.1)
	Diabetes mellitus (DM)	6 (7.6)
	Hypertension (HTN)	18 (22.8)
	Ischemic heart disease (IHD)	2 (2.5)
	Thyroid disease	1 (1.3)
	DM & HTN	5 (6.3)
	DM & IHD	1 (1.3)
	DM, HTN & IHD	2 (2.5)
	HTN & IHD	1 (1.3)
	HTN &	
Cerebrovascular accident (CVA)	2 (2.5)	
	IHD & CVA	2 (2.5)
	HTN, IHD & CVA	1 (1.3)
Drug history	None	45 (57.0)
	Anti-diabetic	5 (6.3)
	Anti-hypertensive	16 (20.3)
	Antiplatelet	7 (8.9)
	Anti-DM & Anti-HTN	2 (2.5)
	Anti-HTN & Antiplatelet	2 (2.5)
	Anti-HTN & Anticoagulant	2 (2.5)
Complications	None	76 (96.2)
	Urosepsis	1 (1.3)
	MI	1 (1.3)
	Clot retention	1 (1.3)
Blood loss group	≤ 1.0 g/dL (Low)	46 (58.2)
	> 1.0 g/dL (High)	33 (41.8)

Table 3.
Comparison of preoperative and postoperative laboratory parameters.

Variable	Preoperative median (IQR)	Postoperative median (IQR)	Z value	p-value
Hemoglobin (g/dL)	13.8 (12.7-14.9)	13.2 (11.7-14.3)	-5.780	< 0.001
Platelet count	227 (200-250)	220 (193-258)	-1.392	0.164
WBC count	7.7 (6.5-9.5)	10.9 (8.7-13.1)	-6.378	< 0.001

According to the statistics in Table 4, age distribution indicated that the percentage of patients (70-79 years) in the high blood loss group was higher (54.5% vs. 39.1%), but not significantly. Notably, a past medical history showed a highly significant association ($p = 0.049$) and patients without comorbidities were more likely to have high blood loss (60.6% vs. 39.1%). History of drug and complications were not statistically significant. Our results highlight comorbidity status as an important predictor of perioperative bleeding risk, which can be used to measure TURP safer management using hemoglobin-based measurement.

Table 4.
Association between categorical variables and blood loss group.

Variable	Category	Low blood loss n (%)	High blood loss n (%)	p-value
Age group	50-59	7 (15.2)	5 (15.2)	0.195
	60-69	16 (34.8)	10 (30.3)	
	70-79	18 (39.1)	18 (54.5)	
	≥ 80	5 (10.9)	0 (0.0)	
Past medical history	None	18 (39.1)	20 (60.6)	0.049*
	DM	4 (8.7)	2 (6.1)	
	HTN	14 (30.4)	4 (12.1)	
	Others	10 (21.8)	7 (21.2)	
Drug history	None	24 (52.2)	21 (63.6)	0.729*
	Anti-DM	2 (4.3)	3 (9.1)	
	Anti-HTN	11 (23.9)	5 (15.2)	
	Others	9 (19.6)	4 (12.1)	
Complications	None	46 (100.0)	30 (90.9)	0.069*
	Yes	0 (0.0)	3 (9.1)	

The findings in Table 5 showed that there were high connections between continuous variables and risk of bleeding. Although the age, prostate size, duration of operation and preoperative hematological parameters were not statistically significant, PSA levels were significantly higher in the high blood loss group (median 3.73 ng/mL vs. 2.18 ng/mL, $p = 0.022$). Most importantly, hemoglobin-based quantification of perioperative hemorrhage was confirmed to be a valid measure of high blood loss through a significant decrease of postoperative hemoglobin in high blood loss patients (median 12.3 g/dL vs. 13.7 g/dL, $p = 0.001$). There were trends of pre- and postoperative platelet counts and WBC, which were attained to nearly

Table 5.
Association between continuous variables and blood loss group (Mann-Whitney U test).

Variable	Low blood loss median (IQR)	High blood loss median (IQR)	p-value
Age (years)	69.5 (62-74)	71 (64.5-74.5)	0.955
Prostate size (cc)	56 (40-82)	70 (52.5-101)	0.085
Duration (min)	30 (20-40)	35 (30-45)	0.092
PSA (ng/mL)	2.18 (1.20-5.63)	3.73 (2.08-7.93)	0.022
PVRV (cc)	143.5 (34.5-267)	179 (69-335)	0.490
Hb pre-op (g/dL)	13.7 (12.5-14.7)	14.1 (13-15.15)	0.176
Platelet pre-op	220 (196.7-247.3)	231 (213.5-283.5)	0.123
WBC pre-op	7.35 (6.21-8.83)	8.2 (6.99-10.0)	0.057
Post-op Hb (g/dL)	13.7 (12.78-14.63)	12.3 (11.4-13.3)	0.001
Post-op Platelet	211.5 (189-236)	226 (197.5-289.5)	0.056
Post-op WBC	10.75 (7.9-13.78)	11.2 (9.7-12.95)	0.380

Table 6.

Multivariate logistic regression analysis for predictors of high blood loss.

Variable	B	Odds ratio (Exp B)	p-value
Age	0.004	1.004	0.903
Prostate size (cc)	0.009	1.009	0.335
Duration (min)	0.017	1.017	0.570
Hb pre-op (g/dL)	0.321	1.378	0.102
PSA (ng/mL)	0.009	1.009	0.655
PVRV (cc)	0.001	1.001	0.664
Constant	-6.462	–	0.138

statistical significance. Our research results highlight PSA and postoperative hemoglobin as the important predictors of bleeding, which aligns with the research aim of identifying clinical predictors of perioperative blood loss and aid safer surgery management in TURP.

A multivariate logistic regression analysis on predictors of high blood loss in patients having TURP is shown in Table 6. All the variables examined such as age ($p = 0.903$), prostate size ($p = 0.335$), length of operation ($p = 0.570$), preoperative hemoglobin ($p = 0.102$), PSA ($p = 0.655$) and post-void residual volume ($p = 0.664$) were not statistically significant. Though the odds ratio of the preoperative hemoglobin was the largest ($OR = 1.378$), its association with the high blood loss was not significant. These results indicate that in this cohort, there was no individual clinical or procedural predictor of high perioperative blood loss, and thus, hemorrhage in TURP is multifactorial and should not be predicted using one variable alone.

According to the data presented in Table 7 in keeping with the main aim of the study, which was to determine predictors of increased hemorrhage, hemoglobin drop was statistically significantly correlated with three variables. The highest correlation was observed between PSA level and blood loss ($r = 0.307$, $p < 0.01$). Higher PSA values are indicative of higher gland burden and are connected with exuberant perioperative bleeding. Other significant correlations with hemoglobin drop were seen in prostate size ($r = 0.235$, $p < 0.05$) and operative duration ($r = 0.236$, $p < 0.05$), supporting the clinical intuition

that large glands take more time and cause more blood loss to be lost. The WBC count was found to correlate with hemoglobin drop in a modest yet significant manner ($r = 0.284$, $p < 0.05$), which might be explained by the inflammatory or physiological stress reaction that relates to more massive surgical procedures. Interestingly, pre-operative hemoglobin, platelet count and post-void residual volume (PVRV) showed no statistically significant association with blood loss, indicating that these factors are not as predictive as independent factors of hemorrhage in this cohort.

DISCUSSION

Perioperative blood loss after TURP

Hemoglobin-based method was found to be objective and clinically effective for managing perioperative blood loss in TURP patients. This finding aligns with the study by Vanderbruggen *et al.* (2023) who assessed the levels of hemoglobin, hematocrit, and operative duration among bipolar TURP patients (11). Similarly, Mithani *et al.* (2018) noticed that median hemoglobin decrease was 11.8 g/dL after surgery in 1,000 TURP patients (2018), which proves the reliability of hemoglobin as an indicator of intraoperative blood loss (12).

Patient demographics and blood loss

Age and body mass index (BMI) could not stratify patients by risk of blood loss; therefore, they did not act as independent predictors of perioperative hemorrhage. Similarly, Dutt *et al.* (2021) found no difference in baseline characteristics of the groups (age of 67 years; BMI of 22 kg/m²) (13). Moreover, Li *et al.* (2025) observed mean blood loss of 214.24 ± 29.10 mL and a decrease of 14.47 ± 0.62 to 11.35 ± 0.93 g/dL in hemoglobin level, highlighting the importance of blood loss monitoring irrespective of age (14).

Comorbidities and blood loss

Perioperative blood loss had a significant correlation with the presence or absence of comorbidity in TURP patients. However, a higher degree of blood loss was seen in patients without any comorbidities, which can be attributed to a number of factors like small sample size, presence of unknown confounding variables, and surgery

Table 7.

Spearman correlation between blood loss and clinical variables.

Variable	Hb drop	Prostate size	PSA	Duration	Hb pre-op	Platelets	WBC	PVRV
Hb drop	1.000	0.235*	0.307**	0.236*	0.150	0.123	0.284*	0.064
Prostate size	0.235*	1.000	0.299**	0.677**	-0.022	0.062	0.253*	-0.021
PSA	0.307**	0.299**	1.000	0.278*	-0.093	0.130	0.302**	0.058
Duration	0.236*	0.677**	0.278*	1.000	0.023	0.073	0.215	0.033
Hb pre-op	0.150	-0.022	-0.093	0.023	1.000	0.189	0.175	-0.035
Platelets	0.123	0.062	0.130	0.073	0.189	1.000	0.272*	0.011
WBC	0.284*	0.253*	0.302**	0.215	0.175	0.272*	1.000	-0.189
PVRV	0.064	-0.021	0.058	0.033	-0.035	0.011	-0.189	1.000

complexity, which requires cautious interpretation. According to Islam *et al.* (2024), postoperative complications like hematuria and clot retention in TURP patients resulted more frequent in patients with diabetes mellitus and hypertension (15). Similarly, Sharawy *et al.* (2025) found that poor TURP outcomes are mainly related to type-2 diabetes and preoperative urinary infections (16).

Antihypertensive and antiplatelet therapy

It is important to note that antihypertensive drugs and antiplatelets had a marked impact on perioperative bleeding risk. He *et al.* found that continuous use of antithrombotic medication during TURP surgery increased bleeding and transfusion risks among patients compared to those who discontinued their treatment 5-10 days before surgery (17). Furthermore, Li *et al.* reported that temporary cessation of aspirin and clopidogrel prior to TURP was associated with favorable bleeding parameters in 31 patients on chronic antithrombotic therapy who had no need for transfusions and reoperations (18). The current study provides the results concerning both classes of drugs within the framework of comorbidity profiling.

Prostate volume and PSA

PSA proved the most important independent blood loss predictor, thereby confirming the notion of the positive correlation between the size of the gland and its hemorrhagic potential. The prostate volume and operative duration were shown to have statistically significant correlations due to the well-established link between the size of the gland and the extent of resection surgery and thus the volume of bleeding. According to Mbaeri *et al.*, mean prostate volume of $221.56 \pm 62.78 \text{ cm}^3$ and PSA level of $25.61 \pm 22.08 \text{ ng/mL}$ were associated with significant perioperative packed cell volume (PCV) reduction, which emphasizes the importance of glandular mass (19).

DECLARATIONS

Ethical approval and consent for participate: This study was conducted in accordance with international ethical standards, including the principles of the 2008 Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of the College of Medicine, University of Sulaimani, Iraq. Confidentiality of all participants was strictly maintained, and verbal informed consent was obtained from every patient prior to inclusion in the study.

Competing interests: The author declare that no competing interests exist. Consent for Publication Not applicable at this stage.

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Similarly, Uğurlu *et al.* confirmed the predictive value of prostate volume, PSA level, and operative time in large-volume BPH as an example of a multifactorial hemorrhagic process requiring individualized risk stratification (20).

CONCLUSIONS

The present prospective observational study establishes that the quantification of perioperative blood loss in TURP patients using hemoglobin-based methods is a valid and clinically feasible technique to objectively measure perioperative blood loss. This method is an acceptable monitoring strategy as indicated by the observed postoperative hemoglobin decrease, as well as the high white blood cell (WBC) counts that are a consequence of the surgical inflammation. The PSA level proved to be the most important correlate of blood loss, and the prostate size, as well as the duration of operations, showed significant correlations. However, a multivariate analysis did not show any single independent predictor of high perioperative hemorrhage, highlighting the multifactoriality of the bleeding in TURP. These data confirm that comprehensive preoperative risk stratification including comorbidity profile, PSA, and hematological parameters maximize perioperative management and improve surgical safety in patients undergoing TURP.

Limitations

Our study faced several limitations. The comparatively small sample of 60 patients restricts the extrapolation of results and the statistical strength of multivariate tests. Single-surgeon performance, although being technically consistent restricts its applicability to broader, large scale surgical settings. The research was carried out in two centers in the same region, which might have limited external validity. Moreover, estimation of blood loss was based on the decline of hemoglobin only without a direct quantitative determination, which can lead to imprecision in quantification. Further follow-up would be also justified to record delayed hemorrhagic complications after 24 hours of operation.

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