

Predictive Factors for Hemoglobin Decrease After Simple Open Prostatectomy: Single-center Clinical Experience

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What's known on the subject? and What does the study add?

Simple open prostatectomy (SOP) is a well-established treatment for large prostates but carries a higher risk of bleeding and transfusion. Few studies have investigated perioperative predictors of hemoglobin decrease after SOP. This study identifies preoperative hemoglobin, hematocrit, and operative time as predictors of postoperative hemoglobin decrease, supporting a more evidence-based approach to perioperative blood management in SOP.

Abstract

Objective: In patients with benign prostatic hyperplasia (BPH) presenting with moderate-to-severe lower urinary tract symptoms and prostate volumes greater than 80 cc, simple open prostatectomy (SOP) remains the standard surgical treatment, alongside endoscopic enucleation techniques. However, SOP is associated with increased bleeding, higher transfusion requirements, and prolonged hospital stays compared to other surgical methods. This study aimed to evaluate factors predicting postoperative decreases in hemoglobin in patients undergoing SOP.

Materials and Methods: Following approval by the institutional ethics committee, 81 patients who underwent SOP in our clinic between January 2019 and December 2024 were included in the study. Postoperative decrease in hemoglobin was calculated as the difference between preoperative hemoglobin level and the hemoglobin level measured within the first 4 hours after surgery. Patients were divided into two groups according to whether their decrease in hemoglobin was below or above the mean value (1.43 g/dL). Preoperative, intraoperative, and postoperative parameters were compared between groups using statistical analysis with SPSS software. Preoperative hemoglobin ($p<0.001$), preoperative hematocrit ($p<0.001$), and longer operative time ($p=0.024$) were identified as significant factors associated with a decrease in hemoglobin. Hemoglobin and hematocrit values were positively correlated with each other, while operative time was negatively correlated with both. Receiver operating characteristic curve analysis revealed a cut-off value of 93 minutes for operative time.

Results: SOP remains the gold-standard surgical technique for patients with large prostate volumes (≥ 80 cc) requiring surgical treatment for BPH, along with endoscopic enucleation techniques. Compared with transurethral, endoscopic, and minimally invasive techniques, SOP is associated with increased bleeding, higher transfusion rates, and longer hospital stays. To date, no studies have specifically addressed perioperative predictors of hemoglobin decrease.

Conclusion: Our study demonstrated that preoperative hemoglobin and hematocrit levels, as well as operative time were significant predictors. Incorporating these predictors into clinical practice may help prevent unnecessary transfusions, prolonged hospital stays, and excess healthcare costs. Further large-scale, randomized controlled studies are needed to validate these findings.

Keywords: Simple open prostatectomy, benign prostatic hyperplasia, hemoglobin decrease, blood loss, predictive factors, transfusion requirements, postoperative outcomes

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Introduction

Benign prostatic hyperplasia (BPH) is a urological condition characterized by lower urinary tract storage and voiding dysfunction (1). Various treatment options have been described for patients with BPH, including conservative, medical, minimally invasive, and open surgical approaches. Surgical indications include failure of medical therapy, recurrent urinary tract infections, recurrent hematuria, acute urinary retention, bladder stone formation, bladder diverticula, and upper urinary tract involvement (2).

Simple open prostatectomy (SOP) is generally preferred for patients with BPH who have prostate volumes of 80-100 cc or greater. Additional indications include large bladder stones and symptomatic bladder diverticula, while contraindications include prostate cancer and small prostate volume (3). Despite the availability of endoscopic enucleation techniques, SOP remains the standard surgical treatment for patients with moderate-to-severe lower urinary tract symptoms (LUTS) and prostate volumes greater than 80 cc (2,4).

Over the years, SOP has been shown to increase maximal urinary flow rate (Qmax) and reduce International Prostate Symptom Score (IPSS), making it an effective surgical approach. However, complications such as bleeding, the need for blood transfusions, and reoperations for recurrence have driven the search for minimally invasive alternatives (5). SOP has long been perceived as a procedure with significant hemorrhage risk, often resulting in unnecessary blood transfusions. Many clinicians have reported that blood transfusion during SOP is common and is even considered a standard procedure in many surgical centers (6). Although there are no standardized guidelines for routine blood transfusions, it is clear that randomized controlled trials are needed to identify perioperative factors predicting postoperative decreases in hemoglobin (Hb).

In this study, we retrospectively investigated the predictive factors for a decrease in Hb in patients undergoing SOP, with the aim of preventing unnecessary blood transfusions, associated complications, and additional healthcare costs.

Materials and Methods

Study Design and Patients

After obtaining ethical approval, we conducted a retrospective analysis of 81 patients who underwent SOP between January 2019 and December 2024. This study was approved by the Hitit University Faculty of Medicine Ethics Committee (approval no: 2025-52, date: 09.04.2025).

Demographic and clinical variables included age, comorbidities, use of anticoagulant medications, history of previous urological

surgeries, preoperative Hb, hematocrit, creatinine, free and total prostate-specific antigen (PSA) levels, free/total PSA ratio, PSA density, prostate volume, presence of bladder stones, history of urinary retention, preoperative Qmax, mean urinary flow rates, IPSS, operative time, postoperative Hb and creatinine levels, pathological outcomes (benign/malignant), length of hospital stay, catheterization duration, drain removal time, and postoperative Qmax, mean urinary flow rates, and PSA levels.

Patients with coagulopathies, hematologic malignancies, those actively receiving anticoagulant therapy, individuals with a history of urethral and/or prostate surgery, and patients without postoperative follow-up data were excluded from the study.

Surgical Technique

All SOP procedures were performed using a standard transvesical (Freyer) approach. After opening the bladder, the adenoma was enucleated by finger dissection. Hemostasis was achieved with electrocautery and, when necessary, traction sutures. A 22 Fr three-way Foley catheter was inserted at the end of the procedure, and continuous bladder irrigation was initiated.

Definition of Hb Change

Postoperative Hb decrease was calculated as the difference between preoperative and postoperative Hb levels, with postoperative values measured within the first 4 hours after surgery.

The mean decrease in Hb (1.43 g/dL) was used as the threshold, and patients were divided into two groups: those below and those above the mean, for comparative analysis.

Data Collection

Clinical, laboratory, operative, and postoperative variables were extracted from electronic medical records using a standardized data collection form. Preoperative, intraoperative, and postoperative parameters were compared between the two Hb-based groups to identify factors associated with postoperative Hb decrease.

Sample Size Calculation

Sample size was estimated using G*Power 3.1, resulting in a minimum required sample of 34 patients (Figure 1).

Statistical Analysis

All statistical analyses were performed using SPSS version 21.0 (IBM Corp., Armonk, NY, USA). Continuous variables were tested for normality using the Kolmogorov-Smirnov and Shapiro-Wilk tests. Normally distributed variables are presented as mean $\pm$ standard deviation, and non-normally distributed variables are presented as median (minimum-maximum). Categorical variables are presented as numbers and percentages.

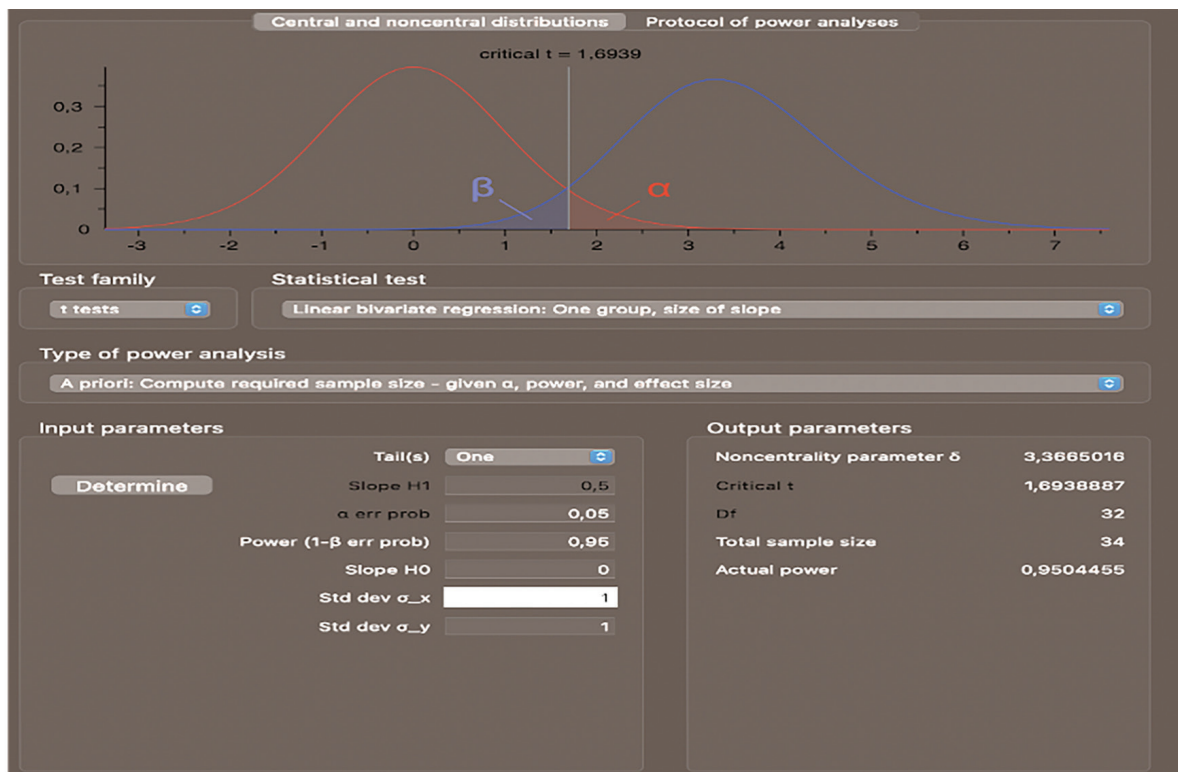


Figure 1. Sample size calculation

For comparisons between the two Hb-based groups (below vs. above the mean value), the Student's t-test was used for normally distributed continuous variables, the Mann-Whitney U test for non-normally distributed continuous variables, and the chi-square or Fisher's exact test for categorical variables. Correlations between perioperative variables and the postoperative decrease in Hb were assessed using Pearson or Spearman correlation coefficients, depending on the distribution of the data.

Receiver operating characteristic (ROC) curve analysis was performed to determine the optimal operative time threshold associated with a greater decrease in Hb. Two-sided p-values <0.05 was considered statistically significant; exact p-values are reported for all hypothesis tests.

In addition to the absolute decrease in Hb, the percentage change in Hb ($\Delta\text{Hb}\%$) was calculated as $[(\text{preoperative Hb} - \text{postoperative Hb}) / \text{preoperative Hb}] \times 100$. This parameter was included as a supplementary measure to evaluate whether the observed associations were influenced by baseline Hb levels.

Results

The mean age of the 81 patients included in the study was 69.62 years (range: 53-86). Comorbidities included diabetes mellitus in 19 patients (23%), hypertension in 34 patients (42%), and coronary artery disease in 12 patients (14.8%). A total of 18

patients (22%) were on anticoagulant therapy preoperatively; all anticoagulants were discontinued before surgery after consultation with the relevant departments, and low-molecular-weight heparin was initiated.

The mean preoperative total PSA level was 10.15 ng/mL (range: 0.6-45); the mean free PSA was 2.42 ng/mL (range: 0.1-14.2); and the mean free/total PSA ratio was 0.25 (range: 0.05-0.87). The mean prostate volume was 134.1 cc (range: 30-330), and the mean PSA density was 0.07 (range: 0.001-0.35). The mean preoperative Qmax was 7.3 mL/s (range: 4-14 mL/s), the mean flow rate was 4.03 mL/s (range: 2-9 mL/s), and the mean IPSS was 28.3 (range: 21-36).

Preoperative Hb levels averaged 13.37 g/dL (range: 10.1-17.2), hematocrit levels averaged 40.8% (range: 30.6-48.9), and creatinine levels averaged 0.94 mg/dL (range: 0.5-2.4). Bladder stones were present in 13 patients (16%), and 24 patients (29%) required preoperative indwelling catheters for urinary retention.

The mean operative time was 92.95 minutes (range: 48-150 minutes). Postoperative Hb averaged 11.94 g/dL (range: 9.3-14.7 g/dL), and creatinine averaged 0.91 mg/dL (range: 0.4-1.6 mg/dL). The mean length of hospital stay was 6.39 days (range: 3-16), the mean drain removal time was 4.25 days (range: 2-11), and the mean catheterization duration was 8.23 days (range: 3-16).

At the 1-month postoperative follow-up, the mean Qmax was 16.27 mL/s (range: 8-22 mL/s), the mean flow rate was 9.62 mL/s

(range: 4-14 mL/s), the mean total PSA was 2.4 ng/mL (range: 0.4-30.6 ng/mL), and the mean free PSA was 0.46 ng/mL (range: 0.01-4.2 ng/mL). Among the 81 patients who underwent surgery with a preoperative clinical or pathological diagnosis of BPH, the final pathological examination revealed malignancy (prostatic adenocarcinoma) in 5 patients (6%), who were subsequently managed with active surveillance.

In our study, preoperative Hb ($p<0.001$) and hematocrit ($p<0.001$) levels were positively correlated with the postoperative decrease in Hb. In contrast, operative time ($p=0.024$) showed a negative correlation, indicating that longer operative times were associated with smaller decreases in postoperative Hb. ROC curve analysis determined a cut-off value of 93 minutes for operative time (Figure 2). Prolonged surgical time was likely associated with increased attention to hemostasis, which reduced postoperative Hb loss; significant effects were observed in surgeries lasting 93 minutes or longer.

When $\Delta\text{Hb}\%$ was evaluated as an additional outcome measure, the direction of the associations remained consistent with the absolute Hb change. Higher preoperative Hb and hematocrit levels were still associated with a greater percentage decrease

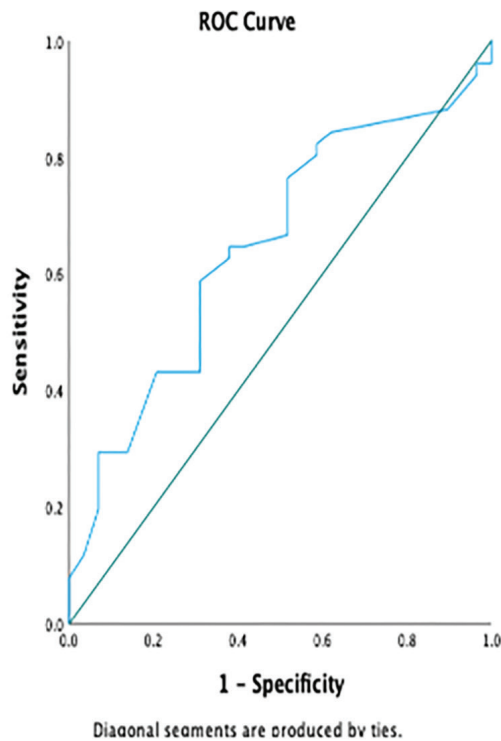
in Hb postoperatively, suggesting that the observed correlation was not solely a mathematical consequence of baseline values.

No significant differences in postoperative Hb decrease were found between the two groups with respect to anticoagulant use ($p=0.219$), prostate volume ($p=0.988$), free PSA ($p=0.23$), total PSA ($p=0.551$), preoperative biopsy status ($p=0.975$), bladder stones ($p=0.653$), urinary retention ($p=0.509$), or other independent variables (Table 1).

Table 1. Hemoglobin decrease and evaluated parameters

Parameters	p-value	Statistical test
Preoperative Hb	<0.001	t-test
Preoperative Hct	<0.001	t-test
Operative time	0.024	t-test
Anticoagulant use	0.219	Chi-square
Prostate volume	0.988	Mann-Whitney U
Free PSA	0.23	Mann-Whitney U
Total PSA	0.551	Mann-Whitney U
History of biopsy	0.975	Chi-square
Presence of bladder stone	0.653	Chi-square
History of urinary retention	0.509	Chi-square

PSA: Prostate-specific antigen, Hb: Hemoglobin, Hct: Hematocrit



Positive if Greater Than or Equal To ^a	Sensitivity	1 - Specificity
47.00	1.000	1.000
58.00	.980	1.000
70.00	.961	1.000
73.00	.961	.966
74.50	.941	.966
75.50	.882	.897
77.00	.863	.759
79.00	.843	.621
80.50	.824	.586
83.00	.804	.586
85.50	.765	.517
87.00	.725	.517
88.50	.686	.517
89.50	.667	.517
90.50	.647	.414
91.50	.647	.379
93.00	.627	.379
94.50	.588	.310
95.50	.471	.310
97.00	.431	.310
99.00	.431	.207
100.50	.294	.138
102.00	.294	.103
103.50	.294	.069
104.50	.275	.069
107.50	.196	.069
112.50	.118	.034
117.50	.078	.000
120.50	.059	.000
123.00	.039	.000
137.50	.020	.000
151.00	.000	.000

Figure 2. Operative time/perioperative hemoglobin decrease ROC curve

ROC: Receiver operating characteristic

Discussion

BPH is one of the most common health problems in elderly men, with a prevalence reaching approximately 80% in their 80s (7). In patients with moderate to severe LUTS and prostate volumes greater than 80 cc, SOP, along with endoscopic enucleation techniques, remains the standard surgical treatment (5). Although SOP has long been considered the gold standard for patients with large prostates, it is associated with increased bleeding, higher transfusion rates, and longer hospital stays compared to alternative methods (8). In addition, complications such as urinary incontinence, urethral stricture, urinary tract infections, and the need for reoperation may occur (9).

When transurethral resection of the prostate and SOP are compared with holmium laser enucleation of the prostate (HoLEP), HoLEP results in shorter hospitalization and catheterization times, less blood loss, and a lower need for transfusion (7). The American Urological Association recommends HoLEP as the first-line treatment for patients at high risk of bleeding (10). Indeed, in a study comparing HoLEP with SOP, the transfusion rate was found to be 2.5 times higher in the SOP group (11). However, the main disadvantages of HoLEP are the long learning curve (12) and the high cost of equipment (13). Therefore, SOP continues to be performed.

In our study, we retrospectively investigated factors that predict postoperative decreases in Hb in patients who underwent SOP. Our aim was to reduce unnecessary transfusions and related complications, thereby lowering healthcare costs.

Our analyses revealed a significant relationship between the postoperative decrease in Hb and preoperative Hb ($p < 0.001$), hematocrit ($p < 0.001$), and operative time ($p = 0.024$). Preoperative Hb and hematocrit levels were positively correlated with a decrease in Hb, whereas operative time was negatively correlated.

Higher preoperative Hb and hematocrit levels were associated with a greater postoperative decrease in Hb. Reports in the literature indicate that higher hematocrit values are associated with greater blood loss (14). Elevated hematocrit has been shown to increase blood viscosity, thereby elevating cardiac workload and blood pressure (15). Our findings are consistent with these pathophysiological mechanisms and parallel previous studies indicating that preoperative hematological status is an important factor in determining perioperative bleeding risk. For example, Kyei et al. (16) reported that low preoperative Hb independently predicted transfusion requirements. Our data also support the notion that baseline hematological profile directly influences perioperative blood loss and transfusion needs.

A negative correlation was observed between the decrease in Hb and operative time in cases lasting longer than 93 minutes.

This may be explained by longer operative times, which allow surgeons to achieve more meticulous hemostasis (17). However, the literature presents conflicting results on this issue. While some studies have reported that longer operations increase transfusion requirements (16), our findings demonstrated the opposite relationship. This discrepancy may be due to careful bleeding control by the surgeon in more challenging cases, rather than the duration itself. Targeted hemostatic maneuvers described by Dall'Oglio et al. (18) further support this interpretation.

No significant difference was found between patients who used anticoagulants and those who did not ($p = 0.219$). This is consistent with the literature suggesting that standardized perioperative anticoagulation management can safely control bleeding risk. Prospective data, particularly from the PAUSE study, have shown that standardized protocols for discontinuation and resumption of direct oral anticoagulants are safe and effective, reducing bleeding and preventing thromboembolic complications (19).

Furthermore, prostate volume, PSA levels, biopsy history, bladder stones, and retention history had no significant effect on postoperative decrease in Hb. Although prostate volume could theoretically increase bleeding risk because of a larger surgical area, studies have shown that this effect is limited (20). Our data confirm this finding, indicating that careful surgical technique and effective hemostasis can minimize blood loss even in patients with large prostates. The literature also emphasizes that prostate volume alone is not the sole determinant and should be evaluated together with other patient- and surgery-related factors (5).

Kyei et al. (16) reported that preoperative Hb level was an independent predictor of perioperative blood transfusion in patients undergoing open prostatectomy. This finding is consistent with our observation that higher preoperative Hb and hematocrit levels were positively correlated with greater postoperative decreases in Hb. Whereas the study by Kyei et al. (16) used transfusion requirement as the primary outcome, our study evaluated a decrease in Hb as a quantitative parameter, and both studies similarly highlight the importance of baseline hematological status in predicting perioperative blood loss. Therefore, it can be inferred that the preoperative Hb level not only influences transfusion decision-making but also significantly affects early postoperative Hb dynamics.

Dall'Oglio et al. (18) demonstrated that targeted hemostatic maneuvers during open prostatectomy may prolong operative time, yet result in reduced perioperative blood loss. This finding parallels our observation that longer operative times were associated with a smaller decrease in postoperative Hb levels. However, the prospective randomized design of the study by Dall'Oglio et al. (18) allowed for better control of confounding variables compared to our retrospective methodology. In our

study, surgeon experience and patient heterogeneity could not be fully eliminated, which represents a limitation. Nevertheless, both studies suggest that operative duration itself is not a direct determinant of increased blood loss and that meticulous hemostasis during longer procedures may effectively minimize bleeding.

To address the possibility that the correlation between baseline hematologic values and postoperative Hb reduction could represent a mathematical artifact, we additionally calculated percentage Hb change ($\Delta\text{Hb}\%$). The consistency of the results between absolute and percentage-based analyses supports the validity of our findings and suggests that the association reflects a true clinical relationship rather than a statistical artifact.

Study Limitations

This study has several limitations that should be acknowledged. First, the retrospective, single-center design inherently limits the generalizability of the findings and increases the risk of selection bias. Second, although the sample size exceeds the minimum required by the power analysis, it remains relatively small and may limit the robustness of subgroup comparisons. Third, postoperative Hb was measured only within the first four hours after surgery. These early measurements may have been affected by perioperative fluid administration and hemodilution and therefore may not fully reflect the true extent of perioperative blood loss. Fourth, multivariate or interaction analyses could not be performed due to the structure of the dataset, preventing a comprehensive evaluation of potential confounders such as surgeon experience, prostate volume, and anticoagulant use. Additionally, variations in intraoperative fluid management and hemostatic techniques could not be fully standardized, which may have contributed to heterogeneity in perioperative outcomes. These limitations should be considered when interpreting our results, and prospective studies with larger cohorts are needed to validate and expand upon these findings.

Conclusion

SOP is associated with increased bleeding, higher transfusion requirements, and prolonged hospital stays compared with transurethral, endoscopic, and minimally invasive techniques. To date, there have been no studies specifically addressing perioperative predictors of a decrease in Hb following SOP.

Our study identified preoperative Hb and hematocrit levels and operative time as significant predictors of postoperative Hb decline. Considering these parameters in clinical practice may help prevent unnecessary transfusions, prolonged hospitalizations, and increased healthcare costs.

Further prospective studies with larger patient populations are required to validate our findings and establish standardized protocols for perioperative blood management in SOP.

Ethics

Ethics Committee Approval: This study was approved by the Hitit University Faculty of Medicine Ethics Committee (approval no: 2025-52, date: 09.04.2025).

Informed Consent: Because the study was designed retrospectively no written informed consent form was obtained from the patients.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.S.Ç., M.K., M.M.B., Concept: M.S.Ç., C.A., M.E., M.M.B., Design: M.S.Ç., M.K., C.A., M.E., A.T., M.M.B., Data Collection or Processing: M.S.Ç., M.K., C.A., M.E., A.T., Analysis or Interpretation: M.S.Ç., M.K., C.A., M.E., A.T., M.M.B., Literature Search: M.S.Ç., M.K., A.T., Writing: M.S.Ç., M.K., A.T.

Conflict of Interest: One of the author of this article, Cemil Aydın is member of the Editorial Board of the Journal of Urological Surgery. However, he was not involved in any stage of the editorial decision of the manuscript. The editors who evaluated this manuscript are from different institutions.

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