Article

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Bleeding Risks in Urologic Surgery: A Prospective Analysis of Anticoagulant and Antiaggregant Use in Transurethral Resection of Prostate, Transurethral Resection of Bladder Tumour and Open Prostatectomy

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Background: The use of anticoagulant (AC) and antiaggregant (AG) medications is increasingly common in elderly patients undergoing urologic surgeries. This prospective observational study aimed to evaluate the influence of AC/AG therapy on bleeding-related complications following transurethral resection of the prostate (TURP), transurethral resection of bladder tumour (TURBT) and open prostatectomy (OP).

Methods: Patients who underwent TURP, TURBT or OP between March 2022 and January 2023 were included in this study. Patients were stratified according to AC/AG usage. Perioperative management details, including low-molecular-weight heparin (LMWH) bridging, were recorded. We evaluated parameters including duration of irrigation, length of stay, episodes of clot retention, transfusion rate and re-admission rate due to haematuria.

Results: Among TURP patients, those using AC/AG therapy had significantly higher rates of transfusion (2.27% vs 0%, p = 0.038), postoperative clot retention (7.57% vs 0.53%, p = 0.008), re-catheterisation (9.09% vs 3.72%, p = 0.046) and re-admission due to haematuria (11.36% vs 3.72%, p = 0.008) compared with those not receiving AC/AG therapy. In the TURBT group, AC/AG use was associated with an elevated rate of rehospitalisation (p = 0.026). OP patients on AC/AG therapy experienced increased transfusion rates (p = 0.030), early postoperative clot retention (p = 0.034) and re-operations (p = 0.016). LMWH bridging was associated with further increases in irrigation volume, early clot retention and rehospitalisation, particularly in TURBT and OP patients.

Conclusions: AC/AG therapy significantly influences bleeding outcomes after TURP, TURBT and OP. LMWH bridging may further exacerbate these risks. This study emphasises the need for caution regarding bleeding-related complications in patients receiving AC/AG therapy.

Keywords: antiplatelet; anticoagulant; bladder; haematuria; prostate

Introduction

Benign prostatic hyperplasia (BPH) and bladder tumour operations rank among the most frequently performed urological surgeries, with a substantial portion targeting the elderly population. The widespread use of oral anticoagulant (AC) or antiaggregant (AG) medication among the elderly increases the likelihood of bleeding-related complications. Perioperative AC/AG management varies depending on the underlying disease and medication type. AC therapy may be discontinued with low-molecular-weight heparin (LMWH) bridging [1]. AG drugs are typically discontinued 3–7 days before elective surgery [2]. LMWH bridging for AG patients minimally affects arterial thromboembolism risk and is reserved for select cases [3].

Transurethral resection of prostate (TURP) is the current standard surgical procedure for patients with prostate volumes of 30–80 mL [4]. Blood transfusion and clot retention rates after bipolar TURP were reported as 2% and 5%, respectively [5,6]. Open prostatectomy (OP) is an invasive surgical procedure recommended in patients with prostate sizes >80 mL when transurethral bipolar enucleation and holmium laser enucleation of prostate cannot be performed [4]. Blood transfusion rates after open prostatectomy have been reported between 7% and 16% [7–9], while bleeding-related complications are observed in approximately 21%–24% of patients [10,11]. In bladder tumours, transurethral resection of bladder tumour (TURBT) is a diagnostic step and a treatment procedure. The transfusion rate for bipolar

TURBT was reported as 1%, and the re-admission rate for haematuria/retention was reported as 2% [12,13].

Few studies have evaluated AC/AG use in patients undergoing BPH or bladder tumour surgery, and most were retrospective. This prospective study aimed to compare bleeding-related complication risks between patients using AC/AG medications and those who do not.

Materials and Methods

Study Design and Patient Selection

This prospective observational study included patients undergoing TURP, complete TURBT or OP between March 2022 and January 2023. The exclusion criteria were incomplete TURBT (failure to achieve complete macroscopic tumour resection), planned second-look TURBT (performed 4–6 weeks later for incomplete resection, absent detrusor muscle, or T1 disease), transurethral resection (TUR)-biopsy (diagnostic resection without visible papillary tumour) and the presence of known or newly diagnosed prostate cancer on postoperative pathology. We recorded age, body mass index (BMI), medical history, use of AC/AG medication, haemoglobin and international normalised ratio (INR) levels, prostate volume, the Turkish version of international prostate symptom score (IPSS) and quality of life (this questionnaire is widely used in clinical practice in Turkey; It was linguistically adapted and authorised by the Turkish Urological Association, and it is freely available; Its reliability and applicability have been demonstrated [14]) in patients with BPH, as well as tumour diameter in patients with bladder tumours. For AC/AG users, the drug type, discontinuation date and LMWH bridging were recorded. Each patient was followed for one month postoperatively.

Outcomes

Primary outcome variables included duration and volume of irrigation, duration of catheterisation, length of hospital stay, blood transfusion, early clot retention, re-admission due to haematuria, transfusion after re-admission, clot retention within the first postoperative month, re-catheterisation, rehospitalisation and re-operation rates. These outcomes were recorded during hospitalisation (for perioperative complications) and within 30 days after discharge (for re-admission, clot retention, re-catheterisation, rehospitalisation or re-operation).

Patients were categorised into three groups based on the type of surgery. Each group was subdivided into AC/AG users and non-users. We compared two groups regarding postoperative haemoglobin levels, irrigation time and volume, catheterisation duration, blood transfusion rates, clot retention, length of hospital stay and re-admission rates within the first postoperative month.

Perioperative Management

Surgical indication was determined by the attending urologist according to the European Association of Urology guidelines [4]. In our clinic, OP is generally performed for prostates >100 mL, although the final decision between OP and TURP is made jointly with the patient. TURP and TURBT were performed using a bipolar resectoscope. The decision regarding the perioperative management of AC therapy, including the timing of discontinuation, initiation of LMWH bridging and its dosing, was determined during the preoperative anaesthesiology consultation. In many cases, the anaesthesiologist made this decision in collaboration with the prescribing physician (e.g., cardiologist or neurologist) through a formal preoperative consultation. The operating urologist had no influence over these management decisions. The urologist's role was limited to deciding when to resume LMWH or restart the patient's original AC/AG therapy, based on the persistence of haematuria or continued bleeding risk. Antiplatelet therapy was stopped 5 days before surgery, and AC therapy was stopped 3 days prior. Patients requiring bridging received enoxaparin at a dose of 6000 anti-Xa IU/0.60 mL subcutaneously twice daily. No patient used a dose of 4000 anti-Xa IU/0.40 mL.

Clot retention was defined clinically as suprapubic discomfort or bladder distension with absent or minimal urine drainage through the Foley catheter. It was confirmed when manual irrigation performed by the attending physician resulted in retrieval of blood clots.

Statistical Analysis

In the literature, Ehrlich *et al.* [15] recruited 120 participants divided into two groups, whereas Deuker *et al.* [16] enrolled 268 across four groups. A priori power analysis was performed using G Power 3.1 (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) to estimate the required sample size for one-way analysis of variance (ANOVA) with six groups. Assuming a medium effect size (Cohen's f = 0.29), significance level $\alpha = 0.05$ and power $(1 - \beta) = 0.95$, the minimum required total sample size was 240 participants (40 per group).

Statistical analyses were performed using Number Cruncher Statistical System 2007 (NCSS, LLC., Kaysville, UT, USA). In addition to descriptive statistics, the independent sample *t*-test and Mann–Whitney U test were used for two-group comparisons. The Pearson Chi-Square test and Fisher's Exact test were used to compare qualitative data. Multivariable linear and logistic regression models were used to adjust for potential confounders, including age, surgical type (TURP (reference), TURBT or OP), diabetes mellitus (DM), coronary artery disease (CAD), preoperative haemoglobin, INR, AC/AG use and LMWH bridging. For the linear regression models, key assumptions were verified. The normality of residuals was assessed using quantile-quantile (Q-Q) plots and the Shapiro–Wilk test,

Table 1. Baseline characteristics of the patients.

Variables	TURP with no AC/AG (n = 188)	TURP with AC/AG (n = 132)	*p*
Age; Mean ± SD, years	66.21 ± 8.11	71.68 ± 7.29	0.001[1]
BMI; Median (IQR), kg/m^2	26.86 (24.65–29.41)	27.75 (24.96–30.41)	0.706[2]
Patients with DM, n (%)	34 (18.08)	17 (12.87)	0.143[3]
Patients with CAD, n (%)	4 (2.12)	68 (51.51)	0.001[4]
PV; Median (IQR), mL	68.50 (53–90)	67.50 (50–87.5)	0.923[2]
IPSS; Mean ± SD	22.74 ± 5.71	23.51 ± 6.55	0.264[1]
Q of life; Mean ± SD	4.40 ± 1.03	4.42 ± 0.98	0.863[1]
Hgb; Median (IQR)	14.17 (13.17–15.01)	13.58 (12.41–14.83)	0.548[2]
INR; Median (IQR)	1.02 (0.97–1.07)	1.04 (0.98–1.16)	0.060[2]
	TURBT with no AC/AG (n = 63)	TURBT with AC/AG (n = 53)	
Age; Mean ± SD, years	61.27 ± 12.50	70.68 ± 9.58	0.001[1]
BMI; Median (IQR), kg/m^2	27.14 (24.22–30.32)	26.78 (24.97–29.30)	0.372[2]
Patients with DM, n (%)	9 (14.28)	6 (11.32)	0.261[3]
Patients with CAD, n (%)	9 (14.28)	27 (50.94)	0.002[3]
Tumour diameter; Median (IQR), mm	30 (20–40)	30 (15–35)	0.372[2]
Hgb; Median (IQR), g/dL	14.30 (12.92–15.30)	13.27 (12.27–14.20)	0.391[2]
INR; Median (IQR)	1.01 (0.96–1.08)	1.03 (0.97–1.12)	0.057[2]
	OP with no AC/AG (n = 45)	OP with AC/AG (n = 41)	
Age; Mean ± SD, years	66.31 ± 6.42	69.15 ± 5.10	0.027[1]
BMI; Median (IQR), kg/m^2	27.50 (23.53–29.39)	28.32 (26.83–31.41)	0.050[2]
Patients with DM, n (%)	2 (4.44)	10 (2.43)	0.193[4]
Patients with CAD, n (%)	3 (6.66)	23 (56.09)	0.021[4]
PV; Median (IQR), mL	139 (115–166)	136 (124–150)	0.458[2]
IPSS; Mean ± SD	26.20 ± 6.04	26.61 ± 4.40	0.081[2]
Q of life; Mean ± SD	4.53 ± 0.81	5 ± 0.67	0.062[2]
Hgb; Median (IQR), g/dL	14.03 (12.50–14.90)	14 (12.66–14.90)	0.967[2]
INR; Median (IQR)	1.02 (0.96–1.10)	1.10 (1.02–1.16)	0.051[2]

[1]Independent sample *t*-test, [2]Mann–Whitney U test, [3]Pearson Chi-Square test, [4]Fisher's Exact test. TURP, transurethral resection of prostate; AC, anticoagulant; AG, antiaggregant; BMI, body mass index; CAD, coronary artery disease; DM, diabetes mellitus; PV, prostate volume; IPSS, international prostate symptom score; Q, quality; Hgb, haemoglobin; INR, international normalised ratio; OP, open prostatectomy.

and homoscedasticity was evaluated by inspecting plots of residuals vs fitted values. These assumptions were met; Therefore, no data transformation or alternative modelling approach was required. Multicollinearity was evaluated using variance inflation factor (VIF). All values were <2.5, suggesting no significant multicollinearity among predictors. Significance was evaluated at $p < 0.05$.

Results

The baseline characteristics are detailed in Table 1. Across all surgical groups, patients receiving AC/AG therapy were older and had a high prevalence of CAD: TURP (51.51% vs 2.12%, $p < 0.001$), TURBT (50.94% vs 14.28%, $p = 0.002$) and OP (56.09% vs 6.66%, $p = 0.021$). Other variables, including BMI, DM, prostate/tumour size, IPSS, haemoglobin and INR, exhibited no significant differences.

A total of 320 TURP patients were included, with 132 receiving AC/AG therapy. Among 113 TURBT patients, 53 were on AC/AG treatment; Of 86 OP patients, 41 were receiving AC/AG therapy. The type and number of AC/AG medications for all procedures are shown in Table 2.

In TURP patients, hospital stay, postoperative transfusion, re-admission, re-catheterisation and clot retention rates within the first month were significantly higher among those on AC/AG therapy than their counterparts (Table 3). In the TURBT group, rehospitalisation due to haematuria was high (Table 4). In the OP group, significant differences were detected in postoperative transfusion rates, number of patients with early postoperative clot retention, number of patients with re-admission with haematuria, re-catheterisation, clot retention and rehospitalisation in the first postoperative month. Moreover, transfusion rates after re-admission and re-operation rates were significantly

Table 2. Distribution of patients according to procedure type and anticoagulant/antiaggregant therapy.

Procedure	Total patients, n	Patients with AC/AG, n (%)	ASA, n (%)	Clop., n (%)	ASA + Clop., n (%)	Warfarin, n (%)	Xa Inh., n (%)	ASA + Xa Inh., n (%)
TURP	320	132 (41.25)	71 (22.17)	19 (5.94)	12 (3.75)	5 (1.56)	25 (7.81)	0
TURBT	113	53 (46.90)	27 (23.89)	5 (4.43)	8 (7.07)	3 (2.66)	9 (7.97)	1 (0.88)
OP	86	41 (47.67)	20 (23.26)	3 (3.48)	5 (5.82)	2 (2.32)	11 (12.79)	0

AC, anticoagulant; AG, antiaggregant; Clop., clopidogrel; Inh., inhibitor; ASA, acetylsalicylic acid; TURP, transurethral resection of the prostate; TURBT, transurethral resection of bladder tumour; OP, open prostatectomy.

Table 3. Comparison of the postoperative characteristics of TURP patients.

Variables	TURP with no AC/AG therapy (n = 188)	TURP with AC/AG therapy (n = 132)	t/χ^2/U	*p*
Postop. Transf.; n (%)	0	3 (2.27)		0.038[4]
Early Postop. clot retention; n (%)	6 (3.19)	9 (6.81)	1.54	0.132[3]
Duration of irrigation; Median (IQR), days	1 (1–1)	1 (1–1)	11992	0.201[2]
Irrigation volume; Median (IQR), days	15000 (12000–18000)	15000 (12000–18000)	11781	0.427[2]
Length of stay; Median (IQR)	1 (1–1)	1 (1–1)	11494	0.043[2]
Duration of catheterisation; Mean ± SD, days	4.72 ± 1.82	4.31 ± 1.63	1.69	0.092[1]
Re-admission with haematuria; n (%)	7 (3.72)	15 (11.36)	5.93	0.008[3]
Re-catheterisation; n (%)	7 (3.72)	12 (9.09)	3.10	0.046[3]
Clot retention in first Postop. month; n (%)	3 (0.53)	10 (7.57)		0.008[4]
Rehospitalisation; n (%)	2 (1.06)	5 (3.78)		0.102[4]
Transfusion after re-admission; n (%)	1 (0.53)	1 (0.75)		0.802[4]

[1]Independent sample *t*-test, [2]Mann–Whitney U test, [3]Pearson Chi-Square test, [4]Fisher's Exact test. TURP, transurethral resection of prostate; AC, anticoagulant; AG, antiaggregant; Postop., postoperative; Transf., transfusion.

Table 4. Comparison of the characteristics of TURBT patients.

Variables	TURBT with no AC/AG therapy (n = 63)	TURBT with AC/AG therapy (n = 53)	t/U	*p*
Postop. Transf.; n (%)	0	1 (1)		0.277[4]
Early Postop. clot retention; n (%)	2 (3.17)	2 (3.77)		0.862[4]
Duration of irrigation; Median (IQR), days	1 (1–1)	1 (1–1)	1628	0.620[2]
Irrigation volume; Median (IQR), mL	12000 (9000–15000)	12000 (9000–15000)	1644	0.882[2]
Length of stay; Median (IQR), days	1 (1–1)	1 (1–1)	1645	0.780[2]
Duration of catheterisation; Mean ± SD, days	3.14 ± 2.23	3.96 ± 2.25	−1.75	0.081[1]
Re-admission with haematuria, n (%)	4 (6.34)	6 (11.32)		0.346[4]
Re-catheterisation; n (%)	3 (4.76)	6 (11.32)		0.192[4]
Clot retention in first Postop. month; n (%)	3 (4.76)	5 (9.43)		0.327[4]
Rehospitalisation; n (%)	0	4 (7.54)		0.026[4]
Transfusion after re-admission; n (%)	0	2 (3.77)		0.122[4]
Re-operation; n (%)	0	2 (3.77)		0.122[4]

[1]Independent sample *t*-test, [2]Mann–Whitney U test, [4]Fisher's Exact test. TURBT, transurethral resection of bladder tumour; AC, anticoagulant; AG, antiaggregant; Postop., postoperative; Transf., transfusion.

higher in patients with AC/AG therapy than in those without AC/AG therapy (Table 5).

AC/AG therapy was discontinued in all patients; 88 TURP, 38 TURBT and 26 OP patients received no LMWH, whereas 44 TURP, 15 TURBT and 15 OP patients received LMWH. No surgery was performed without AC/AG withdrawal. The mean time to re-admission did not differ between AC/AG users and non-users. AC/AG therapy was resumed after a mean of 3.32 ± 1.23 days in TURP, 3.10 ± 1.11 days in TURBT and 4.93 ± 1.52 days in OP patients. Among AC/AG users, LMWH bridging was associated with increased early clot retention and irrigation volume in TURP and OP and with multiple adverse outcomes in TURBT (Table 6).

Multivariable regression analyses were conducted to adjust for potential confounding variables, including age, procedure type (TURBT, TURP and OP), comorbidities such as DM and CAD, preoperative haemoglobin, INR,

Table 5. Comparison of the characteristics of patients who underwent OP.

Variables	OP with no AC/AG therapy (n = 45)	OP with AC/AG therapy (n = 41)	t/χ^2/U	*p*
Perop. Transf.; n (%)	1 (2.22)	0		0.343[4]
Postop. Transf.; n (%)	2 (4.44)	8 (19.51)		0.030[4]
Early Postop. clot retention; n (%)	12 (26.66)	20 (48.78)	4.49	0.034[3]
Duration of irrigation; Median (IQR), days	2 (1–3)	2 (2–3)	693	0.035[2]
Irrigation volume; Median (IQR), mL	24000 (18–36)	30000 (24–51)	683	0.038[2]
Length of stay; Median (IQR), days	3 (2–3)	3 (2–4)	662	0.018[2]
Duration of catheterisation; Mean ± SD, days	7.82 ± 1.97	7.78 ± 1.31	0.11	0.909[1]
Re-admission with haematuria, n (%)	1 (2.22)	7 (17.07)		0.018[4]
Re-catheterisation, n (%)	1 (2.22)	7 (17.07)		0.018[4]
Clot retention in first Postop. month, n (%)	0	7 (17.07)		0.018[4]
Rehospitalisation, n (%)	0	7 (17.07)		0.003[4]
Transfusion after re-admission, n (%)	0	5 (12.19)		0.003[4]
Re-operation, n (%)	0	3 (7.31)		0.016[4]

[1]Independent sample *t*-test, [2]Mann–Whitney U test, [3]Pearson Chi-Square test, [4]Fisher's Exact test. OP, open prostatectomy; AC, anticoagulant; AG, antiaggregant; Perop., perioperative; Postop., postoperative; Transf., transfusion.

AC/AG use and LMWH bridging. TURP was set as the reference procedure for operation type. In the multivariable linear regression analysis, OP was associated with extended irrigation duration and prolonged hospitalisation compared with TURP, whereas no significant differences were observed between TURP and TURBT. LMWH bridging was also independently associated with prolonged irrigation duration. Increasing age was moderately associated with prolonged hospitalisation. In the multivariable logistic regression analysis, OP increased the risk of early clot retention compared with TURP. Transfusion risk was elevated in patients with OP, lower preoperative haemoglobin levels and AC/AG use. AC/AG use was independently associated with re-admission, re-catheterisation and clot retention within the first postoperative month. LMWH bridging was also independently associated with increased in-hospital clot retention (Table 7). No significant associations were observed between CAD, DM or preoperative INR values and bleeding-related outcomes in the multivariable analyses (For CAD: Duration of irrigation $p = 0.716$, duration of catheterisation $p = 0.444$, hospital stay $p = 0.291$, transfusion: $p = 0.242$, early clot retention $p = 0.148$, re-admission $p = 0.628$, and clot retention in first month $p = 0.507$. For DM: Duration of irrigation $p = 0.961$, duration of catheterisation $p = 0.158$, hospital stay $p = 0.164$, transfusion $p = 0.717$, early clot retention $p = 0.806$, re-admission $p = 0.964$, and clot retention in first month $p = 0.890$. For preoperative INR: Duration of irrigation $p = 0.929$, duration of catheterisation: 0.448, hospital stay $p = 0.976$, transfusion $p = 0.206$, early clot retention $p = 0.096$, and clot retention in first month $p = 0.248$).

Discussion

The results of our prospective evaluation shed light on the influence of AC/AG therapy on bleeding-related outcomes in patients undergoing TURP, TURBT and OP. Our investigation examined postoperative outcomes, uncovering significant associations between AC/AG therapy and several bleeding-related outcomes, especially in the TURP and OP groups. In the TURP group, AC/AG use was significantly associated with increased rates of transfusion, re-admission, re-catheterisation and clot retention in the first postoperative month and prolonged hospital stay. In the OP group, AC/AG use was significantly associated with increased transfusion rates, early postoperative clot retention and re-operation, as well as prolonged duration of irrigation, increased irrigation volume and extended hospital stay. Bleeding-related complications were more frequently observed in patients who underwent bridging with LMWH, particularly in those who underwent TURBT, than in their counterparts.

AC use has been more extensively studied in TURP than in TURBT or OP. Descazeaud *et al.* [17] reported that TURP patients receiving AC/AG therapy experience longer hospital stays and higher rates of bladder clots, transfusions, late haematuria and thromboembolic events than those who did not receive AC/AG therapy. However, some patients in their cohort continued AG therapy during the operating period. Kuo *et al.* [18] retrospectively analysed 629 TURP patients, of whom 113 (17.9%) were on AC therapy. All ACs were stopped preoperatively, and 24 patients received LMWH bridging. AC therapy was associated with increased rates of haematuria-related re-admission (27% vs 9.90%, $p < 0.001$) and prolonged haematuria (19% vs 1.60%, $p = 0.01$), whereas re-operation and clot retention rates were similar. Outcomes for LMWH-bridged patients

Table 6. Comparison of patients with LMWH and patients with no LMWH in patients under AC/AG therapy.

Variables	TURP with no LMWH (n = 88)	TURP with LMWH (n = 44)	t/χ^2/U	*p*
Prostate volume; Median (IQR), mL	67.50 (47.50–88)	67.50 (51.50–86)	1890	0.824[2]
Postop. transfusion; n (%)	1 (1.13)	2 (4.54)		0.052[4]
Duration of surgery; Mean ± SD, min	89.82 ± 37.76	91.27 ± 37.57	−0.20	0.841[1]
Duration of irrigation; Median (IQR), days	1 (1–1)	1 (1–1)	1894	0.655[2]
Irrigation volume; Median (IQR), mL	15000 (12000–18000)	15000 (12000–18000)	1512	0.036[2]
Length of stay; Median (IQR), days	1 (1–1)	1 (1–1)	1810	0.339[2]
Early Postop. clot retention; n (%)	2 (2.27)	7 (15.90)		0.003[4]
Duration of catheterisation; Mean ± SD, days	4.37 ± 1.59 (1–8)	4.38 ± 1.79 (1–10)	0.04	0.970[1]
Re-admission with haematuria, n (%)	10 (11.36)	5 (11.36)	0.00	1.000[3]
Rehospitalisation, n (%)	4 (4.54)	1 (2.27)		0.523[4]
Re-operation, n (%)	1 (1.13)	0		0.482[4]
	TURBT with no LMWH (n = 38)	TURBT with LMWH (n = 15)	t/U	*p*
Tumour diameter; Median (IQR)	27.50 (15–35)	30 (20–40)	248	0.461[2]
Postop. transfusion; n (%)	0	1 (6.66)		0.070[4]
Duration of surgery; Mean ± SD, min	56.24 ± 22.12	70.07 ± 23.45	−2.53	0.012[1]
Duration of irrigation; Median (IQR), days	1 (1–1)	1 (1–1)	228	0.026[2]
Irrigation volume; Median (IQR), mL	12000 (9000–15000)	15000 (12000–18000)	146	0.005[2]
Length of stay; Median (IQR), days	1 (1–1)	1 (1–2)	214	0.006[2]
Early Postop. clot retention; n (%)	0	2 (13.33)		0.022[4]
Duration of catheterisation; Mean ± SD, days	3.55 ± 2.75	5 ± 2.30	−0.29	0.077[1]
Re-admission with haematuria, n (%)	1 (2.63)	5 (33.33)		0.001[4]
Rehospitalisation, n (%)	1 (2.63)	3 (20)		0.031[4]
Re-operation, n (%)	0	2 (13.33)		0.022[4]
	OP with no LMWH (n = 26)	OP with LMWH (n = 15)	t/χ^2/U	*p*
Prostate volume; Median (IQR), mL	133 (124–150)	140 (126–150)	172	0.542[2]
Postop. transfusion; n (%)	4 (1.53)	4 (2.66)		0.175[4]
Duration of surgery; Mean ± SD, min	126.77 ± 36.88	116.80 ± 25.13	0.93	0.359[1]
Duration of irrigation; Median (IQR), days	2 (2–2)	2 (2–4)	131	0.054[2]
Irrigation volume; Median (IQR), mL	24000 (20000–48000)	36000 (30000–54000)	119	0.038[2]
Length of stay; Median (IQR), days	3 (2–4)	3 (3–5)	136	0.097[2]
Early Postop. clot retention; n (%)	10 (38.46)	10 (66.66)	4.41	0.036[3]
Duration of catheterisation; Mean ± SD, days	7.81 ± 1.33	7.73 ± 1.33	0.17	0.864[1]
Re-admission with haematuria, n (%)	4 (15.38)	3 (20)		0.187[4]
Rehospitalisation, n (%)	4 (15.38)	3 (20)		0.187[4]
Re-operation, n (%)	2 (7.69)	1 (6.66)		0.187[4]

[1]Independent *t*-test, [2]Mann–Whitney U test, [3]Pearson Chi-Square test, [4]Fisher's Exact test. TURP, transurethral resection of prostate; TURBT, transurethral resection of bladder tumour; OP, open prostatectomy; LMWH, low-molecular-weight heparin; Postop., postoperative.

were not specified. Rühle *et al*. [19] retrospectively assessed bipolar TURP in patients continuing AC/AG therapy without LMWH bridging, reporting 9% clot retention, 4% transfusion, 4% haematuria-related re-admission and 3% re-operation. Becker *et al*. [20] retrospectively reviewed a prospectively collected database, comparing 245 patients on AC (all receiving LMWH bridging) with 1933 non-AC patients undergoing holmium laser enucleation. Bleeding-related complications, including bladder tamponade, re-operation and transfusion, were significantly elevated in the AC group, accompanied with prolonged catheterisation and hospital stay. In our study, TURP patients on AC/AG had heightened rates of transfusion, haematuria-related re-admission, re-catheterisation and clot retention. Those receiving bridging also showed increased early clot retention and irrigation volume. Consistent with the literature, these findings emphasise the need for caution regarding bleeding complications in patients on AC/AG therapy and LMWH after TURP.

Table 7. Multivariable regression analysis.

Outcome	Covariate	Effect size	95% CI	*p*
Duration of irrigation	OP vs TURP	β = 1.01	0.88–1.15	<0.001
	TURBT vs TURP	β = –0.01	−0.13–0.11	0.824
	LMWH bridging	β = 0.16	0.15–0.49	<0.001
Hospital stay	OP vs TURP	β = 0.74	0.58–0.90	<0.001
	TURBT vs TURP	β = –0.06	−0.24–0.10	0.431
	LMWH bridging	β = 0.47	0.22–0.72	<0.001
	Age	β = 0.09	0.02–0.16	0.015
Transfusion	OP vs TURP	OR = 6.27	2.47–15.93	<0.001
	TURBT vs TURP	OR = 0.71	0.05–8.78	0.796
	Preoperative haemoglobin	OR = 0.59	0.41–0.83	0.003
	AC/AG use	OR = 8.05	1.14–56.65	0.036
Re-admission	AC/AG use	OR = 3.81	1.53–9.50	0.004
Re-catheterisation	AC/AG use	OR = 3.67	1.43–9.40	0.007
Clot retention (hospitalisation)	OP vs TURP	OR = 12.43	6.19–29.94	<0.001
	TURBT vs TURP	OR = 0.59	0.18–1.86	0.369
	LMWH bridging	OR = 6.45	2.59–16.06	<0.001
Clot retention (1st month)	AC/AG use	OR = 5.74	1.97–16.75	0.001

OP, open prostatectomy; TURP, transurethral resection of prostate; TURBT, transurethral resection of bladder tumour; LMWH, low-molecular-weight heparin.

Few studies have examined the influence of AC/AG therapy in TURBT. Picozzi *et al.* [21] compared 108 patients on 100 mg of acetylsalicylic acid with 105 controls and found no significant differences in haemoglobin change, transfusion, re-admission or re-operation rates despite continued AG use. Prader *et al.* [22] reported prolonged hospital stays in AG users (2.9 days vs 2.5 days), mainly due to clopidogrel (3.7 days vs 2.5 days), whereas acetylsalicylic acid had no effect. Clopidogrel also increased catheterisation duration, transfusion rates and re-operation rates. Ehrlich *et al.* [15] found no difference in catheterisation duration, persistent haematuria or re-admission between early (24 h) and late (3 weeks) acetylsalicylic acid resumption in patients undergoing TURP, TURBT and OP. Another study linked AC/AG therapy to minor bleeding events, including irrigation and clot retention [23]. In our study, AC/AG therapy was associated only with increased re-hospitalisation rates. No significant difference was detected in other bleeding-related events. Patients receiving LMWH bridging had elevated rates of re-operation, haematuria-related re-admission and early clot retention. Notably, the effect of LMWH bridging on bleeding-related complications after TURBT has not been previously evaluated.

To date, no study has evaluated OP safety in patients on AC/AG therapy. Gardic *et al.* [24] investigated 58 patients with mechanical cardiac valves undergoing prostate surgery (7 OP, 38 TURP and 13 greenlight vaporisation). Conventional surgery (TURP and OP) carried a high transfusion risk, whereas re-operation rates did not differ from greenlight vaporisation. In our study, OP patients on AC/AG had prolonged hospital stays and irrigation duration and elevated rates of all bleeding complications, except catheterisation duration and perioperative transfusion.

Although the AC/AG group comprised older patients with high CAD rates, neither variable was independently associated with bleeding-related outcomes in multivariable analyses. Their apparent significance in univariate models was likely due to their strong association with AC/AG use. When adjusted for factors such as procedure type, LMWH bridging and preoperative haemoglobin, age and CAD did not independently influence bleeding complications. Therefore, the bleeding risks in AC/AG users were primarily related to treatment and procedural factors. Multivariable analysis showed that transfusion and clot-related complications were mainly influenced by procedure type and LMWH bridging, whereas AC/AG use was significantly associated with re-admission, re-catheterisation and clot retention. Age and low-baseline haemoglobin were significantly associated with extended hospital stay and the need for transfusion, respectively, after accounting for other covariates. Overall, bleeding complications in anti-

coagulated patients are multifactorial and should be interpreted in the context of surgical technique and perioperative management alongside AC/AG therapy. LMWH inhibits coagulation by activating antithrombin III, which blocks factor Xa and reduces thrombin and fibrin formation [25]. After TURBT, TURP or OP, which are procedures involving highly vascular tissue, even minimal AC activity may hinder haemostasis. Unlike vitamin K antagonists or direct oral ACs, LMWH is usually administered at therapeutic doses during bridging, increasing the risk of haemorrhage during the first 24–72 h before tissue repair [2]. Our results suggested that LMWH may impair early postoperative haemostasis, with procedure-specific effects. It was associated with increased early clot retention in TURP patients, irrigation volume and clot retention in OP and multiple bleeding-related complications in TURBT.

This study had several limitations. AC/AG agents were analysed as a single group, and individual drug effects were not assessed. Our aim was to evaluate the influence of any medication on the blood coagulation system and compare the rates of bleeding-related complications between patients who used such medication and those who did not. Contemporary laser prostatectomy techniques (e.g., holmium or thulium) were not included, as they were not performed in our clinic during the study period. Thromboembolic events and subgroup analyses for high-risk patients (e.g., elderly and atrial fibrillation) were not included. The timing of discontinuation or alternative regimens for AC/AG was not provided, and all patients received the same LMWH dose, which may have influenced bleeding outcomes as different dosing regimens may yield varying bleeding outcomes. Lastly, the reported statistical values were derived directly from our statistical analysis and accurately reflect our data. However, we acknowledge that some of the estimated effect sizes were either relatively high or low. This may be due to the limited number of events and should be interpreted with caution.

Conclusions

Our prospective evaluation offers important insights into the effects of AC/AG usage, particularly in TURBT and OP patients. The evaluation of postoperative outcomes revealed significant associations between AC/AG therapy and elevated rates of transfusions, re-admissions, re-catheterisations, clot retention and increased length of stay, particularly evident in the TURP and OP groups. Our findings emphasise the need for caution regarding bleeding-related complications in patients receiving AC/AG therapy and LMWH after TURP, TURBT and OP.

Availability of Data and Materials

The datasets used and/or analysed during the current study were available from the corresponding author on reasonable request.

Author Contributions

AI, CE, SK, BD and YOI—designed the study; AI, CE, SK, BD, HA, MA and FG—collected and analyzed the data; AI, BD, FG and YOI—participated in drafting the manuscript. All authors conducted the study and contributed to critical revision of the manuscript for important intellectual content. All authors gave final approval of the version to be published. All authors participated fully in the work, took public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or completeness of any part of the work were appropriately investigated and resolved.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Bezmialem Vakif University (institution review board number, 9.3.2022-E.54140) and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form. This study was registered to the Clinicaltrials.gov database (Clinicaltrials.gov ID: NCT05314582).

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Conflict of Interest

The authors declare no conflict of interest.

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