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Impact of the estimated blood loss during radical prostatectomy on functional outcomes

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Abstract

Objective: To investigate the effect of the estimated blood loss (BL) during radical prostatectomy (RP) for prostate cancer (CaP) on functional outcomes. We hypothesized that the estimated BL during RP for clinically localized CaP does not affect the functional outcomes.

Materials and Methods: Patients who underwent open RP (ORP) or robotic-assisted laparoscopic RP (RALP) were identified. BL was stratified into low, medium and high: ≤500 vs. >500 to 1000 vs. >1,000 ml for ORP and ≤150 vs. >150 to 400 vs. >400 ml for RALP. Multivariable logistic regression models (MLRM) tested the effect of BL on functional outcomes.

Results: About 6,279 consecutive patients with ORP (2008−2015) and 2,720 patients with RALP (2009−2015) were identified. Low, medium, and high BL was recorded in 31.4 vs. 45.7 vs. 22.9% for ORP and in 39.8 vs. 45.2 vs.15.0% for RALP. MLRM predicting potency revealed that high BL was an independent predictor for erectile dysfunction: Odds ratios (OR) were 0.50 ($P = 0.03$) and 0.52 ($P = 0.04$) for ORP and RALP, respectively. MRLM predicting continence in ORP revealed that high BL was an independent predictor for 7-days and mid-term: ORs were 0.80 ($P = 0.04$) and 0.66 ($P = 0.002$). Moreover, high BL was an independent predictor for 7-days continence in RALP: OR were 0.68 ($P = 0.009$).

Conclusion: CaP patients who sustain higher BL during RP showed worse functional outcomes. High BL during ORP or RALP represented an independent predictor of erectile dysfunction and incontinence after surgery. However, the effect of high BL on the continence was temporarily and not present at 1 year after surgery in ORP and after 3 months in RALP. © 2019 Published by Elsevier Inc.

Keywords: Blood loss; Functional outcome; Robotic-assisted prostatectomy; Incontinence; Erectile function; Prostatectomy

1. Introduction

Radical prostatectomy (RP) is one of the main treatment options for clinically localized prostate cancer (CaP). The key objective in RP is, next to optimal long-term oncologic outcome, the preservation of the functional outcome, namely continence and potency. However, intraoperative blood loss (BL) is one of the main complications at RP [1]. Previous studies addressed the impact of the surgical volume on BL during RP and reported a lower BL for high-volume surgeons [2,3].

Moreover, in more contemporary years robotic-assisted laparoscopic prostatectomy (RALP) is becoming the main surgical approach for performing RP. Previously, several investigators demonstrated that the intraoperative BL during RALP is significantly lower compared to open RP [4-7].

Furthermore, two previous studies demonstrated that BL during open RP does not affect oncological outcomes [1,8]. Moreover, one study analyzed the relationship between BL on the functional outcomes within a historic cohort of open

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RP patients and found no association between higher BL and the functional outcomes [8]. However, with the more frequent use of RALP in contemporary years, resulting in a reduction of the intraoperative BL, the role of BL during RP and RALP on the functional outcomes should be clarified.

The aim of our present study was to test the relationship between BL during open RP or RALP and the functional outcomes, within a contemporary cohort. Specifically, we hypothesized that higher BL does not affect continence and erectile function after RP or RALP for clinically localized CaP in patients treated exclusively by high volume surgeons.

2. Materials and methods

2.1. Patient population

Patients were selected from our institutional Martini-Klinik database. We identified 8,999 patients who underwent open RP or RALP between January 2008 and December 2015. Data were collected prospectively into a database approved by the institutional review board. Functional data were assessed using self-administrated questionnaires. RP and RALP were performed as previously described [9-11].

The estimated BL was stratified according to the first and third quartile into ≤500 (low) vs. >500-1000 (medium) vs. >1000ml (high) for open RP cases and into ≤150 (low) vs. >150 to 400 (medium) vs. >400 ml (high) for RALP cases. Subsequently, to reduce the selection bias for the surgical learning curve, all open cases that were not performed by surgeons with more than 500 RP cases, were excluded. Furthermore, all RALP cases that were not performed by surgeons with more than 100 RALP cases, were excluded. Additional exclusion criteria consisted of unknown BL, palliative or salvage surgery. Only patients with bilateral nerve-sparing technique and no preoperative erectile dysfunction were included for analyses of erectile function rates. Potency was defined as international index of erectile function score ≥18. 7-days continence (7-day after catheter removal) was defined as the use zero or one pad per day. Otherwise, continence was defined as the use of zero or one safety pad per day.

2.2. Statistical analyses

Descriptive statistics included frequencies and proportions for categorical variables. Means, medians, and interquartile ranges were reported for continuously coded variables. The Chi-square tested the statistical significance in proportions' differences. The *t* test examined the statistical significance of means' differences.

Univariable and multivariable logistic regression models were used to test the effect of BL on functional outcomes. Specifically, for each of the two different surgical techniques (open RP and RALP) four separate models were fitted to predict 7-days continence, mid-term continence (3 months after surgery), long-term continence (1 year after surgery), and erectile function (1 year after surgery). Multivariable logistic regression models predicting continence were adjusted for: preoperative prostatic specific antigen value (PSA), pathologic Gleason score, pathologic tumor stage, age, year of surgery, adjuvant treatment, and nerve-sparing technique. Multivariable logistic regression models predicting erectile function were adjusted for: PSA, pathologic Gleason score, pathologic tumor stage, age, year of surgery, and adjuvant treatment. Multivariable models were repeated to test the impact of blood transfusion on the functional outcomes. Bar graphs depicted continence and erectile function rates. R software environment for statistical computing and graphics (version 3.4.0) was used for all statistical analyses. All tests were two sided with a level of significance set at $P < 0.05$.

3. Results

3.1. Study population

Overall, 6,279 patients with open RP between 2008 and 2015 and 2,720 patients with RALP between 2009 and 2015 were identified (Table 1). The median follow-up was 46.7 months in the open RP cohort and 24.6 months in the RALP group, respectively. For patients with open RP, 31.4 vs. 45.7 vs. 22.9% had low vs. medium vs. high BL, respectively. In patients who underwent RALP, 39.8 vs. 45.2 vs.15.0% had respectively low vs. medium vs. high BL. Blood transfusion rates were 1.7 ($n = 40$) vs. 3.2 ($n = 106$) vs. 25.8% ($n = 161$) for low vs. intermediate vs. high BL for open RP cases, respectively. Moreover, for RALP cases blood transfusion rates were, respectively, 0.9 ($n = 10$) vs. 1.2 ($n = 15$) vs. 3.9% ($n = 16$).

3.2. Erectile function

Potency rates at 1 year after RP for the low, medium and high BL cohort were 52.2%, 52.0% and 36.5% for open RP cases (Fig. 1a) and 57.8%, 50.5% and 38.5% for RALP cases (Fig. 2a), respectively. Multivariable logistic regression models (Table 2) predicting potency at 1 year after surgery revealed that patients in the high BL group had a significantly lower chance of being potent, compared to patients with low BL. The odds ratios were (OR) 0.50 ($P = 0.02$, 95% Confidence interval [CI]: 0.27–0.88) for open RP and 0.52 ($P = 0.04$, 95% CI: 0.24–0.93) for RALP, respectively.

3.3. Continence

First, 7-days continence rates for the low, the medium and the high BL cohort were 66.3 vs. 61.3 vs. 56.9% for open RP cases (Fig. 1b) and 57.7 vs. 53.0 vs. 45.4% for RALP cases (Fig. 2b), respectively. Multivariable logistic

Table 1
Descriptive characteristics for prostate cancer patients treated with RP stratified according to the blood loss within the surgery technique (open RP vs. RALP).

	Open RP				RALP			
	Overall	Low BL	Medium BL	High BL	Overall	Low BL	Medium BL	High BL
	n = 6,279	*n* = 2,355	*n* = 3,300	*n* = 624	*n* = 2,720	*n* = 1,082	*n* = 1,229	*n* = 409
Age								
Median (Interquartile range)	65.3 (59.8−69.5)	65.4 (59.7−69.5)	65 (59.7−69.5)	66.2 (60.7−70.3)	63.9 (58.1−68.4)	64.3 (58.4−68.5)	63.6 (57.9−68.3)	64.1 (58.1−68.5)
Year of surgery								
Median (Interquartile range)	2011 (2010−2013)	2011 (2009−2013)	2011 (2010−2013)	2011 (2010−2014)	2014 (2012−2015)	2013 (2011−2014))	2014 (2012−2015)	2014 (2013−2015)
PSA								
Median (Interquartile range)	7.0 (4.9−10.7)	6.7 (4.7−10)	7.2 (5.1−11.0)	7.8 (5.3−11.6)	7.3 (5.2−10.8)	7.0 (4.9−10.0)	7.3 (5.2−11.1)	8.1 (5.9−12.0)
Pathologic tumor stage								
T2	4069 (64.8)	1567 (66.5)	2100 (63.6)	402 (64.4)	1840 (67.7)	744 (68.8)	842 (68.5)	254 (62.2)
T3a	1352 (21.5)	492 (20.9)	719 (21.8)	141 (22.6)	563 (20.7)	216 (20.0)	259 (21.1)	88 (21.5)
≥T3b	851 (13.6)	294 (12.5)	477 (14.5)	80 (12.8)	314 (11.5)	122 (11.3)	126 (10.3)	66 (16.1)
N.A.	7 (0.1)	2 (0.1)	4 (0.1)	1 (0.2)	3 (0.1)	0 (0)	2 (0.1)	1 (0.2)
Gleason score								
≤6	773 (12.3)	272 (11.5)	423 (12.8)	78 (12.5)	286 (10.5)	119 (11.0)	135 (11.0)	32 (7.8)
7	5025 (80.0)	1927 (81.8)	2600 (78.8)	498 (79.8)	2249 (82.7)	906 (83.7)	1008 (82.0)	335 (81.9)
≥8	470 (7.5)	153 (6.5)	271 (8.2)	46 (7.4)	182 (6.7)	55 (5.1)	85 (6.9)	42 (10.3)
N.A.	11 (0.2)	3 (0.2)	6 (0.2)	2 (0.3)	3 (0.1)	2 (0.2)	1 (0.1)	0 (0)
Adjuvant treatment								
No	5259 (83.8)	1966 (83.5)	2756 (83.5)	537 (86.1)	2386 (87.7)	959 (88.6)	1081 (88.0)	346 (84.6)
ADT	38 (0.6)	14 (0.6)	17 (0.5)	7 (1.1)	9 (0.3)	3 (0.3)	4 (0.3)	2 (0.5)
Adjuvant RTX	202 (3.2)	79 (3.4)	101 (3.1)	22 (3.5)	74 (2.7)	23 (2.1)	33 (2.7)	18 (4.4)
RTX+ADT	55 (0.9)	17 (0.7)	38 (1.2)	0 (0)	20 (0.8)	6 (0.6)	8 (0.7)	6 (1.5)
Salvage RTX	725 (11.5)	279 (11.8)	388 (11.7)	58 (9.3)	231 (8.5)	91 (8.4)	103 (8.3)	37 (9.0)
Nerve sparing								
None	299 (4.8)	115 (4.9)	153 (4.6)	31 (5.0)	167 (6.1)	50 (4.6)	88 (7.2)	29 (7.1)
Unilateral	1629 (25.9)	532 (22.6)	909 (27.5)	188 (30.1)	622 (22.9)	257 (23.8)	249 (20.3)	116 (28.4)
Bilateral	4351 (69.3)	1708 (72.5)	2238 (67.8)	405 (64.9)	1931 (71.0)	775 (71.6)	892 (72.5)	264 (64.5)

Abbreviations: ADT = androgen deprivation; BL = blood loss; N.A. = not available; PSA = prostatic-specific antigen; RALP = robotic-assisted laparoscopic RP; RP = radical prostatectomy; RTX = radiotherapy.

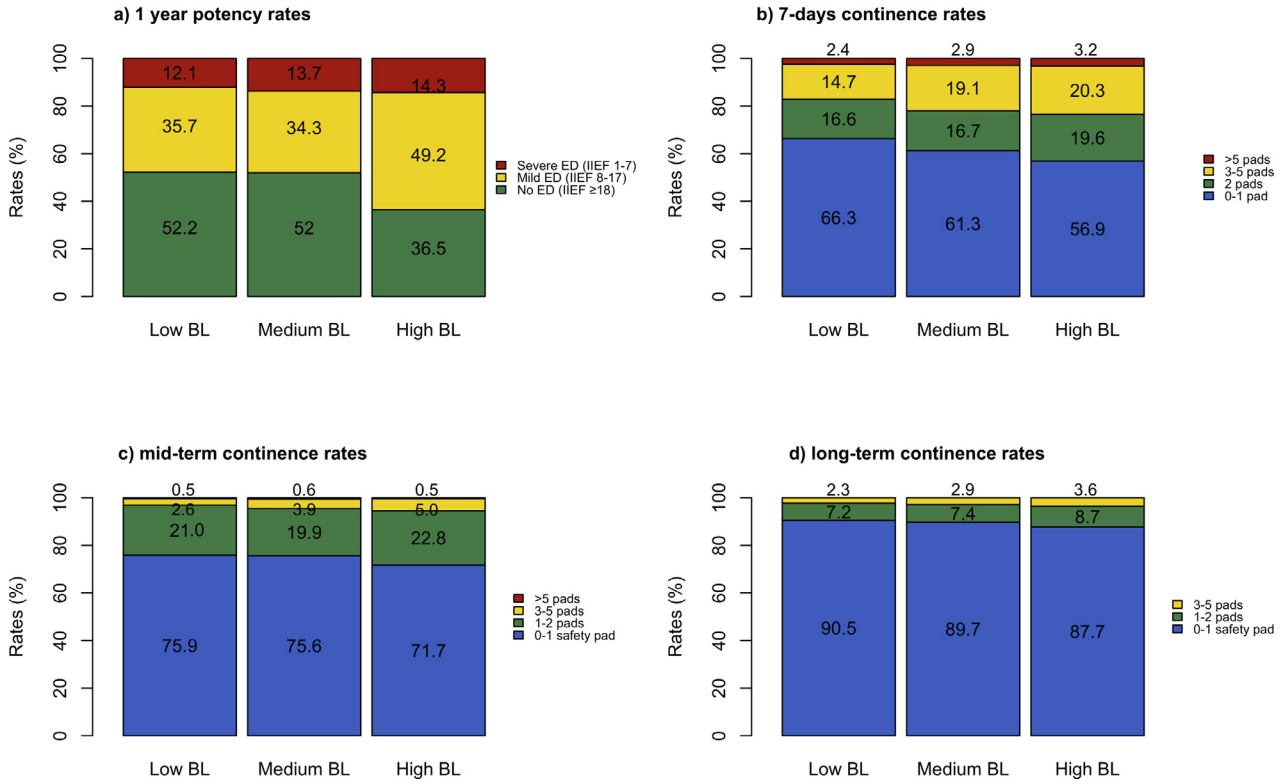

Fig. 1. One-year potency rates (A), 7-days (B), mid-term (C) and long-term (D) continence rates after open radical prostatectomy stratified according to low, medium and high blood loss (BL); ED: erectile dysfunction.

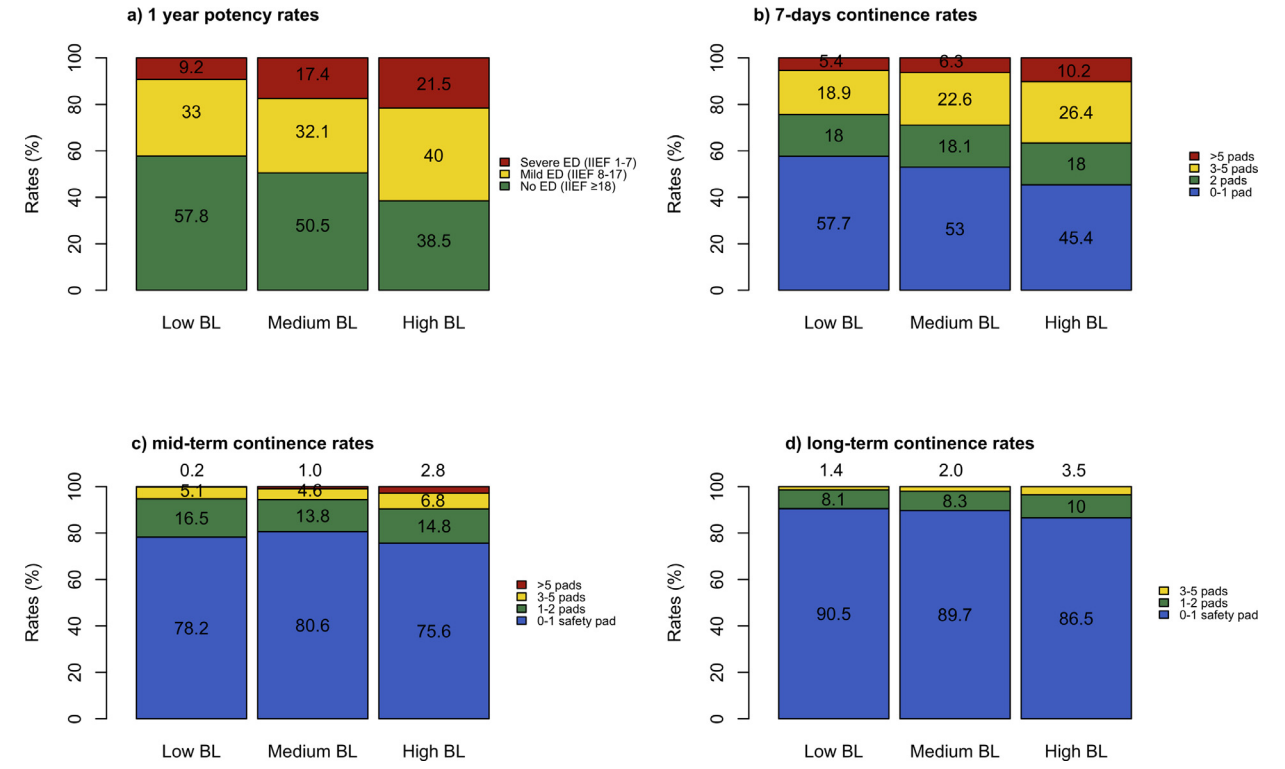

Fig. 2. One-year potency rates (A), 7-days (B), mid-term (C) and long-term (D) continence rates after robotic-assisted radical prostatectomy stratified according to low, medium and high blood loss (BL); ED: erectile dysfunction.

Table 2
Univariable and multivariable logistic regression models predicting 1-year potency and 7-days, mid- and long-term continence in radical prostatectomy patients.

	Univariable odds Ratio (95% CI)	*P* value	Multivariable odds Ratio (95% CI)	*P* value
Predicting 1 year potency				
Open RP				
Low BL (Referent)	1.0	–	1.0	–
Medium BL	0.96 (0.72–1.29)	0.8	1.01 (0.74–1.38)	0.95
High BL	0.52 (0.30–0.88)	0.02	0.50 (0.27–0.88)	0.02
RALP				
Low BL (Referent)	1.0	–	1.0	–
Medium BL	0.75 (0.49–1.13)	0.2	0.85 (0.53–1.34)	0.5
High BL	0.46 (0.25–0.81)	0.01	0.52 (0.24–0.93)	0.04
Predicting 7-days continence				
Open RP				
Low BL (Referent)	1.0	–	1.0	–
Medium BL	0.88 (0.77–0.99)	0.04	0.90 (0.78–1.03)	0.1
High BL	0.73 (0.60–0.90)	0.003	0.80 (0.64–0.99)	0.04
RALP				
Low BL (Referent)	1.0	–	1.0	–
Medium BL	0.83 (0.68–1.00)	0.05	0.85 (0.69–1.05)	0.1
High BL	0.61 (0.47–0.80)	0.0003	0.68 (0.50–0.91)	0.009
Predicting mid-term (3 months) continence				
Open RP				
Low BL (Referent)	1.0	–	1.0	–
Medium BL	0.99 (0.85–1.17)	0.99	1.04 (0.87–1.23)	0.7
High BL	0.68 (0.54–0.87)	0.002	0.66 (0.51–0.86)	0.002
RALP				
Low BL (Referent)	1.0	–	1.0	–
Medium BL	1.16 (0.86–1.56)	0.3	1.16 (0.84–1.61)	0.4
High BL	0.86 (0.58–1.30)	0.5	0.82 (0.53–1.30)	0.4
Predicting long-term (1 year) continence				
Open RP				
Low BL (Referent)	1.0	–	1.0	–
Medium BL	0.92 (0.73–1.16)	0.5	0.97 (0.74–1.25)	0.8
High BL	0.75 (0.52–1.11)	0.1	0.94 (0.62–1.45)	0.8
RALP				
Low BL (Referent)	1.0	–	1.0	–
Medium BL	0.91 (0.60–1.37)	0.7	1.09 (0.70–1.70)	0.7
High BL	0.74 (0.40–1.15)	0.1	0.83 (0.47–1.53)	0.5

All models predicting potency adjusted for: preoperative prostatic specific antigen value, Gleason Score, pathologic tumor stage, age, year of surgery and adjuvant treatment.

All models predicting continence adjusted for: preoperative prostatic specific antigen value, Gleason Score, pathologic tumor stage, age, year of surgery, adjuvant treatment and nerve-sparing

Abbreviations: BL = blood loss; CI = confidence interval; RALP = robotic-assisted laparoscopic RP; RP = radical prostatectomy.

regression models predicting early (Table 2) continence revealed that patients in the high BL group had a significantly lower chance of continence. The ORs in the high BL group were 0.80 ($P = 0.04$, 95% CI: 0.64–0.99) for open RP and 0.68 ($P = 0.009$, 95% CI: 0.50–0.91) for RALP. No significant differences between the medium and low BL groups were present. Finally, blood transfusion represented an independent predictor for 7-days continence (OR: 0.68, 95% CI:0.52–0.90, $P < 0.01$), in multivariable models.

Second, mid-term continence rates for the low, the medium and the high BL cohort were 75.9 vs. 75.6 vs. 71.7% for open RP cases (Fig. 1c) and 78.2 vs. 80.6 vs. 75.6% for RALP cases (Fig. 2c), respectively. Multivariable logistic regression models predicting mid-term (Table 2) continence revealed that open RP patients in the high BL group had lower chance of continence. Here, the OR was 0.66 ($P = 0.002$, 95% CI: 0.51–0.86). Conversely, high BL at RALP represented no independent predictor for mid-term continence (OR: 0.82, $P = 0.4$, 95% CI: 0.53–1.30). However, in multivariable models testing the impact of blood transfusion on mid-term continence, blood transfusion representedan independent predictor (OR: 0.65, 95%-CI:0.47–0.92, $P = 0.01$).

Third, at 1 year after surgery the continence rates for the low, the medium and the high BL cohort were 90.5 vs. 89.7 vs. 87.7% for open RP cases (Fig. 1d) and 90.5 vs. 89.7 vs. 86.5% for RALP cases (Fig. 2d), respectively. Finally, in multivariable logistic regression models predicting long-term (Table 2) continence no significant differences between patients with low, medium and high BL were identified. The ORs for the high BL groups were 0.94 ($P = 0.8$, 95% CI: 0.62−1.45) for open RP and 0.83 ($P = 0.5$, 95% CI: 0.47−1.53) for RALP, compared to the low BL group.

4. Discussion

BL is one of the main complications at RP. Higher BL at RP could be a surrogate parameter for less experienced surgeons, since previous studies reported a lower BL for high volume surgeons or with increasing number of performed RPs [2,3,12]. We hypothesized that higher BL does not affect functional outcomes after open RP or RALP for clinically localized CaP, in patients exclusively treated by experienced high volume surgeons. To test our hypothesis, we relied on a contemporary cohort from a European CaP tertiary referral center. Our analyses demonstrated several noteworthy findings.

First, patients who sustain a higher BL during RP showed worse 1-year erectile function rates. The potency rates were significantly lower in the cohort with high BL (36.5% for open RP and 38.5% for RALP) compared to the cohort with low BL (52.2% for open and 57.8% for RALP) and high BL achieved independent predictor status for erectile dysfunction in multivariable logistic regression models (OR: 0.50, $P = 0.02$ for open RP; OR: 0.52, $P = 0.04$ for RALP). This finding is novel and surgeons should be aware of the effect of higher blood loss on postoperative erectile function rates. Previously, Djavan et al. focused on the effect of BL on erectile function and found no relationship between higher BL and postoperative erectile function at 24 months after surgery [8].

Second, our analyses demonstrated that patients with high BL at RP show worse 7-days continence rates compared to patients with medium and low BL. Seven-day continence rates were 66.3 vs. 61.3 vs. 56.9% for open RP and 57.7 vs. 53.0 vs. 45.4% for RALP, respectively for high, medium and low BL. Moreover, in multivariable logistic regression models, high BL achieved independent predictor status for 7-days incontinence, regardless of the surgery type.

Furthermore, blood transfusions also achieved independent predictor status for 7-days continence.

Third, high BL also achieved independent predictor status for mid-term continence in open RP cases, compared to low BL (OR: 0.66, $P = 0.002$). Similarly, blood transfusions also achieved independent predictor status for mid-term continence. Conversely, high BL did not achieve independent predictor status for mid-term continence in RALP patients.

Finally, for 1-year continence rates no statistically significant differences between low, medium and high BL patients in multivariable logistic regression models were recorded. Similar to our findings for the erectile function rates after RP and RALP, also the effect of high BL on the continence gives important novel information for surgeons. To the best of our knowledge also the findings for the continence rates have never been reported before. In regard of the mid-term continence rates in RALP patients, our results corroborate the report by Goldenberg et al., who found no differences in the perioperative BL between incontinent and continent patients at 3 months after RALP [13]. However, the study by Goldenberg et al. was based on a small cohort of 47 patients. Moreover, Djavan et al. who focused on the relationship between BL and continence did not analyze the 7-days or mid-term continence rates [8]. Furthermore, for long-term continence rates we found no negative effect of BL. This finding corroborates the results from Djavan et al. who also found no effect of BL on long-term continence rates at 24 months after surgery [8].

Taken together, our analyses demonstrated that higher BL at RP or RALP adversely affects the functional outcomes, regardless of the surgical approach. However, the effect was only temporarily with respect to postoperative continence rates. The phenomenon that patients with a higher BL during RP show worse functional outcome could be due to higher difficulty in these patients, e.g. higher BL leads to less visibility during surgery, which results in an inferior preparation of the neurovascular bundles and the sphincter and therefore adversely affects the functional outcomes. On the other hand, the preparation of the prostate can be more challenging, e.g. tumor-related or due to inflammatory changes, and in such cases, higher BL represents a surrogate parameter for a more difficult preparation and thus lead to worse functional results. This would be in line with previous results reported from our database, where we demonstrated that the quality of the nerve-sparing affects the early and mid-term continence rates but not the long-term continence rates, as well as that the full functional-length preservation is important for the postoperative continence and both quality characteristics might not be fully apply in cases with high BL [10,11]. Further explanations could be related to biological reasons that blood may play an important role in the recovery of the functional results, which could explain why the effect of the continence was temporary and disappeared after 1 year. However, we are unaware of any studies supporting this explanation.

To the best of our knowledge this is the first report of worse functional outcomes after higher BL at RP. Previous studies, found no effect of BL at RP on the functional outcome. Djavan et al. reported that higher BL does not adversely affect the functional outcomes [8]. However, in the current study we relied on a larger sample size compared to Djavan et al. (8,999 vs.1,567). Moreover, we included open and robotic cases in our analyses. Conversely, Djavan et al. only relied on a historical cohort (2000-2008) of open

RP cases by a single surgeon. Similar, Goldenberg et al. also did not identify BL as a risk factor for continence within a cohort of 47 RALP patients at 3 months after surgery, which also were performed by a single surgeon [13]. Other studies that analyzed perioperative predictors for functional outcome did not include the perioperative BL in their analyses [10,14-17]. In consequence, further validation studies from other institutional series should ideally be completed to validate our findings.

The current study is not devoid of limitations. First and foremost, it shares all limitations of studies that relied on a retrospective design and a single-institution database. Moreover, our analysis is based on the estimated BL. However, previous studies reported a discrepancy between the estimated BL and the measured BL [18]. Ideally, changes in hematocrit or hemoglobin should be used to measure the BL. Unfortunately, both variables were unavailable in our database. Therefore, the use of the estimated BL may have influenced our results. Additionally, all RPs were performed by experienced high-volume surgeons, which may differ from other centers. Finally, it is possible despite multivariable adjustment that other unknown factors influencing continence and potency may have affected our results. Despite these limitations this is the first reporting that higher BL during RP has a significantly negative affect on the functional outcomes after RP.

5. Conclusion

In conclusion, CaP patients who sustain a higher BL during RP showed worse functional outcomes. High BL during open RP or RALP represented an independent predictor of erectile dysfunction and incontinence after surgery. However, the effect of high BL on the continence was temporary and not present at 1 year after surgery in open RP patients and after 3 months in RALP patients.

Conflict of interest

None to declare.

References

[1] Boehm K, Beyer B, Tennstedt P, et al. No impact of blood transfusion on oncological outcome after radical prostatectomy in patients with prostate cancer. World J Urol 2015;33:801–6.

[2] Nojiri Y, Okamura K, Tanaka Y, et al. Influence of hospital surgical volume of radical prostatectomy on quality of perioperative care. Int J Clin Oncol 2013;18:898–904.

[3] Vesey SG, McCabe JE, Hounsome L, Fowler S. UK radical prostatectomy outcomes and surgeon case volume: based on an analysis of the British Association of Urological Surgeons Complex Operations Database. BJU Int 2012;109:346–54.

[4] Alemozaffar M, Sanda M, Yecies D, Mucci LA, Stampfer MJ, Kenfield SA. Benchmarks for operative outcomes of robotic and open radical prostatectomy: results from the Health Professionals Follow-up Study. Eur Urol 2015;67:432–8.

[5] Schmitges J, Trinh QD, Abdollah F, et al. A population-based analysis of temporal perioperative complication rates after minimally invasive radical prostatectomy. Eur Urol 2011;60:564–71.

[6] Kordan Y, Barocas DA, Altamar HO, et al. Comparison of transfusion requirements between open and robotic-assisted laparoscopic radical prostatectomy. BJU Int 2010;106:1036–40.

[7] Sammon JD, Karakiewicz PI, Sun M, et al. Robot-assisted versus open radical prostatectomy: the differential effect of regionalization, procedure volume and operative approach. J Urol 2013;189:1289–94.

[8] Djavan B, Agalliu I, Laze J, Sadri H, Kazzazi A, Lepor H. Blood loss during radical prostatectomy: impact on clinical, oncological and functional outcomes and complication rates. BJU Int 2012;110:69–75.

[9] Budaus L, Isbarn H, Schlomm T, et al. Current technique of open intrafascial nerve-sparing retropubic prostatectomy. Eur Urol 2009;56:317–24.

[10] Michl U, Tennstedt P, Feldmeier L, et al. Nerve-sparing surgery technique, not the preservation of the neurovascular bundles, leads to improved long-term continence rates after radical prostatectomy. Eur Urol 2016;69:584–9.

[11] Schlomm T, Heinzer H, Steuber T, et al. Full functional-length urethral sphincter preservation during radical prostatectomy. Eur Urol 2011;60:320–9.

[12] Sharma NL, Papadopoulos A, Lee D, et al. First 500 cases of robotic-assisted laparoscopic radical prostatectomy from a single UK centre: learning curves of two surgeons. BJU Int 2011;108:739–47.

[13] Goldenberg MG, Goldenberg L, Grantcharov TP. Surgeon performance predicts early continence after robot-assisted radical prostatectomy. J Endourol 2017;31:858–63.

[14] Novara G, Ficarra V, D'Elia C, et al. Evaluating urinary continence and preoperative predictors of urinary continence after robot assisted laparoscopic radical prostatectomy. J Urol 2010;184:1028–33.

[15] Suardi N, Moschini M, Gallina A, et al. Nerve-sparing approach during radical prostatectomy is strongly associated with the rate of postoperative urinary continence recovery. BJU Int 2013;111:717–22.

[16] Bartoletti R, Mogorovich A, Francesca F, Pomara G, Selli C. Combined bladder neck preservation and posterior musculofascial reconstruction during robotic assisted radical prostatectomy: effects on early and long term urinary continence recovery. BMC Urol 2017;17:119.

[17] Porpiglia F, Bertolo R, Manfredi M, et al. Total anatomical reconstruction during robot-assisted radical prostatectomy: implications on early recovery of urinary continence. Eur Urol 2016;69:485–95.

[18] Conner SN, Tuuli MG, Colvin R, Shanks AL, Macones GA, Cahill AG. Accuracy of estimated blood loss in predicting need for transfusion after delivery. Am J Perinatol 2015;32:1225–30.