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Association between ABO blood group and unfavorable prostate cancer features after radical prostatectomy: Retrospective study of 1149 patients

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Abstract

Objectives: To test hypothesized associations between the ABO blood group (ABO-bg) system and the pathological features of prostate cancer (PCa).

Material and methods: Between January 2013 and September 2019, 1173 patients underwent radical prostatectomy. Associations between ABO-bg levels and pathological features were evaluated using statistical methods.

Results: Overall, 1149 consecutive patients were evaluated using the ABO-bg system, which was represented by O-bg (42.8%) and A-bg (41.3%), followed by B-bg (11.1%) and AB-bg (4.8%). Only positive surgical margins (PSMs) was correlated with ABO-bg (Pearson correlation coefficient, $r = 0.071$; $p = 0.017$), and the risk was increased in group-O (odds ratio [OR], 1.497; 95% confidence interval, 1.149–1.950; $p = 0.003$) versus non–O-bg. In clinical and pathological models, O-bg was at increased risk of PSM after the adjustment for prostate-specific antigen, percentage of biopsy-positive cores, and high surgical volume (adjusted OR, 1.546; 95% confidence interval, 1.180–2.026; $p = 0.002$); however, the adjusted OR did not change after the adjustment for tumor load and stage as well as high surgical volume.

Conclusions: In clinical PCa, the risk of PSM was higher in O-bg versus non–O-bg patients after the adjustment for standard predictors. Confirmatory studies are needed to confirm the association between ABO-bg and unfavorable PCa features.

Keywords: ABO blood system; Prostate cancer; Radical prostatectomy; Tumor load; Tumor stage

1. Introduction

Prostate cancer (PCa) is among the most investigated cancers in aging men that is likely to be detected at the early stage.[1,2] Management options include active surveillance, primary radiation, and radical prostatectomy (RP), which may be performed as open RP (ORP) or more frequently by robot-assisted RP (RARP).[1,2] Clinical PCa includes a heterogeneous set of patients who are classified into risk categories by prognostic clinical factors, including prostate-specific antigen (PSA), tumor stage, and tumor grade.[1,2] Tumor upgrading and upstaging as well as positive surgical margins (PSMs) are unfavorable outcomes that require further management decisions.[1,2] Thus, more aggressive PCa biology may be detected in patients undergoing RP; as such, more clinical prognostic factors are required to stratify patients in risk category subgroups.[1,2]

The ABO blood group system (ABO-bgs), the first discovered and most important available classification methodology, has demonstrated associations with nononcological and oncological diseases as well.[3] Case-control studies demonstrated that certain ABO-bg may be associated with the risk of several epithelial cancers.[3–10] For example, the risk of gastric cancer is increased in patients in the A-bg, whereas individuals belonging to non–O-bg are at an increased risk of pancreatic cancer.[3–7] Associations between phenotype ABO-bgs and PCa were hypothesized in a case-control study that did not show any significant association.[11] However, a retrospective study that investigated a small heterogeneous cohort of PCa patients reported that high-risk PCa was independently associated with the non–O-bg phenotype.[12] Thus, we aimed to test the hypothesis of an association between ABO-bg and PCa pathological features.

2. Materials and methods

This retrospective study was approved by our local institutional review board. Informed signed consent was obtained from all patients. Data were prospectively collected. Between January 2013 and September 2019, 1173 patients underwent RP performed by

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skilled, experienced, and dedicated surgeons, 2 with a high surgical volume (>100 procedures per year), and 6 with a low surgical volume. Robot-assisted RP was performed using a da Vinci Robot System (Intuitive Surgical, Inc, Sunnyvale, CA) through the transperitoneal approach with antegrade prostatic dissection, whereas ORP was performed as described by Walsh et al.[13,14] Extended pelvic lymph node dissection was performed according to surgical guidelines or the surgeon's decision.[1,15] A lymph node dissection was performed according to a standard template, including the external iliac, the obturator, and Cloquet's and Marcille's anatomical regions.[16–19] Each patient's perioperative surgical risk was evaluated using the American Society of Anesthesiologists scoring system.[20] Postoperative surgical complications were graded according to the Clavien-Dindo system.[21]

Specimens were evaluated for tumor grade and stage, surgical margins, and the number of removed and metastatic nodes. Tumors were graded according to the International Society of Urological Pathology system.[1,2,22] Surgical margins were positive when the cancer invaded the inked surface of the specimen; furthermore, tumor load was evaluated as the percentage involving the prostate gland.[1,2] Tumors were staged according to the Tumor-Node-Metastasis system.[1,2] The evaluated factors are listed in Table 1, and patients were classified into risk classes.[1,2] The ABO-bgs genotype was investigated in each patient before surgery in our hospital's Department of Transfusion Medicine. All ABO-bgs were routinely determined on microplates using reactant and instrumentation LIFE (AstraFormedic, Gruppo De Mori, Milan, Italy).

We hypothesized that ABO-bgs could indicate PCa biology. We tested this hypothesis by assessing the association of clinical and pathological features with ABO-bgs. According to their distributions, continuous variables are represented as median (interquartile range) and mean (SD), whereas categorical variables are shown as frequency (percentage). The association between the ABO-bgs and clinical and pathological variables was assessed using univariate and multivariate regression models. IBM SPSS version 26 (IBM Corp, Armonk, NY) was used for the analysis. All tests were 2-sided with values of $p < 0.05$ considered statistically significant.

3. Results

3.1. Demographics of patient population

Overall, 1149 consecutive patients who underwent PCa surgery at our institution were evaluated using the ABO-bgs. Their demographics are reported in Table 1. According to European Association of Urology risk classes, 318 patients were at low risk (27.7%), 603 at intermediate risk (52.5%), and 228 at high risk (19.8%). The American Society of Anesthesiologists score was 1 to 2 in 1036 cases (90.2%). Robot-assisted RP was performed in 970 cases (84.4%). Overall, 45.3% of procedures were performed by high surgical volume. Postoperative complications occurred in 334 cases (29.1%); among 5.8% of cases, the Clavien-Dindo score was greater than 2. The median length of hospital stay was 5 days (interquartile range, 4–6 days), whereas the readmission rate was 5%.

3.2. Associations between ABO blood group system and pathological features of prostate specimens

The ABO-bg distribution of the patient cohort is depicted in Figure 1, with the most being in O-bg (n = 492 [42.8%]) and A-bg (n = 474 [41.3%]), followed by B-bg (n = 128 [11.1%]) and AB (n = 55 [4.8%]). Among the clinical and pathological features shown in Table 2, only PSM was related to the ABO-bg system (Pearson correlation coefficient, r = 0.071; p = 0.017); furthermore, the risk of PSM was higher in the O-bg (odds ratio, 1.497; 95% confidence interval, 1.149–1.950; p = 0.003) versus the other groups. Figure 2 illustrates the distribution of PSM by ABO-bgs classification.

Associations between clinical and pathological PCa factors and the risk of PSM are illustrated in Table 3. In both models, the features of ABO-bgs, surgical approach (ORP vs. RARP), and surgeon volume (low vs. high surgical volume) were also assessed. In the clinical model evaluation, the risk of PSM was independently predicted by the O-bgs, PSA, biopsy-positive cores (BPCs), and high surgical volume. Specifically, the risk of PSM was increased by O-bgs (vs. non–O-bgs), PSA, and BPCs but was decreased by high surgical volume; furthermore, body mass index, tumor grade and stage, and RARP, which was associated with a decreased risk on

Table 1

Demographics of patients treated with radical prostatectomy (n = 1149).

	Mean (SD) or n (%)	Median (IQR)
Clinical features		
Age, yr	65.4 (6.3)	66 (61–70)
Body mass index, kg/m^2	26 (3.4)	25.8 (23.9–28.1)
Prostate-specific antigen, ng/mL	9.4 (10.3)	6.9 (5.1–9.9)
Prostate volume, mL	43.1 (18.2)	40 (30–52)
Biopsy-positive cores, %	40 (22.9)	34 (21–54)
Clinical stage		
cT1	751 (65.4)	
cT2	362 (31.5)	
cT3	36 (3.1)	
Clinical nodal stage		
cN0	1107 (96.3)	
cN1	42 (3.7)	
ISUP		
1	452 (39.3)	
2	368 (32)	
3	186 (16.2)	
4	115 (10)	
5	28 (2.4)	
Radical prostatectomy		
Open radical prostatectomy	179 (15.6)	
Robot-assisted radical prostatectomy	970 (84.4)	
Surgical volume		
Low	629 (54.7)	
High	520 (45.3)	
Pathological features		
Prostate weight, g	56.1 (19.8)	52 (43–66)
Tumor load, % of prostate affected by cancer	22.1 (17.6)	18 (10–30)
ISUP		
1	153 (13.3)	
2	436 (37.9)	
3	305 (26.5)	
4	170 (14.8)	
5	85 (7.4)	
Pathological stage		
pT2	868 (75.6)	
pT3a	128 (11.1)	
pT3b	153 (13.3)	
Pathological nodal stage		
pNx	414 (36)	
pN0	642 (55.9)	
pN1	93 (8.1)	
Positive surgical margins		
No	848 (73.8)	
Yes	301 (26.2)	

IQR = interquartile range; ISUP = International Society of Urologic Pathology.

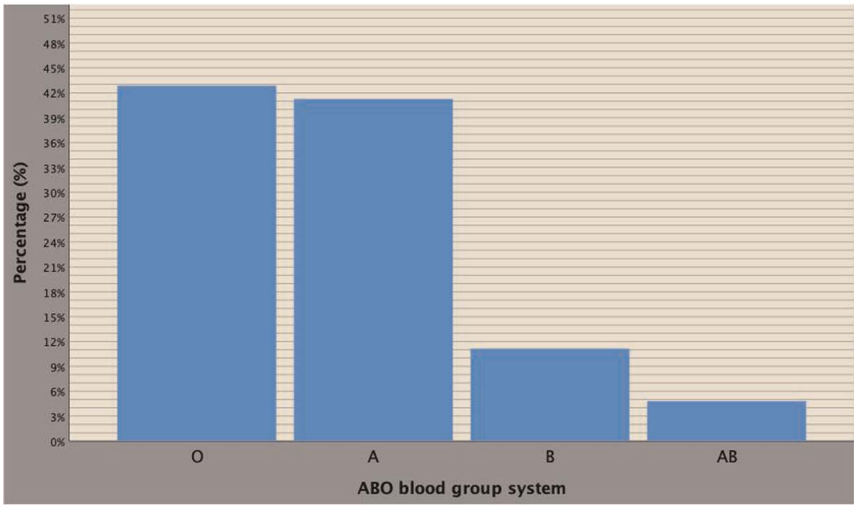

Figure 1. Distribution of 1149 subjects who underwent radical prostatectomy according to the ABO blood group system.

the univariate analysis, lost significance. In the pathological model evaluation, the risk of PSM was independently predicted by O-bgs, tumor load, extracapsular extension, seminal vesicle invasion, and high surgical volume. Specifically, the risk of PSM was increased by O-bgs, tumor load, extracapsular extension, and seminal vesicle invasion but decreased by high surgical volume; furthermore, tumor grade was not significant. Further details are presented in Table 3, whereas the association between tumor load and PSM is shown in Figure 3.

The independent association of ABO-bgs (exposure variable) with the risk of PSM is shown in Table 4. In the clinical model comparing O-bg with non–O-bg, the former increased the risk of PSM independently by PSA, BPCs, and high surgical volume (adjusted odds ratio, 1.532; 95% confidence interval, 1.168–2.009; $p = 0.002$); specifically, the odds of PSM were 53.2% higher for genotype O-bg than for non–O-bg subjects; furthermore, the adjusted odds did not change for the multivariate pathological model. Further details are provided in Table 4.

Table 2

Associations between ABO blood group and clinical and pathological factors of patients treated with radical prostatectomy (univariate analysis; n = 1149).

	ABO blood group system*		Blood group O vs. groups A, B, and AB†	
	r	*p*	OR (95% CI)	*p*
Clinical factors				
Age	0.030	0.920	0.988 (0.970–1.006)	0.190
Body mass index	−0.013	0.660	0.994 (0.959–1.030)	0.739
Prostate-specific antigen	−0.004	0.885	0.999 (0.985–1.013)	0.943
Prostate volume	0.001	0.981	1.000 (0.993–1.006)	0.895
BPCs	0.010	0.732	0.998 (0.992–1.003)	0.442
ISUP >2	0.020	0.497	0.985 (0.760–1.276)	0.908
cT >1	0.029	0.328	0.993 (0.729–1.193)	0.579
cN1	0.007	0.807	1.002 (0.537–1.867)	0.996
Pathological factors				
Prostate weight	0.010	0.745	1.000 (0.994–1.006)	0.968
Tumor load	−0.020	0.507	1.002 (0.995–1.008)	0.633
ISUP >2	−0.010	0.720	1.092 (0.865–1.380)	0.459
pT3	−0.027	0.363	1.053 (0.803–1.381)	0.710
Positive surgical margins	−0.071	0.017	1.497 (1.149–1.950)	0.003

BPCs = biopsy-positive cores; CI = confidence interval; ISUP = International Society of Urologic Pathology; OR = odds ratio; *r* = Pearson correlation coefficient.
*Correlation analysis.
†Logistic regression analysis.

4. Discussion

The ABO-bgs is traced out by the *ABO* gene, which is single and located on chromosome 9q34, and has been associated with the risk of several carcinomas, including stomach, pancreas, ovary, kidney, and skin.[3–10] The non–O-bg classification increased the risk of cancers involving the pancreas, kidney, and ovary but not non-melanoma skin cancer, which was increased in the O-bg classification. Furthermore, gastric cancer was the first malignant tumor identified as associated with the A-bg phenotype.[3–10]

Associations between the ABO-bgs and PCa biology have yet to be investigated; as such, they represent novelty in the academic urology literature. A large case-control study retrieved data of 15,359 cancer patients from the tumor registry of the European Institute of Oncology in Milan and investigated the association of ABO-bgs with cancer in the Italian general population.[4] In this study, which showed no significant association between ABO-bgs and the risk of cancer, the distribution of the ABO-bg classification between controls and PCa cases was 46% versus 42% for O-bg, 42% versus 43% for A-bg, 9% versus 10% for B-bg, and 3% versus 4% for AB-bg. The distribution of the ABO-bgs of the 719 PCa patients was similar to that of the general Italian population.[4] A recent large case-control study restricted to men of European ancestry that included 2774 aggressive PCa cases and 4443 controls found no significant association between ABO-bg and risk of aggressive PCa or PCa-specific mortality.[11] In this study, the distribution of the ABO-bgs classifications for controls versus cases was 42% versus 40% for O-bg, 43% versus 44% for A-bg, 10% versus 12% for B-bg, and 5% versus 5% for AB-bg. Furthermore, the investigation was restricted to men of European ancestry, which might limit the generalizability of its findings to other ethnicities, who show a different prevalence of blood types and PCa.[11] In a single-center study of a PCa subpopulation, Wang et al.[12] showed

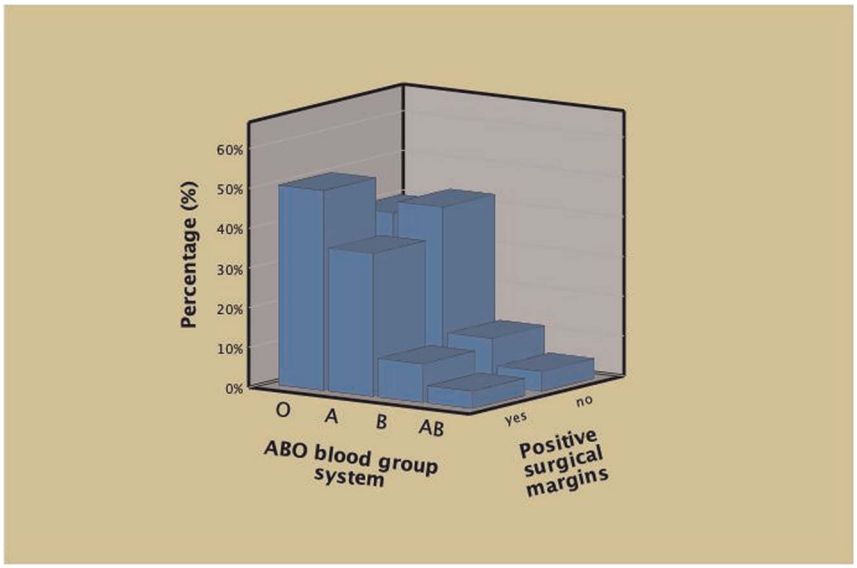

Figure 2. Associations between ABO blood group and prostate cancer biology expressed as positive surgical margins.

Table 3

Analysis of factors associated with the risk of positive surgical margins of patients treated with radical prostatectomy (n = 1149).

	Negative surgical margins	Positive surgical margins	Univariate analysis		Multivariate analysis	
Statistics	**Median (IQR) or n (%)**	**Median (IQR) or n (%)**	**OR (95% CI)**	***p***	**OR (95% CI)**	***p***
Clinical model*						
Blood group						
Non-O	507 (77.2)	150 (22.8)	1			
O	341 (69.3)	151 (30.7)	1.497 (1.149–1.950)	0.003	1.532 (1.167–2.011)	0.002
Age, yr	66 (61–70)	65 (60–70)	1.006 (0.958–1.026)	0.598		
Body mass index, kg/m^2	26 (24.2–28.1)	25.5 (23.5–27.9)	0.956 (0.917–0.997)	0.037	0.959 (0.919–1.001)	0.058
PSA, ng/mL	6.3 (4.8–8.5)	7 (5.1–11.1)	1.031 (1.014–1.048)	<0.0001	1.021 (1.003–1.038)	0.020
Prostate volume, mL	40 (30–50)	38 (30–47)	0.993 (0.986–1.001)	0.090		
BPCs, %	29 (17–43)	33.3 (21–55)	1.016 (1.010–1.022)	<0.0001	1.014 (1.007–1.020)	<0.0001
ISUP <3	620 (75.6)	200 (24.4)	1		1	
ISUP >2	228 (69.3)	101 (30.7)	1.373 (1.034–1.823)	0.028	1.100 (0.812–1.491)	0.537
cT <2	572 (76.2)	179 (23.8)	1		1	
cT >1	276 (69.3)	122 (30.7)	1.413 (1.077–1.853)	0.013	1.112 (0.830–1.490)	0.475
cN0	819 (74)	288 (26)	1			
cN1	29 (69)	13 (31)	1.275 (0.654–2.486)	0.476		
ORP	121 (67.6)	58 (32.4)	1		1	
RARP	727 (74.9)	243 (25.1)	0.697 (0.494–0.985)	0.041	1.022 (0.691–1.512)	0.914
Low surgical volume	437 (69.5)	192 (30.5)	1		1	
High surgical volume	520 (45.3)	411 (79)	0.604 (0.460–0.791)	<0.0001	0.635 (0.470–0.859)	0.003
Pathological model*						
Blood group system						
Non-O					1	
O					1.530 (1.153–2.030)	0.003
Prostate weight, g	51 (42–66)	50 (41–62)	0.994 (0.987–1.001)	0.086		
Tumor load, % of prostate affected by cancer	15 (10–25)	25 (15–40)	1.038 (1.030–1.045)	<0.0001	1.031 (1.022–1.040)	<0.0001
ISUP <3	475 (56)	114 (37.9)	1		1	
ISUP >2	373 (44)	187 (62.1)	2.089 (1.545–2.735)	<0.0001	1.314 (0.971–1.778)	0.077
pT2	692 (81.6)	176 (58.5)	1		1	
pT3a	72 (8.5)	56 (18.6)	3.058 (2.078–4.501)	<0.0001	2.211 (1.463–3.372)	<0.0001
pT3b	84 (9.9)	69 (22.9)	3.230 (2.256–4.652)	<0.0001	1.693 (1.115–2.572)	0.014
ORP					1	
RARP					1.290 (0.853–1.851)	0.227
Low surgical volume					1	
High surgical volume					0.657 (0.483–0.893)	0.007

BPCs = biopsy-positive cores; CI = confidence interval; IQR = interquartile range; ISUP = International Society of Urologic Pathology; OR = odds ratio; ORP = open radical prostatectomy; PSA = prostate-specific antigen; RARP = robot-assisted radical prostatectomy.

*ABO blood group system, ORP/RARP, and surgical volume (low, high) included in the models.

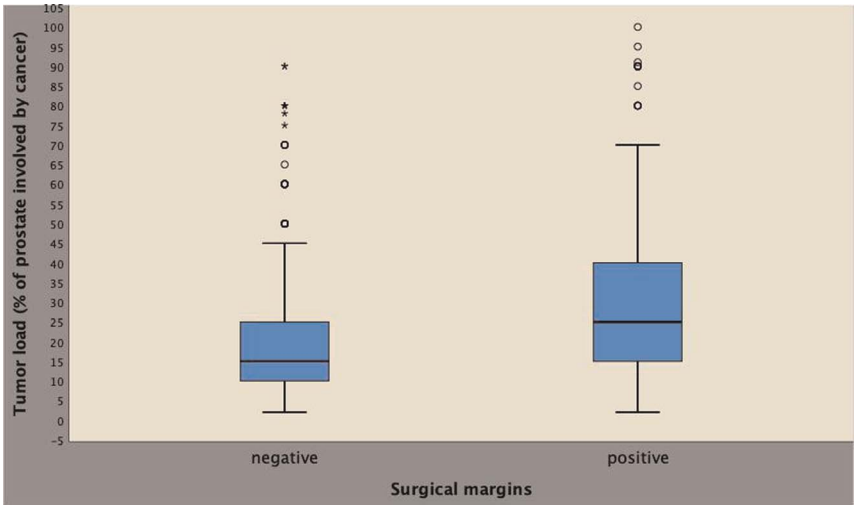

Figure 3. Aggressive prostate cancer biology represented by associations between tumor load expressed as percentage of cancer involving the volume of the prostate and positive surgical margins. A positive independent association was noted between the risk of positive surgical margins and prostate cancer biology and is expressed as tumor load.

that the non–O-bg patients were at higher risk of aggressive PCa; however, the trial had several limitations including its retrospective nature, small sample size, and methodology used to categorize "high-risk" patients who were widely heterogeneous but with high-risk, locally advanced, or even metastatic disease; furthermore, the low- to middle-risk subpopulation included only 43 cases (18.1%). Although the study includes several limitations, it is the only study to date to investigate the associations between ABO-bgs and PCa biology in a small and heterogeneous cohort of Chinese patients who showed a different prevalence of blood types and PCa risk than those of White ethnicity; therefore, it is difficult to apply their results to populations of European ancestry.[11,12] In our study, the distribution of ABO-bgs was 42.8% for O-bg, 41.3% for A-bg, 11.1% for B-bg, and 4.8% for AB-bg. Figure 1 shows that the population included 1149 PCa patients of White ethnicity. As such, the cases in our study are comparable to those reported by Iodice et al.[4] and Markt et al.,[11] and the distribution of the ABO-bgs overlaps those reported by the 2 aforementioned studies.

Our study showed an indirect association between ABO-bgs and PCa biology because it independently predicted the risk of PSM, which is related to advanced tumor stage and load; furthermore, in the clinical and pathological models, ABO-bgs was independent from high surgical volume, which further decreased the risk of PSM. In the clinical model, the odds of PSM was 53.2% higher for O-bgs than that for non–O-bgs. These findings are novel in the urology literature. The prevalence of PSM after RP was 8.8% to 37%, and independent predictors included surgical volume and tumor biology, including tumor load, extension, and aggressiveness.[23,24] At tertiary referral centers, where both surgical procedures are performed, RARP versus ORP was associated with a decreased risk of PSM, further supporting the advantages of oncological outcomes of robotic surgery.[25] In our study, although both RARP and high surgical volume decreased the risk of PSM in univariate analysis, only high surgical volume was an independent factor in the multivariate analysis, which might be related to the fact that high-surgical-volume surgeons performed robotic surgery exclusively as well as patient selection bias. Positive surgical margin adversely affects the natural history of PCa in terms of biochemical recurrence, metastatic progression, and disease-specific mortality.[26,27] Compared with the study by Wang et al.,[12] ours is larger, includes a more homogenous population, and features results that can be generalized to the European population of White ethnicity; moreover, the clinical associations between O-bg and the risk of PSM were supported by multivariate clinical and pathological models. Our study is novel, and its findings have important implications for clinical practice.

Our results might be attributable to the biology of the ABO-bg system, whose antigens are expressed not only on erythrocytes but also on epithelial and endothelial cells.[3–12] Such an association is due to several mechanisms, including intercellular adhesion, membrane signaling, angiogenesis, inflammation, and immune surveillance of malignant transformed cells; it may also be related to tumor progression.[3–12] Expression of the O-bg genotype by PCa cells theoretically influences intercellular adhesion and membrane signaling, whereas the stimulation of angiogenesis and decrease in immunosurveillance may promote tumor growth and extension, thus increasing the risk of PSM. A more developed

Table 4

Risk of positive surgical margins by ABO blood group of patients treated with radical prostatectomy (n = 1149).

				Univariate analysis	Multivariate analysis	
ABO blood group	**Total, n**	**NSM, n(%)**	**PSM, n (%)**	**Univariate model, OR (95% CI)**	**Clinical model*, OR (95% CI)**	**Pathological model†, OR (95% CI)**
Non-O	657	507 (77.2)	150 (22.8)	Reference	Reference	Reference
O	492	341 (69.3)	151 (30.7)	1.497 (1.149–1.950)	1.532 (1.168–2.009)	1.538 (1.160–2.039)
p				0.003	0.002	0.003

BPCs = biopsy-positive cores; CI = confidence interval; NSM = negative surgical margins; OR = odds ratio; PSA = prostate-specific antigen; PSM = positive surgical margins.

*OR adjusted for PSA, BPCs, and high surgical volume.

†OR adjusted for tumor load, extracapsular extension, seminal vesicle invasion, and high surgical volume.

periprostatic lymphatic network may favor disease diffusion in patients with the O-bg genotype.[28]

The present study has limitations, including its retrospective nature, grouping of surgeons according to surgical volume, and failure to adjust for the effect of nerve sparing on the risk of PSM because such data were not available for all patients. However, it also has strengths, including its data being collected prospectively and the population being large and homogenous; moreover, we already demonstrated the risk of biochemical recurrence associated with PSM and high surgical volume in terms of focal linear extent. Furthermore, nerve sparing reportedly has no impact on biochemical recurrence.[29,30]

5. Conclusions

In clinical PCa, the risk of PSM is increased in patients with the O-bg versus non–O-bg genotype after the adjustment for standard predictors. Thus, our results suggest that the association between ABO-bgs and unfavorable PCa features requires exploration in controlled studies.

Acknowledgments

None.

Statement of ethics

This retrospective study was approved by our local institutional review board. Informed signed consent was obtained from all patients. All procedures performed in this study involving human participants were done so in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Conflict of interest statement

No conflict of interest has been declared by the authors.

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None.

Author contributions

ABP: Project development, data analysis and interpretation, and manuscript writing;
NA, AT: Project development; data collection, analysis, and interpretation; and manuscript writing;
RR, LT, MDM, AB, SG, RO, FC, PIO, AG: Data collection, data analysis, and interpretation;
MB, PP, FM, SZA, VL, MAC, AA, WA: Other (supervision and critical revision).

References

[1] Mottet N, van den Bergh RCN, Briers E, et al. EAU-EANM-ESTRO-ESUR-SIOG guidelines on prostate cancer—2020 update. Part 1: Screening, diagnosis, and local treatment with curative intent. *Eur Urol* 2021;79(2):243–262.
[2] Carroll PH, Mohler JL. NCCN guidelines updates: Prostate cancer and prostate cancer early detection. *J Natl Compr Canc Netw* 2018;16(5S):620–623.
[3] Reid ME, Bird GW. Associations between human red cell blood group antigens and disease. *Transfus Med Rev* 1990;4(1):47–55.
[4] Iodice S, Maisonneuve P, Botteri E, Sandri MT, Lowenfels AB. ABO blood group and cancer. *Eur J Cancer* 2010;46(18):3345–3350.
[5] Wolpin BM, Kraft P, Gross M, et al. Pancreatic cancer risk and ABO blood group alleles: Results from the pancreatic cancer cohort consortium. *Cancer Res* 2010;70(3):1015–1023.
[6] Nakao M, Matsuo K, Hosono S, et al. ABO blood group alleles and the risk of pancreatic cancer in a Japanese population. *Cancer Sci* 2011;102(5):1076–1080.
[7] Risch HA, Yu H, Lu L, Kidd MS. ABO blood group, helicobacter pylori seropositivity, and risk of pancreatic cancer: A case-control study. *J Natl Cancer Inst* 2010;102(7):502–505.
[8] Joh HK, Cho E, Choueiri TK. ABO blood group and risk of renal cell cancer. *Cancer Epidemiol* 2012;36(6):528–532.
[9] Gates MA, Wolpin BM, Cramer DW, Hankinson SE, Tworoger SS. ABO blood group and incidence of epithelial ovarian cancer. *Int J Cancer* 2011;128(2):482–486.
[10] Xie J, Qureshi AA, Li Y, Han J. ABO blood group and incidence of skin cancer. *PLoS One* 2010;5(8):e11972.
[11] Markt SC, Shui IM, Unger RH, et al. ABO blood group alleles and prostate cancer risk: Results from the breast and prostate cancer cohort consortium (BPC3). *Prostate* 2015;75(15):1677–1681.
[12] Wang FM, Zhang Y, Zhang GM, Liu YN, Sun LJ, Liu Y. Association of ABO blood types and clinicopathological features of prostate cancer. *Dis Markers* 2017;2017:9237481.
[13] Menon M, Tewari A, Peabody J, VIP Team. Vattikuti institute prostatectomy: Technique. *J Urol* 2003;169(6):2289–2292.
[14] Walsh PC, Gittes RE, Perlmuter AD, Stamey TA. Campbell's Urology. 5th edVolume 2. Philadelphia: WB Saunders Company; 1986.
[15] Porcaro AB, De Luyk N, Corsi P, et al. Association between basal total testosterone levels and tumor upgrading in low and intermediate risk prostate cancer. *Urol Int* 2017;99(2):215–221.
[16] Porcaro AB, Cacciamani GE, Sebben M, et al. Lymph nodes invasion of Marcille's fossa associates with high metastatic load in prostate cancer patients undergoing extended pelvic lymph node dissection: The role of "marcillectomy". *Urol Int* 2019;103(1):25–32.
[17] Cacciamani GE, Porcaro AB, Sebben M, et al. Extended pelvic lymphadenectomy for prostate cancer: Should the Cloquet's nodes dissection be considered only an option?*Minerva Urol Nefrol* 2019;71(2):136–145.
[18] Porcaro AB, Siracusano S, Luyk N, et al. Clinical factors stratifying the risk of tumor upgrading to high-grade disease in low-risk prostate cancer. *Tumori* 2018;104(2):111–115.
[19] Porcaro AB, Cavicchioli F, Mattevi D, et al. Clinical factors of disease reclassification or progression in a contemporary cohort of prostate cancer patients elected to active surveillance. *Urol Int* 2017;98(1):32–39.
[20] Dripps RD, Lamont A, Eckenhoff J. The role of anesthesia in surgical mortality. *JAMA* 1961;178:261–266.
[21] Dindo D, Demartines N, Clavien PA. Classification of surgical complications: A new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg* 2004;240(2):205–213.
[22] Pierorazio PM, Ferrucci L, Kettermann A, Longo DL, Metter EJ, Carter HB. Serum testosterone is associated with aggressive prostate cancer in older men: Results from the Baltimore longitudinal study of aging. *BJU Int* 2010;105(6):824–829.
[23] Fontenot PA, Mansour AM. Reporting positive surgical margins after radical prostatectomy: Time for standardization. *BJU Int* 2013;111(8):E290–299.
[24] Yossepowitch O, Bjartell A, Eastham JA, et al. Positive surgical margins in radical prostatectomy: Outlining the problem and its long-term consequences. *Eur Urol* 2009;55(1):87–99.
[25] Antonelli A, Sodano M, Peroni A, et al. Positive surgical margins and early oncological outcomes of robotic vs open radical prostatectomy at a medium case-load institution. *Minerva Urol Nefrol* 2017;69(1):63–68.
[26] Yossepowitch O, Briganti A, Eastham JA, et al. Positive surgical margins after radical prostatectomy: A systematic review and contemporary update. *Eur Urol* 2014;65(2):303–313.
[27] Zhang L, Wu B, Zha Z, et al. Surgical margin status and its impact on prostate cancer prognosis after radical prostatectomy: A meta-analysis. *World J Urol* 2018;36(11):1803–1815.
[28] Boscolo-Berto R, Siracusano S, Porzionato A, et al. The underestimated posterior lymphatic drainage of the prostate: An historical overview and preliminary anatomical study on cadaver. *Prostate* 2020;80(2):153–161.
[29] Porcaro AB, Tafuri A, Sebben M, et al. Linear extent of positive surgical margin impacts biochemical recurrence after robot-assisted radical prostatectomy in a high-volume center. *J Robot Surg* 2020;14(4):663–675.
[30] Porcaro AB, Sebben M, Corsi P, et al. Risk factors of positive surgical margins after robot-assisted radical prostatectomy in high-volume center: Results in 732 cases. *J Robot Surg* 2020;14(1):167–175.

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