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Original Article

Surgical checklist adherence across urology expertise levels impacts transurethral resection of bladder tumour quality indicators

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Objectives

To address the association of perioperative surgical checklist across variable surgical expertise with transurethral resection of bladder tumour (TURBT) accuracy and oncological outcomes in non-muscle-invasive bladder cancer.

Patients and Methods

We relied on our prospective collaborative database of patients treated with TURBT between 2012 and 2017. Surgical experience was stratified into three groups: resident vs young vs expert consultants. The association of surgical experience with detrusor muscle (DM) presence and adherence to the standardised peri-procedural nine-items TURBT checklist was evaluated with logistic regression models. A Cox regression model was used to investigate the association of surgical experience with recurrence-free survival (RFS).

Results

A total of 503 patients were available for analysis. TURBT was performed by expert consultants in 265 (52.7%) patients, by young consultants in 149 (29.6%) and by residents in 89 (17.7%). Residents were more likely to have DM in the TURBT specimen than expert consultants (odds ratio [OR] 1.75, 95% confidence interval [CI] 1.03–2.99, P = 0.04). Conversely, no differences in DM presence were seen between young vs expert consultants (OR 1.09, 95% CI 0.71–1.70, P = 0.69). The median checklist completion rate was higher for both residents and young consultants when compared to experts' counterparts (56% and 56% vs 44%, P = 0.009). When focusing on patients receiving a second-look TURBT, the persistent disease was associated with resident status (OR 4.24, 95% CI 1.14–17.70, P = 0.037) at initial TURBT. Surgical experience was not associated with 5-years RFS.

Conclusion

Surgeon's experience in the case of adequate perioperative surgical checklist implementation was inversely associated with the presence of DM in the specimen but directly linked to higher probability of persistent disease at re-TURBT, although no 5-year RFS differences were noted.

Keywords

non-muscle-invasive bladder cancer, transurethral resection of bladder tumour, bladder cancer, surgical experience, resident, #BladderCancer, #blcsm, #uroonc

Introduction

The presence of detrusor muscle (DM) in transurethral resection of bladder tumour (TURBT) specimens [1,2] is an accepted surrogate parameter for the accuracy and completeness of the tumour resection and is associated with survival outcomes. Overall surgeon experience is thought to have an influence on the quality of the TURBT and the likelihood of DM in the specimen [3–5]. In addition, in academic centres, as TURBT is usually assigned to more junior-level residents, the attending surgeon performing the surgery may have a more sizeable impact on TURBT adequacy.

To improve quality and standardise the TURBT protocol, surgical checklists (SCs) and quality performance indicator programmes have been implemented in clinical practice and are recommended by international guidelines [6]. These tools have been shown to improve resection quality and decrease the rate of recurrence [7–10]. In the present study, we sought to investigate the prospective implementation of our TURBT SC, stratified by different levels of expertise, on both TURBT-related quality indicators and recurrence-free survival (RFS) outcomes.

Patients and Methods

Patient Selection and Stratification

We analysed the data originating from our prospective cooperative group programme to identify patients treated with TURBT for non-muscle-invasive bladder cancer (NMIBC) between 2012 and 2017 at two high-volume academic centres. Surgeons were stratified according to surgical experience in to three groups: (i) residents, (ii) young consultants, and (iii) senior attendings. Young consultants and senior attendings were defined, respectively, as those who have been in practice ≤5 and >5 years after the completion of residency. At each participating centre, residents were always supervised during procedures. We excluded patients with tumours in bladder diverticula, patients staged as clinical T0, and any MIBC diagnosis [11]. Additionally, patients with missing data on the presence/absence of DM were also excluded. Finally, none of the patients included in the study had upper tract urothelial carcinoma at the time of surgery.

Surgical Checklist

The nine-item SC was systematically adopted for TURBT-procedure reporting and was investigated as a surrogate parameter for the overall quality of the TURBT. The SC consisted of two main domains addressing: (i) tumour description (tumour size, tumour appearance, number of tumours, clinical T stage and concomitant carcinoma in situ [CIS]) and (ii) adequacy of surgical procedure (bimanual palpation under anaesthesia, TURBT macroscopically complete, macroscopic presence of DM, and bladder perforation). The SC is shown in the Supplementary Materials (Fig. S1; Table S1).

Surgical Procedure, Histological Examination, and Follow-Up

All patients underwent TURBT with or without photodynamic diagnosis (PDD) and some underwent immediate single-dose postoperative chemotherapy instillation, as described in a previous manuscript [12,13]. Also, data on second-look TURBT (re-TURBT) performed following primary resection was available for a subset of patients 2–6 weeks following primary resection according to European Association of Urology (EAU) Guidelines [6]. In these patients, re-TURBT was performed by surgeons with the same level of expertise (residents, young consultant, and/or senior consultant) as at the time of the initial TURBT. Histopathology was rendered by dedicated uropathologists at each centre. Tumour stage was assigned according to the American Joint Committee on Cancer TNM Staging System, while tumour grade was determined according to the 2004 WHO system. Finally, the presence of lymphovascular invasion in the lamina propria, concomitant CIS, and histological subtypes were also assessed. Follow-up was performed according to international guidelines and usually included regular flexible cystoscopy and voided urine cytology [14].

Cold biopsy/TURBT of suspected areas was performed whenever needed.

Study Endpoints

The primary objective was to test the association between surgical experience coupled with the SC and the presence of DM on histological examination.

The secondary objective was to investigate the association between surgeon experience at initial TURBT with the perioperative SC and the presence of the persistent disease when a re-TURBT was performed. For this objective, persistent disease was defined as persistent NMIBC and/or upstaging to MIBC vs the absence of cancer at the scar site/sites of the first resection.

Finally, the study attempted to evaluate RFS differences for NMIBCs that underwent TURBT with the SC, per different levels of surgical expertise. For this objective, disease recurrence was defined as pathologically confirmed tumour relapse in the bladder or prostatic urethra, regardless of tumour stage.

Statistical Analysis

Statistical analyses were performed via multiple steps. First, we used univariable logistic regression modelling to investigate the association of surgical experience with the presence of DM in the TURBT specimen. Next, on multivariable logistic regression analysis, we adjusted for the effect of known confounders, such as tumour size (<3 vs ≥3 cm), tumour focality (uni- vs multifocal), clinical T stage (cTa/is vs cT1), tumour grade (low grade vs high grade), gender, image modality (white-light only vs PDD), and the SC completeness (none to nine items). Then, we investigated the association of the number of the SC items completed with the presence of DM in the specimen using logistic regression modelling. Local polynomial smoother weighted function (LOWESS) was used to graphically plot the association of checklist adherence with the probability of DM presence, after accounting for all the above-mentioned predictors and according to surgical expertise.

On exploratory analyses in patients who received a re-TURBT, we investigated the association of surgical experience with persistent disease.

Finally, we investigated the association of surgical experience with RFS using univariable Cox regression analysis. Survival estimates were plotted using the Kaplan–Meier method. The log-rank test was used to assess the difference in survival between groups.

Statistical analyses were performed using R software environment for statistical computing and graphics (version 3.4.3; R Foundation for Statistical Computing, Vienna, Austria). Stata version 17.1 (Stata Corporation, College Station, TX, USA) was used to generate LOWESS curves. All tests were two-sided, with $P < 0.05$ set as threshold for statistical significance.

Results

A total of 503 patients were included in the analyses. Overall, 265 patients were treated by either expert (n = 265, 52.7%), young consultants (n = 149, 29.6%), or urology residents (n = 89, 17.7%) and represented the final sample size evaluated. Clinicopathological features of the patients are shown in Table 1. No clinically relevant or significant differences were recorded regarding clinicopathological features after stratification according to surgical experience. Patients treated by young consultants had higher rates of PDD-TURBT (43.6% vs 27.2% vs 30.3%, P = 0.002) as well as an immediate postoperative intravesical mitomycin C instillation (32.3% vs 20.7% vs 23.3%, P = 0.040) compared to expert consultants or residents.

The median perioperative SC completion rate was higher in both residents and young consultants when compared to expert consultants (56% and 56% vs 44%, respectively, P = 0.009). In particular, reporting of concomitant CIS, macroscopic presence of DM, clinical T stage, as well as intraoperative perforation and bimanual palpation were more frequently reported by residents when compared to young or expert consultants. No differences were found for reporting on a macroscopically complete resection, tumour appearance, focality, or size (Table S1).

At the final pathological report, DM was present in 50.6%, 54.4%, and 62.9% of specimens provided by experts, young consultants, and residents, respectively. On univariable logistic regression analyses, resident status (odds ratio [OR] 1.66, 95% CI 1.02–2.74, P = 0.04), as well as SC completeness were significantly associated with the presence of DM in the specimen. On multivariable analysis (Table 2), residents were more likely to include DM than expert consultants (OR 1.75, 95% CI 1.03–2.99, P = 0.04), while no differences were observed between young vs expert consultants (OR 1.09, 95% CI 0.71–1.70, P = 0.7). Moreover, the addition of each single SC item was found to increase the probability of DM sampling by 18% (OR 1.18, 95% CI 1.06–1.31, P = 0.002). Additionally, when exploring the predicted probability generated by the LOWESS function, a trend in the threshold for probability being >50% was identified after the completion of five of the nine items (Fig. 1), with overlapping trajectories across the different levels of expertise assessed.

On subgroup analyses of patients treated with re-TURBTs, we found a significant association of resident status with persistent disease (OR 4.24, 95% CI 1.14–17.7, P = 0.037, Table 3). Moreover, similar to the previous aim, young and

Table 1 Baseline characteristics of the overall cohort (*N* = 503) stratified according to surgeon experience: expert consultants, young consultants, and residents.

Variables	*N**	Expert consultants 265 (52.7%)	Young consultants 149 (29.6%)	Residents 89 (17.7%)	*P*†
Age, years					
Median (IQR)	503	69 (62–75)	68 (63–76)	72 (62–76)	0.7
Gender, *n* (%)					
Female	503	45 (17.0)	25 (16.8)	25 (28.1)	0.050
Male		220 (83.0)	124 (83.2)	64 (71.9)	
Smoking status, *n* (%)					
Actual smoker	290	40 (26.7)	31 (36.5)	21 (38.2)	0.1
Former smoker		63 (42.0)	34 (40.0)	26 (47.3)	
Never smoker		47 (31.3)	20 (23.5)	8 (14.5)	
Charlson Comorbidity Index					
Median (IQR)	231	5.0 (3.0–7.0)	6.0 (4.0–8.0)	4.0 (2.0– 6.0)	0.054
Median tumour size, cm					
Median (IQR)	503	1.8 (1.0–3.0)	2.0 (1.0–4.0)	2.0 (1.0–3.0)	0.007
Tumour size, cm, *n* (%)					
<3		185 (69.8)	82 (55.0)	61 (68.5)	0.008
≥3		80 (30.2)	67 (45.0)	28 (31.5)	
Number of lesions					
Median (IQR)	503	2 (1–3)	2 (1–3)	2 (1–3)	0.8
Tumour focality, *n* (%)					
Unifocal	503	127 (47.9)	72 (48.3)	43 (48.3)	>0.9
Multifocal		138 (52.1)	77 (51.7)	46 (51.7)	
Macroscopic appearance, *n* (%)					
Papillary	428	195 (85.5)	108 (86.4)	60 (80.0)	0.7
Solid/sessile		29 (12.7)	15 (12.0)	13 (17.3)	
Flat/scar		4 (1.8)	2 (1.6)	2 (2.7)	
Histology, *n* (%)					
Pure urothelial	503	257 (97.0)	145 (97.3)	86 (96.6)	>0.9
Variant histology		8 (3.0)	4 (2.7)	3 (3.4)	
Primary tumour stage, *n* (%)					
Ta/is	503	170 (64.2)	101 (67.8)	62 (69.7)	0.6
T1		95 (35.8)	48 (32.2)	27 (30.3)	
Tumour grade (WHO 2004), *n* (%)					
Low grade	503	144 (54.3)	85 (57.0)	55 (61.8)	0.5
High grade		121 (45.7)	64 (43.0)	34 (38.2)	
Lymphovascular invasion, *n* (%)					
Presence	364	13 (6.5)	6 (5.9)	4 (6.3)	>0.9
Concomitant CIS, *n* (%)					
Presence	414	37 (17.0)	22 (18.6)	11 (14.1)	0.7
Imaging modality, *n* (%)					
White light only	503	193 (72.8)	84 (56.4)	62 (69.7)	0.002
PDD		72 (27.2)	65 (43.6)	27 (30.3)	
Perioperative chemotherap instillation, *n* (%)					
Delivered	457	50 (20.7)	43 (32.3)	19 (23.2)	0.040
DM, *n* (%)					
Presence	503	134 (50.6)	81 (54.4)	56 (62.9)	0.1

**Number of patients with available information according to each variable. †Wilcoxon rank-sum exact test; Wilcoxon rank-sum test; Fisher's exact test; Pearson's chi-square test.*

expert consultants performed similarly (OR 1.91, 95% CI 0.58–6.42, P = 0.3, Table 3).

Finally, the 5-year RFS rates were 32.7% (95% CI 24.0–44.7%) vs 15.0% (95% CI 3.2–69.8%) vs 24.6% (95% CI 11.4–52.8%) for patients treated by experts vs young consultants vs residents, respectively (log-rank, P = 0.6, Fig. 2). Adjusted rates at multivariable Cox regression concluded that no differences were detected among the three different levels of expertise among TUR-operators (hazard ratio [HR] 1.07, 95% CI 0.68–1.69, P = 0.8; and HR 1.20, 95% CI 0.79–1.82, P = 0.4).

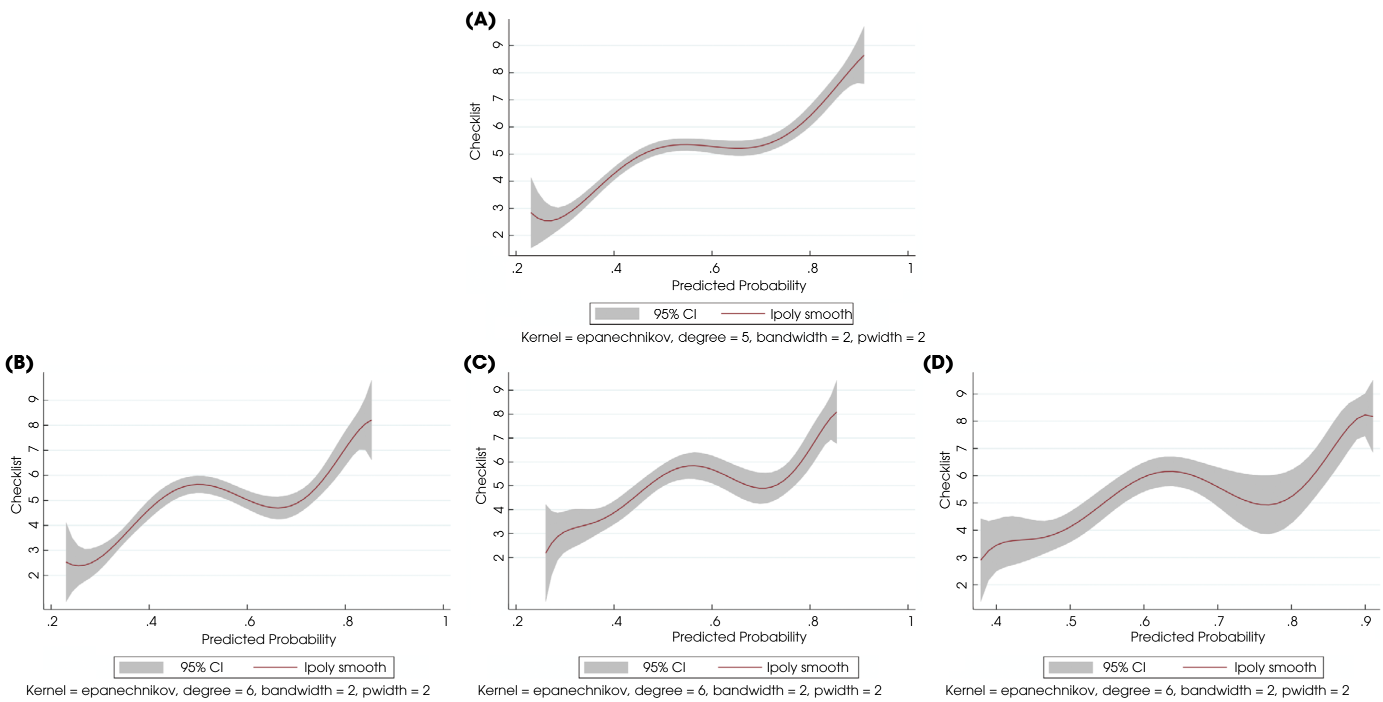
Discussion

Both bladder cancer survival and management rely on accurate tumour staging at the primary diagnosis, which is directly correlated to the quality of the initial TURBT [1]. However, as reported by Mostafid et al. [15], TURBTs are 'neglected' procedures among urological communities with NMIBC referral centres, and a dedicated NMIBCs SC is lacking in most international centres. Interestingly, although there have been some improvements in techniques such as en bloc resection, enhanced visualisation and the use of bipolar

Table 2 Uni- and multivariable logistic regression models investigating the association of surgical experience and SC with presence of DM at final pathology in 503 patients treated with TURBT.

	Univariable		Multivariable	
	OR (95% CI)	***P***	**OR (95% CI)**	***P***
Surgeon experience				
Expert consultants	–	–	–	–
Young consultants	1.17 (0.78–1.74)	0.5	1.09 (0.71–1.70)	0.688
Residents	1.66 (1.02–2.74)	0.044	1.75 (1.03–2.99)	0.040
Tumour focality				
Unifocal	–	–	–	–
Multifocal	0.92 (0.65–1.31)	0.6	0.99 (0.68–1.45)	0.954
Tumour size, cm				
<3	–	–	–	–
≥3	2.28 (1.56–3.36)	0.001	1.63 (1.07–2.49)	0.024
T stage				
Ta/Tis	–	–	–	–
T1	3.14 (2.12–4.70)	0.001	2.70 (1.61–4.60)	<0.001
Tumour grade				
Low grade	–	–	–	–
High grade	2.22 (1.55–3.19)	0.001	1.04 (0.64–1.69)	0.863
Gender				
Female	–	–	–	–
Male	1.24 (0.80–1.95)	0.340	1.36 (0.84–2.20)	0.212
Image modality				
White light only	–	–	–	–
PDD	1.02 (0.70–1.49)	0.903	1.08 (0.71–1.63)	0.731
SC (continuous)	1.23 (1.12–1.35)	0.001	1.18 (1.06–1.31)	0.002

Fig. 1 LOWESS was adopted to graphically explore the effect of checklist adherence on the predicted probability of DM presence at TURBT within the overall cohort (**A**) and after stratification according to surgeon experience: resident (**B**), young consultant (**C**) and expert consultant (**D**).



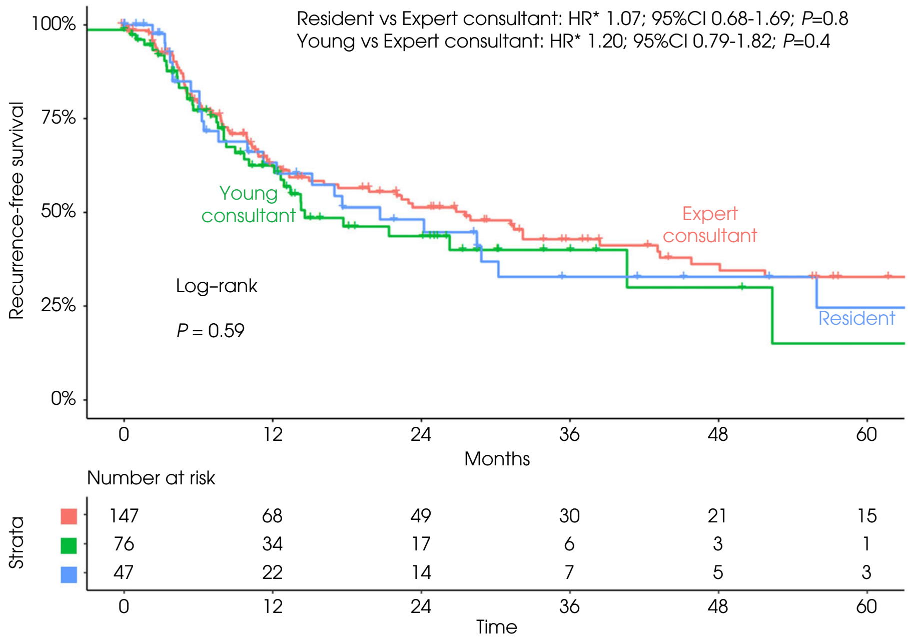
energy, the rate of innovation lags when the frequency of the procedure and the incidence of bladder cancer diagnosis are taken into account.

Although training programmes in most institutions initially involve junior-level residents with endoscopic procedures such as TURBTs, the learning curve of the procedure is not

Table 3 Logistic regression predicting persistent disease at secondary resection after initial TURBT with complete resection (*n* = 70 patients).

	Univariable		Multivariable	
	OR (95% CI)	***P***	**OR (95% CI)**	***P***
Surgeon experience at initial TURBT				
Expert consultant	–	–	–	–
Young consultant	1.80 (0.58–5.70)	0.3	1.91 (0.58–6.42)	0.3
Resident	4.80 (1.36–19.02)	0.018	4.24 (1.14–17.70)	0.037
Tumour focality at initial TURBT				
Unifocal	–	–	–	–
Multifocal	0.58 (0.22–1.52)	0.3	0.61 (0.20–1.80)	0.4
Tumour size at initial TURBT, cm				
<3	–	–	—	–
≥3	1.74 (0.65–4.87)	0.3	1.79 (0.61–5.61)	0.3
T stage at initial TURBT				
Ta/Tis	–	–	–	–
T1	1.08 (0.34–3.61)	0.9	1.16 (0.30–4.68)	0.8
Tumour grade at initial TURBT				
Low grade	–	–	–	–
High grade	0.88 (0.29–2.81)	0.8	0.97 (0.26–3.82)	1.0
Imaging modality at initial TURBT				
White light only	–	–	–	–
PDD	0.50 (0.16–1.47)	0.2	0.50 (0.14–1.65)	0.3
SC at initial TURBT (continuous)	0.97 (0.71–1.33)	0.84	0.87 (0.59–1.27)	0.5

Fig. 2 The 5-year RFS according to surgeon experience in NMIBC after first TURBT. Cox regression model tested the association between surgical experience and recurrence after multivariable adjustments for T stage, tumour grade, tumour size, tumour focality, SC, and image modalities.



trivial. Poletajew et al. [16] suggested relatively flat trajectories, with ~100 procedures required to obtain satisfactory surgical and oncological results. Moreover, the authors found no improvement in the risk of surgical complications despite experience gained during training, highlighting once again the challenges hidden within the learning curve of the procedure. These considerations lead to the observed and shared conclusion that high-quality TURBTs are actually quite challenging procedures, ultimately characterised by relatively low sensitivity for MIBC detection and low oncological resectability in the case of high-risk NMIBC. The two most demanding objectives are indeed to include DM in the resecting specimen and to eradicate the entirety of the tumour. As such, a growing body of evidence has demonstrated that urology residents performing TURBTs are associated, not only with prolonged operative time, postoperative hospital stay, and higher rate of re-admissions, but also with reduced chance for a complete procedure, reduced RFS, or longer time to cystectomy [16].

To date, the introduction of peri-TUR SCs has been established both to standardise the procedure and to allow improvements in operative reporting, a proxy of surgical quality. Nevertheless, studies on the impact of a SC according to different levels of expertise are lacking. Recently, Suarez-Ibarrola et al. [9] correlated the use of an eight-item SC with a significant improvement in RFS. Our study is the first to report the influence of routine implementation of a SC stratified across three different levels of surgical expertise. Although we confirmed the independent importance of perioperative adoption of a SC, we interestingly found a significant trend in favour of the resident subgroup regarding improved DM specimen sampling when performing TURBTs. This might be surprising and potentially misleading if not adequately contextualised. Bos et al. [17] had indeed previously demonstrated how active involvement of residents in TURBTs procedures was associated with a decreased rate of DM presence in TURBT specimens and a prolonged time to cystectomy. This was also true in those higher-risk subgroups of NMIBCs (e.g., T1, high grade, and CIS). However, in our series we found a significant tendency of residents to strictly adhere to most of the SC items proposed when compared to young and senior consultants. While we would carefully interpret such findings, this may represent clear evidence that standardisation of the resecting technique by implementing perioperative reporting through a SC may adjust for expertise imbalances and result in even better perioperative outcomes regardless of the learning curve background. However, the same findings were not confirmed for the persistent disease outcome at secondary resection, underlining once again that diligence alone without advanced experience cannot be considered a guarantee for the performance of a high-quality TURBT.

Several limitations to the present analyses have to be acknowledged. While we prospectively implemented the introduction of a SC during TURBTs, the retrospective design of our study may have led to limitations, in particular with SC data collection. Additionally, while we relied on multi-institutional cohort population study, our results could be influenced by the relatively small sample size that could have over- or underestimated the effect sizes observed. Finally, even if we accounted for most of the relevant clinicopathological confounders, the classification of our surgical expertise level relies on 'a priori' definition criteria rather than on a real quantification of the case volume exposed to each single operator in the study. This may indeed limit the generalisability of our findings to other centres and operators' definitions.

Conclusions

In our study, we demonstrated that a higher adherence to a TURBT SC was associated with a higher presence of DM in the specimen, without long-term RFS differences among surgeons with different levels of experience.

Although further important suggestions on quality indicators for appropriate endoscopic resection will be hopefully soon delivered by the ongoing RESECT trial (www.bursturology.com/Studies/Resect/Overview), our analysis corroborates the importance of SC implementation at each step of the learning curve underling the importance that operative reporting may add to the technical advancements in bladder cancer care.

Disclosure of Interests

Paolo Gontero is a company consultant for Arquer, Ferring, Ismar Healthcare, Lightpoint and Photocure; has received researchgrants from ABMedica, Astellas, Coloplast, Ipsen, Janssen and Storz; and has received lecture grants from Cepheid and Medacs. Shahrokh F. Shariat received honoraria from Astellas, Astra Zeneca, Bayer, BMS, Cepheid, Ferring, Ipsen, Janssen, Lilly, MSD, Olympus, Pfizer, Pierre Fabre, Richard Wolf, Roche, Sanochemia, Sanofi, Takeda, Urogen; is consulting for Astellas, Astra Zeneca, Bayer, BMS, Cepheid, Ferring, Ipsen, Janssen, Lilly, MSD, Olympus, Pfizer, Pierre Fabre, Richard Wolf, Roche, Sanochemia, Sanofi, Takeda, Urogen; is speaker for Astellas, Astra Zeneca, Bayer, BMS, Cepheid, Ferring, Ipsen, Janssen, Lilly, MSD, Olympus, Pfizer, Pierre Fabre, Richard Wolf, Roche, Sanochemia, Sanofi, Takeda, Urogen, Movember Foundation. All other authors have nothing to disclose.

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Abbreviations: CIS, carcinoma in situ; DM, detrusor muscle; HR, hazard ratio; IQR, interquartile range; LOWESS, local polynomial smoother weighted function; (N)MIBC, (non-) muscle-invasive bladder cancer; OR, odds ratio; PDD, photodynamic diagnosis; RFS, recurrence-free survival; SC, surgical checklist; TURBT, transurethral resection of bladder tumour.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Checklist completion stratified by surgeon experience vs independent items.

Fig. S1. Checklist completion stratified by surgeon experience vs independent items.