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ARTICLE

Surgical experience is predictive for bladder tumour resection quality

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ABSTRACT

Objectives: To assess the resection quality of transurethral bladder tumour resection (TURBT) and the association to surgeon experience depending on the presence of detrusor muscle.

Methods: A retrospective study on 640 TURBT procedures performed at Zealand University Hospital, Denmark, from 1 January 2015 – 31 December 2016. Data included patient characteristics, procedure type, surgeon category, supervisor presence, surgical report data, pathological data, complications data and recurrence data. Analysis was performed using simple and multiple logistic regression on the association between surgeon experience and the presence of detrusor muscle in resected tissue from TURBT.

Results: Supervised junior residents had significant lower detrusor muscle presence (73%) compared with consultants (83%) (OR = 0.4, 95% CI = 0.21–0.83). Limitations were the retrospective design and the diversity of included TURBT.

Conclusions: It was found that surgical experience predicts detrusor muscle presence and supervised junior residents performing TURBT on patients resulted in less detrusor muscle than consultants.

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Introduction

Transurethral resection of bladder tumours (TURBT) is a standard procedure in bladder cancer management. TURBT aims to ensure tumour tissue for grading and staging and to remove all tumour tissue. Detrusor muscle presence is a resection quality marker in TURBT. Detrusor muscle absence is associated with inaccurate staging, residual tumour and early recurrence [1]. Accordingly, detrusor muscle status in the tissue sample is central for the initial TURBT success.

Cumberbatch et al. [2] reported that far from all TURBT result in detrusor muscle presence and half the patients had residual tumours after primary resection. Mounting evidence has drawn attention to the influence of surgical experience on TURBT quality indicators [3]. Moreover, studies have identified significant variations in recurrence rates among different European countries [4]. Thus, there is a need to improve TURBT performance [5].

Several approaches have been added to improve the TURBT. First, improving tumour detection by using intravesical fluorescence, higher definition cameras and optical methods for image enhancement [6]. Second, improving tumour resection by using image enhancement techniques such as narrow band imaging and intravesical fluorescence, novel resection techniques such as en bloc and immediate postoperative adjuvant intravesical therapy [7,8]. Third, non-invasive methods such as magnetic resonance imaging have recently been proposed to assist tumour grading [9]. Finally, it has been suggested to improve the quality of TURBT procedure by improving the skills of the surgeon [10]. Surgical skills are learned by gaining knowledge, skills training and performing supervised procedures [11]. Most surgical training is based on classical apprenticeship, defined as an apprentice that learns surgical skills by observing an experienced surgeon performing procedures on patients, followed by supervised procedures under the guidance and observation from the experienced surgeon. While the classical apprenticeship promotes surgical skills training, it should not inhibit patient safety.

The aim of this study was to investigate the association between surgeon experience and the resection quality of TURBT assessed by the presence or absence of detrusor muscle.

Materials and methods

We performed a retrospective study on 640 TURBT procedures performed at Zealand University Hospital, Denmark, from 1 January 2015 – 31 September 2016. Patients were invited to participate in 2019. Written consents were obtained from all included patients. Final data collection was ended in May 2021. The database included: patient characteristics (age and sex), procedure date, procedure type (primary TURBT (primTURBT), repeated TURBT (reTURBT) 2–6 weeks after primTURBT or recurrent TURBT (recTURBT)),

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surgeon category (Junior residents (from the first postgraduate year until the first half of urological specialist training); Senior residents (final half of urological specialist training); and Consultants), supervisor presence, surgical report data (tumour size, tumour multiplicity, resection completeness), pathological report data (detrusor muscle presence, tumour stage, tumour grade), complication rate and first recurrence rate.

At our institution at the time of inclusion, the bladder tumour management was based on national and EAU guidelines on non-muscle-invasive bladder cancer from 2015 to 2016 [12]. The standard TURBT procedure was resection including detrusor muscle, except in small recurrent Ta low grade tumours [12]. Bipolar electrocautery with piecemeal resections were mainly performed. Patients with a suspicion of or previous high-grade tumours or carcinoma *in situ* (CIS) were given preoperative fluorescence; white/blue-light video-resectoscopes were used; postoperative adjuvant intravesical mitomycin C installation was given. In accordance with the classical apprenticeship, residents performed TURBT under supervision from either a more experienced resident or a consultant. Residents who were deemed competent by the supervisor and felt competent progressed to independent procedures. Direct observation assessment was used occasionally but not systematically, if so a general objective structured assessment of technical skills (OSATS) assessment tool was used. In accordance with guidelines at the study time, the surgical report should describe tumour numbers, tumour diameter and resection extent. For skills training, a virtual reality simulator was available for training (TURP/B Mentor^{TM} virtual reality (VR) simulator, 3D Systems/Simbionix).

Inclusion criteria

Patients undergoing transurethral removal of pathological tissue from the bladder wall including primTURBT, reTURBT and recTURBT; confirmed patient consent.

Exclusion criteria

Cystoscopy with biopsy control after intravesical therapy of CIS. Cystoscopy with biopsy for benign conditions (interstitial cystitis, painful pelvic syndrome); no patient consent.

Statistical analyses and variable definitions

Categorical and continuous variables were reported as frequencies and proportions and means and standard deviations (SD), respectively. Associations were evaluated with the χ^2 test for categorical variables and analysis of variance (ANOVA) for continuous variables.

The primary outcome detrusor muscle was explored by simple and multiple logistic regression.

Results were reported using the STROBE guideline for cohort studies.

The institute's ethical committee approved data collection (Journal no. 18-000080) and Danish Data Protection Agency (REG-100-2018). Four investigators reviewed the patient records (MT, MC, RB, SB). Study data were collected and managed using REDCap (Research Electronic Data Capture) electronic data capture tools hosted at Capital Region, Denmark. RStudio was used for statistical analysis (RStudio Team (2020). RStudio: Integrated Development for R. RStudio, PBC, Boston, MA).

Results

In the study period, 956 TURBT were identified. Two hundred and ninety-six patients were excluded (Figure 1). In total, 370 patients with 640 TURBT procedures were included in the cohort. The median follow-up time in months after the first TURBT procedure to study exit was 65 months (interquartile range = 17). Patient and procedure characteristics are summarised in Table 1.

The mean age at entry was 70.9 years (SD = 10.9), and most patients were men (79%). Procedures were primTURBT (48%), recTURBT (35%) and reTURBT (16%). Perioperative findings were a single tumour, multiple tumours or other (including flat lesions only or uncharacteristic lesions) in 49%, 31% and 21% of procedures, respectively. Tumour size was missing in the surgical report in almost half the cases (46%). A statement on resection completeness was missing in 56% of procedures. Postoperatively, the pathological findings included Ta, T1, muscle-invasive tumours, primary CIS, and benign findings in 61%, 10%, 5%, 2%, and 23%, respectively. The tumours were low-grade in 57% of procedures. DM was missing in 27% of procedures. The 30-day complication rate

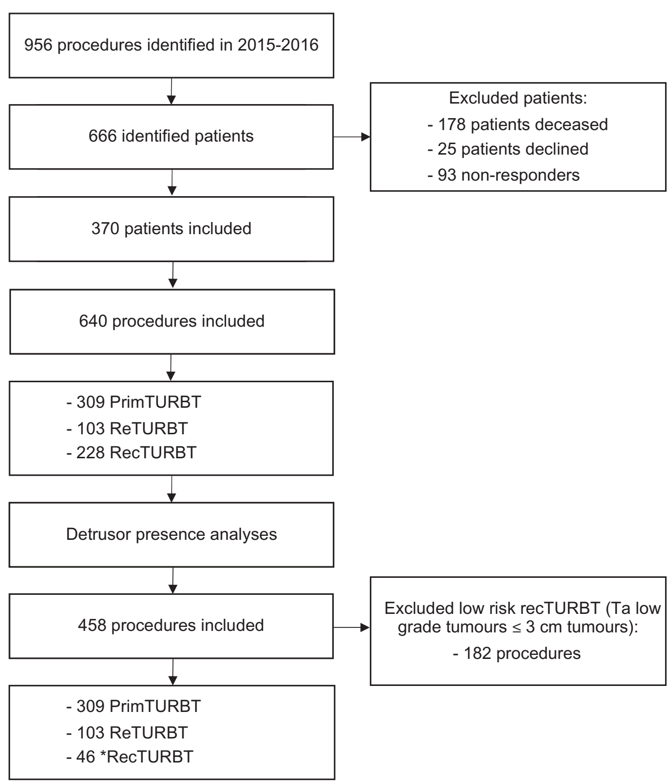

Figure 1. Flowchart of participant inclusion and final procedure inclusion for detrusor presences analyses.
PrimTURBT: Primary TURBT; ReTURBT: Repeated TURBT; RecTURBT: Recurrent TURBT; DM: Detrusor muscle. *Selected recTURBT including only procedures from the EAU NMIBC 2021 scoring model intermediate, high and very high risk groups.

Table 1. Baseline characteristics for patients, including all TURBT procedures ($n = 640$).

Variable	Level	Not supervised Junior residents ($n = 43$)	Supervised junior residents ($n = 159$)	Not supervised senior residents ($n = 158$)	Supervised senior residents ($n = 52$)	Consultants ($n = 228$)	Total ($n = 640$)	*p*-value
Age at entry								0.17
	Mean (SD)	71.4 (9.2)	71.4 (9.1)	72 (9.3)	68.3 (10.3)	70.4 (10.9)	70.9 (9.9)	
Sex								0.12
	Male (%)	39 (90.7)	119 (74.8)	126 (79.7)	45 (86.5)	177 (77.6)	506 (79.1)	
	Female (%)	4 (9.3)	40 (25.2)	32 (20.3)	7 (13.5)	51 (22.4)	134 (20.9)	
Procedure type								<0.001
	PrimTURBT (%)	18 (41.9)	58 (36.5)	80 (50.6)	27 (51.9)	126 (55.3)	309 (48.3)	
	ReTURBT (%)	5 (11.6)	15 (9.4)	27 (17.1)	13 (25.0)	43 (18.9)	103 (16.1)	
	RecTURBT (%)	20 (46.5)	86 (54.1)	51 (32.3)	12 (23.1)	59 (25.9)	228 (35.6)	
Tumour multiplicity								0.94
	1 (%)	24 (55.8)	73 (45.9)	83 (52.5)	25 (48.1)	106 (46.5)	311 (48.6)	
	>1 (%)	12 (27.9)	52 (32.7)	44 (27.8)	16 (30.8)	72 (31.6)	196 (30.6)	
	Not specified (%)	7 (16.3)	34 (21.4)	31 (19.6)	11 (21.2)	50 (21.9)	133 (20.8)	
Tumour size								0.02
	≤3 cm (%)	16 (37.2)	58 (36.5)	44 (27.8)	10 (19.2)	44 (19.3)	172 (26.9)	
	>3 cm (%)	5 (11.6)	7 (4.4)	10 (6.3)	6 (11.5)	19 (8.3)	47 (7.3)	
	Flat lesion (%)	9 (20.9)	31 (19.5)	28 (17.7)	11 (21.2)	50 (21.9)	129 (20.2)	
	Not specified (%)	13 (30.2)	63 (39.6)	76 (48.1)	25 (48.1)	115 (50.4)	292 (45.6)	
Macro-radical resection								<0.001
	Yes (%)	19 (44.2)	47 (29.6)	75 (47.5)	23 (44.2)	61 (26.8)	225 (35.2)	
	No (%)	2 (4.7)	12 (7.5)	14 (8.9)	8 (15.4)	19 (8.3)	55 (8.6)	
	Not described (%)	22 (51.2)	100 (62.9)	69 (43.7)	21 (40.4)	148 (64.9)	360 (56.2)	
Tumour stage*								0.27
	Ta (%)	22 (51.2)	93 (58.9)	96 (60.8)	26 (50.0)	151 (66.2)	388 (60.7)	
	T1 (%)	5 (11.6)	12 (7.6)	16 (10.1)	10 (19.2)	21 (9.2)	64 (10.0)	
	T2–T4 (%)	3 (7.0)	4 (2.5)	8 (5.1)	3 (5.8)	11 (4.8)	29 (4.5)	
	CIS (%)	2 (4.7)	2 (1.3)	4 (2.5)	1 (1.9)	3 (1.3)	12 (1.9)	
	Benign (%)	11 (25.6)	47 (29.7)	34 (21.5)	12 (23.1)	42 (18.4)	146 (22.8)	
Concomitant CIS								0.20
	Tx + CIS (%)	15 (6.6)	5 (11.6)	10 (6.3)	14 (8.9)	8 (15.4)	52 (8.1)	
Tumour grade								0.17
	Low grade (%)	18 (56.2)	71 (65.1)	65 (53.3)	17 (43.6)	104 (56.8)	275 (56.7)	
	High grade (%)	14 (43.8)	38 (34.9)	57 (46.7)	22 (56.4)	79 (43.2)	210 (43.3)	
	Missing (%)	11	50	36	13	45	155	
Detrusor muscle								<0.001
	Absent (%)	21 (48.8)	62 (39.0)	40 (25.3)	9 (17.3)	40 (17.5)	172 (26.9)	
	Present (%)	22 (51.2)	97 (61.0)	118 (74.7)	43 (82.7)	188 (82.5)	468 (73.1)	
Complication								0.23
	No (%)	39 (90.7)	131 (82.4)	129 (81.6)	45 (86.5)	177 (77.6)	521 (81.4)	
	Yes (%)	4 (9.3)	28 (17.6)	29 (18.4)	7 (13.5)	51 (22.4)	119 (18.6)	
Recurrence								0.036
	No (%)	17 (39.5)	74 (46.5)	88 (55.7)	30 (57.7)	96 (42.1)	305 (47.7)	
	Yes (%)	26 (60.5)	85 (53.5)	70 (44.3)	22 (42.3)	132 (57.9)	335 (52.3)	

*One T-stage missing for supervised junior residents.
SD: standard deviation; CIS: Carcinoma *in situ*; Tx + CIS: Any T-stage with concomitant CIS.

was 19%. Half of the patients (52%) had a recurrence in the follow-up period.

Detrusor muscle status

Detrusor muscle was analysed for primTURBT, reTURBT and selected recTURBT including only high grade and > 3 cm tumours (intermediate and high risk of progression to muscle invasive disease in EAU NMIBC 2021 scoring model) [13]. Detrusor muscle was present in 375/458 (81%) of the procedures (Table 2).

We performed a simple and multiple logistic regression adjusting for surgeon category, procedure type, tumour size, and tumour multiplicity. A tendency of lower detrusor muscle presence rate was identified for unsupervised junior residents (OR = 0.4, 95% CI = 0.14–1.15). This insignificant finding could be a type II error since only a few procedures were performed by unsupervised junior residents ($n = 26$). Detrusor muscle presence was significantly lower in supervised junior residents (73%) compared with consultants (83%) (OR = 0.4, 95% CI = 0.21–0.83). Unsupervised senior residents had an insignificantly lower detrusor muscle presence rate (OR = 0.6, 95% CI = 0.29–1.13) and tumour resections by supervised senior residents were comparable to procedures by consultants (OR = 1.0, 95% CI = 0.37–3.37) (Table 2).

Patients who underwent reTURBT had a significant increase in detrusor muscle presence and patients who underwent recTURBT had an insignificant decrease in detrusor muscle presence compared with primTURBT.

Table 2. Odds ratio for DM presence in the postoperative pathological report of 458 TURBT from a single centre database stratified by surgical type, tumour characteristics and surgeon category.

Variable	Level	Detrusor present ($n = 375$)	Detrusor absent ($n = 83$)	OR (95% CI)
Surgeon category	Consultants	158 (87.3)	23 (12.7)	1.0 (REF)
	Unsupervised Junior Residents	21 (75.0)	7 (25.0)	0.4 (0.1–1.2)
	Supervised Junior Residents	64 (72.7)	24 (27.3)	0.4 (0.2–0.8)
	Unsupervised Senior Residents	94 (79.7)	24 (20.3)	0.6 (0.3–1.1)
	Supervised Senior Residents	38 (88.4)	5 (11.6)	1.0 (0.4–3.4)
Procedure type	PrimTURBT	248 (80.3)	61 (19.7)	1.0 (REF)
	ReTURBT	98 (95.1)	5 (4.9)	6.2 (2.5–18.7)
	RecTURBT*	29 (63.0)	17 (37.0)	0.7 (0.3–1.4)
Tumour size	≤3 cm	94 (74.6)	32 (25.4)	1.0 (REF)
	>3 cm	43 (91.5)	4 (8.5)	3.8 (1.4–13.5)
	Flat lesion only	64 (75.3)	21 (24.7)	0.4 (0.1–1.0)
	Not specified	174 (87.0)	26 (13.0)	1.7 (1.0–3.2)
Tumour multiplicity	1	198 (83.9)	38 (16.1)	1.0 (REF)
	>1	101 (78.3)	28 (21.7)	0.7 (0.4–1.3)
	Not specified	76 (81.7)	17 (18.3)	1.1 (0.4–2.9)

Reference odds = 5.2 (2.7–10.2) in multiple logistic regression.
*Selected recTURBT including only procedures from the EAU NMIBC 2021 scoring model intermediate, high and very high risk groups.
OR: Odds ratio; REF: reference; PrimTURBT: Primary TURBT; ReTURBT: Repeated TURBT; RecTURBT: Recurrent TURBT.

Tumours >3 cm had a significantly higher odds ratio for detrusor muscle presence, compared with tumours ≤3 cm (Table 2).

Discussion

When supervised junior residents perform TURBT, the detrusor muscle presence in bladder tumour specimens is lower compared with patients treated by consultant surgeons. This is significant even after adjusting for surgery type (prim TURBT, reTURBT or selected recTURBT), tumour size and tumour count.

These findings are in line with previous studies. Mariappan et al. [1] highlighted in 2010 the importance of detrusor muscle presence in primTURBT specimens, effects on recurrence rates and also the differences in TURBT outcome when performed by junior doctors or senior doctors. Several studies have since reported higher recurrence rates, less detrusor presence and delayed time to cystectomy when residents performed the TURBT [14–16].

In 2020, Mariappan et al. [17] reported an insignificant difference in detrusor muscle presence between specialist trainees (75%) and consultants (78%) (OR = 1.21, 95% CI = 0.97–1.51). The specialist trainees were defined as residents with > 5 years of training. Mariappan et al. [17] state that all TURBT were carried out under supervision. Accordingly, our finding is in line, as the specialist training group corresponds to our group of supervised senior residents, with comparable detrusor muscle presence to the consultants (83% vs 82%, see Table 1).

The presence of detrusor muscle in primTURBT (80%) was comparable to previously reported cohorts. Mariappan et al. [17] reported a detrusor muscle presence of 77%. Ninety-five per cent of reTURBT had detrusor muscle presence, which is notably higher than reported by Blindheim et al. [18] (75%), Gendy et al. [19] (44%) and Herr and Donat [20] (66%). An explanation could be that senior residents and consultants performed 61% of the reTURBT in our study.

The overall recurrence rate (52%) was also comparable with other studies, with 62% (overall, median follow-up time 60 mounts) and 45% (recurrence rate at first follow-up cystoscopy) [14,21].

We found an increased risk of detrusor muscle absence when supervisor guided junior residents was compared with consultants. This is in line with a study in acute abdominal surgery which found that trainee participation was independently associated with adverse intra- and postoperative outcomes [22]. Kasotakis et al. [22] reported data from a cohort-mached study on surgical emergency procedures; patients whom trainees operated on had a longer hospital stay, higher blood transfusion rates, unplanned returns to the operating theatre and increased major postoperative complications.

TURBT has significant variation in complexity and the learning curve is equivalently long. Poletajew et al. [23] reported that the surgeon needs more than 100 supervised procedures to reach acceptable oncological outcomes. Roumiguié et al. [24] suggested a comprehensive complexity score to predict TURBT complexity prior to the procedure. Mostafid and Brausi [25] stressed the need for dedicated teaching programmes in TURBT and concluded that it was perhaps no longer acceptable for junior residents to perform unsupervised TURBT without adequate training.

In summary, supervision is an essential part of surgical training and ensures future high-quality surgeons. Nevertheless, the negative effects on patient outcomes by resident participation in TURBT highlights the necessity of preparing residents appropriately and ensuring surgical skills in patient-free environments prior to supervised procedures accordingly.

Needs assessment among Danish urological specialists and educators identified TURBT as one of the most-wanted procedures to learn by simulation-based training [26]. The positive effects of simulation training are well established compared with the classical apprenticeship [27] and further enhanced when applying deliberate, time-distributed and proficiency-based training designs [28,29]. However, a gap between evidence and clinical use remains. A simulator-based test in TURBT with validity evidence now exists which makes it possible to establish a mandatory training programme ensuring surgical skills before clinical performance on patients [30].

In the operating theatre, surgical training should continue to ensure surgical competence, based on proficiency-levels as well. However, direct observation assessment is a social and biased interaction, complexity of cases varies, definition of surgical quality is debatable [31] and reliable assessment tools with validity evidence are needed as the foundation of direct observations [32]. To overcome parts of these obstacles, a novel assessment tool for TURBT assessment was designed with validity evidence in accordance with Messick's framework of validity [33]. Standardised proficiency-based direct observations and video assessments with feedback could potentially improve patient-safety and oncological outcomes. Ultimately, it would be very interesting to see whether a mastery learning training programme with initial simulator-based training followed by supervised TURBT and video assessments could reduce or eliminate the negative impact of trainees on surgical results in the future. A simulator-based training curriculum has been implemented to support the classical apprenticeship at our institute and resulted in improved TURBT performance by novice doctors [34].

Our findings have several limitations. First, the study is limited by its retrospective nature. Second, the database included all TURBT procedures and not only primTURBT, which makes generalisability difficult. A recent study suggests that detrusor muscle presence can be omitted in primary TURBT of Ta low grade tumours [35]. Deep resections of recurrent small apparently low grade tumours in patients with a history of Ta low grade can be unjustified. Therefore, we excluded recTURBT procedures of Ta low grade and ≤ 3 cm tumours from the detrusor muscle analyses [12]. Third, 296 patients were excluded from the study according to Figure 1, which may affect the results, e.g. the rate of muscle-invasive bladder cancer is low in our cohort due to the participant selection (selection bias).

Conclusions

We find that supervised junior residents performing TURBT on patients have less detrusor muscle presence than consultants and that supervision of residents does not compensate for the lower level of experience.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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