

Cautery artifact understages urothelial cancer at initial transurethral resection of large bladder tumours

Matthew Truong, MD¹; Lorraine Liang, MD¹; Janet Kukreja, MD²; Jeanne O'Brien¹; Jerome Jean-Gilles, MD³; Edward Messing, MD¹

¹Department of Urology, University of Rochester Medical Centre, Rochester, NY; ²Department of Urology, MD Anderson, Houston, TX; ³Department of Pathology, University of Rochester Medical Centre, Rochester, NY; United States

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Abstract

Introduction: We sought to determine how frequently cautery (thermal) artifact precludes an accurate determination of stage at initial transurethral resection of bladder tumour (TURBT) of large bladder tumours.

Methods: We queried our institution's billing data to identify patients who underwent TURBT for large bladder tumours >5cm (CPT 52240) by two urologists at an academic centre from January 2009 through April 2013. Only patients who underwent initial-staging TURBT for urothelial cancer were included. Pathological reports were reviewed for stage, number of separate pathological specimens per TURBT, and presence of cautery artifact. Operative reports were reviewed for whether additional cold cup biopsies were taken of other suspicious areas of the bladder, resident involvement, and type of electrocautery.

Results: We identified 119 patients who underwent initial staging TURBT for large tumours. Cautery artifact interfered with accurate staging in 7/119 (6%) of cases. Of these, six patients underwent restaging TURBT, with 50% percent experiencing upstaging to T2 disease. Tumour size, tumour grade, whether additional cold cup biopsies were taken, number of separate pathological specimens sent, and resident involvement were not associated with cautery artifact (all $p>0.05$). Bipolar resection had a higher rate of cautery artifact 5/42 (12%), compared to monopolar resection 2/77 (2.6%) approaching significance ($p=0.095$).

Conclusions: Cautery artifact may delay accurate staging at initial TURBT for large tumours by understaging up to 6% of patients.

Introduction

In 2014, there were 74 690 new cases of urothelial cancer (UC) of the bladder diagnosed in the U.S.¹ Transurethral resection of bladder tumour (TURBT) is the initial treatment for virtually all bladder cancers and provides valuable staging information. An accurate determination of muscularis

propria invasion (T2 disease) or even lamina propria invasion (T1 disease) is critical information for optimizing treatment and surveillance. Currently, monopolar and bipolar electrocautery are used for endoscopic management of bladder lesions. A disadvantage of electrosurgical techniques is the creation of cautery artifact or thermal damage to tissues, which can hinder accurate histological staging.^{2,3}

Cautery artifact has been previously defined as distorted tissue with swelling and homogenation of connective tissue fibers, vacuolization, and blurring of nuclei.² Cautery artifact can be seen in virtually all pathological specimens when monopolar or bipolar electrocautery is used for TURBT, but can vary in severity. The rates of reported cautery artifact varied dramatically in previous studies, ranging from 25–66% of cases.^{2,4,5} Large tumours have been found to incur more cautery artifact during TURBT.⁶

Inaccuracies in bladder cancer staging at initial TURBT can delay diagnosis and treatment. Currently, it is not known whether cautery artifact can interfere with pathological staging at the time of initial TURBT. The primary objectives of this study are: 1) to determine how frequently cautery artifact affects staging in patients who undergo large TURBT for UC; and 2) to identify any technical factors that may be associated with cautery artifact.

Methods

After institutional review board approval, institutional billing data was queried to identify patients who underwent initial staging TURBTs for large bladder tumours >5cm (CPT 52240) by two urologists at an academic centre from January 2009 through April 2013. One surgeon will frequently obtain additional cold cup biopsies of the tumour base whereas the other surgeon solely uses the resectoscope to obtain tissue. In addition, small tumours were not analyzed because they were primarily resected using cold cup forceps.

A total of 371 large TURBT cases were identified using billing codes. Given wide variations in the method of resec-

tion and tumour characteristics, strict inclusion criteria were required for this study. Patients who underwent the following TURBTs were excluded: 1) TURBTs that did not identify malignancy (nephrogenic adenoma, polypoid cystitis, cystitic glandularis, or chronic inflammation); 2) TURBTs that identified malignancy other than UC (prostate adenocarcinoma, squamous cell carcinoma, bladder adenocarcinoma, lymphoma, etc.); 3) TURBTs that involved large lawns of suspected carcinoma in situ (CIS) or superficial-appearing papillary growths, since suspicious areas were only fulgurated and not resected using electrocautery; and 4) TURBTs that were re-resections after initial TURBT, since significant necrotic tissue may be present in these specimens.

Monopolar resection was performed with the 24 or 27 Fr Storz regular or ultralong resectoscope using water (or glycine) irrigation with cutting and coagulation settings of 35–60 W and 30–50 W, respectively. Bipolar resection was performed with the 26 Fr Olympus resectoscope using saline irrigation, with cutting and coagulation settings of 200–280 W and 140–200 W, respectively. Operative reports were reviewed for surgeon, resident involvement, the type of electrocautery used, tumour size, and whether additional cold cup biopsies were taken.

Pathology reports were reviewed for grade, depth of invasion, number of separate pathological specimens per TURBT, and presence of cautery artifact. Retrospective chart review of pathological reports was conducted to identify cases in which the pathologist was unable to accurately stage the cancer due to cautery artifact. Cases were re-reviewed by a single genitourinary pathologist to verify that the cautery artifact indeed precluded an accurate determination of stage. Pathological reports of patients who experienced significant cautery artifact on initial TURBT were reviewed for upstaging on subsequent TURBT.

Univariable analysis of categorical variables was performed using Chi-square tests. Univariable analysis of continuous variables was performed using a t-test. All tests were two-tailed and a p value <0.05 was considered statistically significant. All statistical analyses were performed using SPSS Statistical Software Version 10 (IBM, Armonk, NY, U.S).

Results

After query of our institution’s billing data, we identified 119 patients who had undergone a large TURBT for UC and met the inclusion criteria for this study. Cautery artifact interfered with the diagnosis of stage in 7/119 (6%) of patients (Table 1). Six of these seven patients (86%) underwent restaging TURBT. Among those who underwent restaging TURBT, 3/6 (50%) experienced upgrading to T2 disease. Most often, cautery artifact interfered with the determination of muscularis invasion, and less often, lamina propria invasion. Grade determination was not impacted by cautery artifact.

The average tumour size, estimated by the diameter of the resectoscope sheath equaling about 1 cm, was 7.8 cm. Tumour size did not predict the presence of cautery artifact (p=0.65). Most tumours resected were high-grade (72%). Although cautery artifact was seen only in cases involving high-grade tumours, grade was not a statistically significant predictor of cautery artifact (p=0.19). Whether additional cold cup biopsies were taken of other suspicious areas in the bladder and number of separate specimens sent did not influence cautery artifact (all p>0.05). Both surgeons experienced similar rates of cautery artifact (p=0.81). Residents were involved in 78% of all cases, but did not influence the rate of cautery artifact (p=0.35). Bipolar resection had a higher rate of cautery artifact 5/42 (12%) compared to monopolar resection 2/77 (2.6%), approaching significance (p=0.095). Table 2 summarizes predictors of clinically significant cautery artifact

Discussion

In this study, cautery artifact prevented accurate staging in up to 6% of patients who underwent initial staging TURBT for large tumours. Cautery artifact can obscure the ability to determine lamina propria or muscularis propria invasion (Fig. 1), but more frequently affected determination of muscularis invasion. We did not identify any cases in which cautery artifact resulted in overstaging of tumours. When significant cautery artifact is present, 50% of patients were understaged, which poses a greater problem for the

Table 1. Characteristics of patients with indeterminate stage initial TURBT (>5 cm) due to cautery artifact

Patient	Age at diagnosis	Pathology at initial TURBT	Surgical management	Subsequent pathology	Followup time (months)	Status at most recent followup
1	91	Ta, unable to determine lamina invasion	Restaging TURBT	Ta	28	Alive
2	66	T1, unable to determine muscularis invasion	Restaging TURBT	T0	72	Alive
3	82	T1, unable to determine muscularis invasion	Restaging TURBT	T2	18	Deceased
4	81	T1, unable to determine muscularis invasion	Restaging TURBT	T2	25	Deceased
5	63	Tis, unable to determine muscularis invasion	Cystectomy	TisN0Mx	47	Alive
6	76	T1, unable to determine muscularis invasion	Restaging TURBT	T0	58	Alive
7	92	T1, unable to determine muscularis invasion	Restaging TURBT	T2	0	Lost to followup

TURBT: transurethral resection of bladder tumour.

Table 2. Predictors of clinically significant cautery artifact

Variable	No cautery artifact	Cautery artifact	p
Tumour size (cm)			0.65
Mean (SD)	7.7 (2.9)	8.2 (3.2)	
Grade			0.19
Low	33 (29%)	0 (0%)	
High	79 (71%)	7 (100%)	
Additional cold cup biopsies taken			0.71
No	60 (53%)	3 (43%)	
Yes	40 (46%)	4 (57%)	
No of separate specimens sent			0.53
Mean (SD)	2.5 (2)	2 (0.8)	
Surgeon			0.81
1	92 (82%)	6 (86%)	
2	20 (18%)	1 (14%)	
Resident involved			0.35
No	25 (22%)	3 (43%)	
Yes	87 (78%)	4 (57%)	
Electrocautery type			0.095
Monopolar	75 (67%)	2 (29%)	
Bipolar	37 (33%)	5 (71%)	

SD: standard deviation.

patient than overstaging. The rates of cautery artifact were not statistically significant comparing bipolar and monopolar resection. However, given that the amount of energy varied, it is unclear whether the type electrocautery inherently influenced the degree of cautery artifact.

To our knowledge, this is the first study to characterize the effects of cautery artifact on accurate pathological staging. Previous studies have reported the presence of cautery artifact in TURBT specimens with use of monopolar and bipolar devices. One study observed cautery artifact in 66% of cases, but did not mention whether artifact adversely affected the elements of diagnosis or staging.⁵ In a study composed of 26 patients, the pathologist was unable to determine the

depth of invasion in two cases, but this was primarily due to limited sampling (specimen was <3 mm) rather than the degree thermal damage.² One study involving 11 patients who underwent TURBT with bipolar electrocautery claimed that the pathologist had no difficulty correctly grading and staging all tumours despite the presence of cautery artifact.⁶ However, these studies were small and comprised mainly of TURBTs of small (0.5 up to 2 cm) and medium-sized (2.0 up to 5 cm) tumours, which were probably subjected to less thermal energy compared to large tumours (>5 cm).

Previous authors have suggested that cautery artifact can vary depending on surgeon and technical skill.² In this study, resident involvement did not appear to influence the rate of cautery artifact, but we could not accurately quantify how much of the resection was performed by the resident vs. the attending surgeon. Energy settings can also play a role and would be of interest for a future study. Finally, taking several separate cold cup biopsy at the base of the tumour containing muscle could theoretically eliminate the damaging effects of cautery artifact, but this was not evaluated in our study since the locations of cold cup biopsies were not standardized.

The main limitations of this study include its single institution and inclusion of only large tumours. At our institution, small tumours were typically resected using cold cup forceps given our belief that small tumours are most often susceptible to cauterization artifact. Thus, we were unable to examine the effects of electrocautery on smaller tumours, and this will limit the generalizability of our findings. Another potential limitation is that energy settings may vary, and thus the observed degree cautery artifact may be institution-dependent. Furthermore, the impact of cautery artifact may be underestimated by this study. It is conceivable that other tumours were understaged without the pathologist recognizing that cautery artifact had played a role. A prospective study would be needed to more accurately determine the frequency of understaging due to cautery artifact.

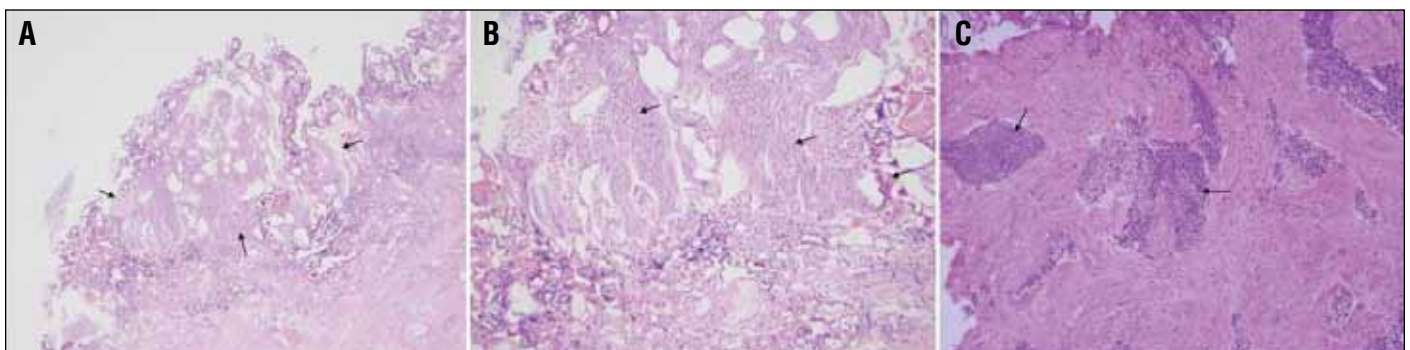


Fig. 1 (A) High-power view of the cautery damage demonstrating the distorted tissue with homogenization of the connective tissue, vacuolization and blurring of nuclei (arrows) (hematoxylin and eosin [H&E], original magnification x 100); (B) cautery damage (arrows) affecting the neoplastic papillary urothelium and the underlying lamina propria (H&E, original magnification x 40); and (C) severe cautery damage resulting in tissue infarction (arrows) that can preclude characterization of muscularis invasion (H&E, original magnification x 100).

Missing muscle invasion on initial staging TURBT can carry high morbidity and costs.⁷ We demonstrate that cautery artifact poses a problem for accurate staging urothelial cancer by obscuring the presence of muscularis invasion. While many large tumours will undergo a “second-look TURBT” for removal of residual tumour, obtaining a diagnosis of muscularis invasion at initial TURBT can be advantageous for counselling patients and avoiding delays in providing more definitive treatment.

Conclusion

In this study, a total of seven out of 119 patients were not accurately staged after initial TURBT for large bladder tumours due to significant cautery artifact. At the surgeon’s discretion, reduction in time of contact of the cutting element with tissue, use of the lowest energy settings possible while still allowing for an adequate resection, and submitting separate cold cup biopsies at the base of tumour may aid the pathologist in reducing inaccuracies in staging. Although cautery artifact is a widely recognized phenomenon by urologists and pathologists, understaging of bladder tumours due to cautery artifact may be previously underestimated.

Competing interests: The authors report no competing personal or financial interests.

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Correspondence: Dr. Matthew Truong, Department of Urology, University of Rochester School of Medicine and Dentistry, Rochester, NY, United States; matthew_truong@urmc.rochester.edu