BJU Int 2023 doi:10.1111/bju.16223

BJUI
BJU International

Research Letter

Positive surgical margins in partial nephrectomy: a collaborative effort to maintain surgical quality

Partial nephrectomy (PN) has been recognised as the 'gold standard' for management of small renal masses, with equivalent oncological outcomes and superior functional outcomes compared to radical nephrectomy. However, PN carries a risk of positive surgical margin (PSM) that is often used as a surrogate of incomplete oncological control. PSM rates have been documented to be between 2% and 8% for PN [1]. The impact of PSMs on oncological and survival outcomes is controversial [2–5]. Some studies have suggested local recurrence to be more likely in patients with PSM, which may lead to increased intensity of surveillance [2,3]. Moreover, a PSM may increase patient anxiety, as has been demonstrated with prostate cancer.

The Michigan Urological Surgery Improvement Collaborative-Kidney mass: Identifying and Defining Necessary Evaluation and therapY (MUSIC-KIDNEY) is a statewide quality improvement (QI) initiative focused on improving care for patients with clinical stage T1 renal masses (cT1RM) [6]. The MUSIC-KIDNEY offers a unique opportunity to evaluate and improve rates of PSM by use of specific QI interventions discussed at regular collaborative-wide meetings. Prior literature has shown various patient, tumour, and surgical factors to be associated with PSM rates [1–3]. Our aim is to further investigate the influence of practice-level variation, patient, and tumour factors on PSM rates in the MUSIC-KIDNEY cohort.

The MUSIC-KIDNEY commenced prospective data collection in June 2017 with >150 urologists. The registry now includes >5000 patients with newly diagnosed cT1RM. Data abstractors record 122 clinical data points for each patient at least 120 days after initial consultation with subsequent data collection annually. We examined PSM rates for patients undergoing PN from May 2017 to August 2022 and associations with practice, patient, and perioperative factors.

All patients diagnosed with cT1RM who had undergone PN within the study period have been included, other than patients aged <18 years, those having imaging-determined benign lesions (Bosniak I, II, and IIF cysts, and angiomyolipomas), and when surgical margin status was not available. The following variables were extracted for each patient: age, gender, Charlson Comorbidity Index, race, estimated GFR, body mass index, tumour size, tumour nephrometry (R.E.N.A.L. [Radius, Exophytic/Endophytic, Nearness, Anterior/Posterior, Location]) score, and PSM rates. The R.E.N.A.L. nephrometry scores and surgical approach were collected as documented by the treating urologist in their clinical notes. Practice variation in rates of PSM, practice type, and annual practice volume were assessed.

Practice volume reflects the number of PNs performed at each centre. A practice volume of ≤20 was categorised as low volume, while >20 was categorised as high volume; this threshold was predetermined and consistently used across the MUSIC-KIDNEY studies. Statistical analysis was performed utilising a multivariable logistic regression model to identify factors associated with PSM. Analyses were performed utilising the Statistical Analysis System (SAS) version 9.4 (SAS Institute Inc., Cary, NC, USA) and statistical significance was set at $P < 0.05$.

A total of 1142 patients underwent PN in 14 MUSIC-KIDNEY practices for cT1RM. The median (interquartile range [IQR]) age was 59 (49–67) years, and the median (IQR) tumour size was 2.9 (2.1–3.8) cm; 20.5% were stage T1b tumours. R.E.N.A.L. nephrometry scores were documented for 55.9% of patients; of these, 44.3% of the R.E.N.A.L. nephrometry scores were 4–6, 47.8% were 7–9, and 7.8% were ≥10 (Table 1). The overall rate of PSM in the MUSIC-KIDNEY practices was 6.7%. The endophytic component (E) of the R.E.N.A.L. nephrometry score ($P = 0.014$), surgical approach ($P < 0.001$), and annual practice volume of ≤20 ($P < 0.001$) were independently associated with PSM (Table 1). On multivariable analysis, only annual practice volume was significantly associated with PSM (odds ratio 0.96, 95% CI 0.94–0.98, $P < 0.001$). No other differences in patient, tumour, or surgical factors were significant. Wide variation in the rate of PSM was noted between practices, ranging from 1% to 24% (Figure S1). When examining individual practice characteristics, practices that are academic or hybrid with PN volume of >100 had PSM rates of <10%. Among patients with ≥1 year of follow-up ($n = 1094$), the median (IQR) number of surveillance scans per year for those with PSM was 0.77 (0.47–1.26) compared to 0.75 (0.38–1.17) for those with negative margins ($P = 0.34$ from Wilcoxon rank-sum test).

Our finding corroborates prior literature demonstrating that high-volume centres have lower rates of PSM following PN [7]. Although PN is now performed routinely for small, low complexity tumours, PN for large and/or anatomically complex tumours is a more challenging task. Removal of completely endophytic tumours demands a high level of expertise, as attested to in several single-centre series [8]. While these findings may support the centralisation of care to high-volume centres, real-world practice may not always reflect this, and access to tertiary care centres is not universal. Although similar results have been previously published, our study through the MUSIC-KIDNEY is the first in

Published by John Wiley & Sons Ltd. www.bjui.org

Table 1 Patient, tumour, and practice factors associated with PSM.

Variable	All cT1RM patients undergoing PN	PSM		*P*
		No	Yes	
Age, years, median (IQR)	59 (49–67)	59 (49–67)	60 (47–68)	0.76
Sex, *n* (%)				
Male	707 (61.9)	657 (92.9)	50 (7.1)	0.47
Female	435 (38.1)	409 (94.0)	26 (6.0)	
Race, *n* (%)				
White	902 (79.0)	839 (93.0)	63 (7.0)	0.67
African American	120 (10.5)	113 (94.2)	7 (5.8)	
Other/Unknown	120 (10.5)	114 (95.0)	6 (5.0)	
Body mass index, kg/m^2, *n* (%)				
<25	157 (13.7)	149 (94.9)	8 (5.1)	0.38
≥25	974 (85.3)	906 (93.0)	68 (7.0)	
Charlson Comorbidity Index, *n* (%)				
0	678 (59.4)	631 (93.1)	47 (6.9)	0.91
1	224 (19.6)	210 (93.8)	14 (6.3)	
≥2	239 (20.9)	224 (93.7)	15 (6.3)	
Preoperative GFR, mL/min/1.73 m^2, *n* (%)				
≤60	154 (13.5)	144 (93.5)	10 (6.5)	0.78
>60	838 (73.4)	784 (93.6)	54 (6.4)	
Unknown/not performed	150 (13.1)	138 (92.0)	12 (8.0)	
Tumour size, cm, median (IQR)	2.9 (2.1–3.8)	2.9 (2.1–3.9)	2.7 (2.0–3.5)	0.18
Clinical tumour stage, *n* (%)				
T1a	908 (79.5)	843 (92.8)	65 (7.2)	0.18
T1b	234 (20.5)	223 (95.3)	11 (4.7)	
R.E.N.A.L. nephrometry score, *n* (%)				
Low	283 (24.8)	267 (94.3)	16 (5.7)	0.86
Intermediate	305 (26.7)	283 (92.8)	22 (7.2)	
High	50 (4.4)	46 (92.0)	4 (8.0)	
Unknown	504 (44.1)	470 (93.3)	34 (6.7)	
Endophytic component (E) of R.E.N.A.L. score, *n* (%)				
1–2	586 (84.8)	548 (93.5)	38 (6.5)	**0.014**
3	105 (15.2)	91 (86.7)	14 (13.3)	
Surgical approach, *n* (%)				
Robotic	1036 (90.7)	964 (93.0)	72 (7.0)	**<0.001**
Laparoscopic	52 (4.6)	51 (98.1)	1 (1.9)	
Open	54 (4.7)	51 (94.4)	3 (5.6)	
Practice annualised PN volume, *n* (%)				
≤20	217 (19.1)	186 (85.7)	31 (14.3)	**<0.001**
>20	919 (80.1)	876 (95.3)	43 (4.7)	
Practice type, *n* (%)				
Academic	311 (27.2)	305 (98.1)	6 (1.9)	0.46
Hybrid	771 (67.5)	712 (92.3)	59 (7.7)	
Community/private	60 (5.3)	49 (82.0)	11 (18.0)	

Bold values statistically significant at P < 0.05.

our knowledge to uniquely describe current practice patterns and outcomes in an entire State across academic, hybrid, and community institutions. The MUSIC-KIDNEY also brings this information to the urologists' themselves, and then implement steps to drive QI in outcomes, such as improvement in PSM rates, as a collaborative.

To date, we have attempted to impact PSM rates on two levels. On a micro-level, tri-annual reports are delivered to individual surgeons to allow them to compare their individual and institution's rates to others in the State of Michigan anonymously. This allows surgeons to reflect upon and improve their own quality of surgical care by participation in our workshops and QI projects or other ways of their choosing, such as review of PN videos. A limitation of our study is that R.E.N.A.L. nephrometry scores were missing in 44.1% of patients. To encourage documentation of nephrometry scores, the surgeons in the collaborative were provided a note template that includes R.E.N.A.L. nephrometry scores and practices were given placards to post in clinic explaining a simple modified method of R.E.N.A.L. nephrometry scoring. This remains an ongoing QI practice in our collaborative. On a macro-level, we held a virtual skills workshop to disseminate information regarding technique by skilled surgeons with lower rates of PSM and how they approach PN in general and particularly for challenging tumours. Importantly, we focused on endophytic tumours with in-depth discussion of technique and tools, such as intraoperative ultrasound. The MUSIC includes diverse practice patterns, and some surgeons may not routinely utilise

intraoperative ultrasound if a portion of the tumour can be identified, even for partially endophytic tumours. During the skills workshop, we discussed intraoperative ultrasound technique with different types of ultrasounds and tumours. We subsequently conducted a live skills session consisting of peer-to-peer discussion of PN technique observed on surgeon-submitted videos. We recently conducted a review of 28 PN videos submitted by the MUSIC-KIDNEY surgeons with provision of formal feedback from peer reviewers. Additionally in a future collaborative-wide meeting, we are planning to discuss the impact of pathology reporting practices on PSM rates; we believe increased collaboration will improve understanding between surgeons and pathologists, leading to decreased PSM rates. Although we did not note a significant difference in follow-up imaging after PSM, surveillance imaging may increase in frequency according to AUA guidelines, revealing another area for future QI initiatives. We will assess the long-term impact of our QI interventions and investigate additional surgeon-specific and institutional factors that may drive continued variation.

For patients undergoing PN, the regular use of ultrasound during planning and resection of endophytic tumours, potential use of three-dimensional models for more complex tumours, and referral of more challenging cases to higher volume surgeons may improve PSM rates. Further, within the MUSIC-KIDNEY we have reported that active surveillance is commonly applied to patients with cT1RM, including any patient with a tumour of <2 cm, and for selected patients with larger tumours, finding this approach to be safe and effective [6]. Most importantly, we hope this report of the initial steps MUSIC-KIDNEY has taken to address PSM rates with PN will help encourage urological surgeons to critically consider the elements of their surgical approach, refine their technical skills, and consequently achieve an improved PSM rate.

Funding

Funding was provided in part by Blue Cross Blue Shield of Michigan.

Disclosure of Interests

The authors have no conflicts of interest.

Mohit Butaney[1], Samantha Wilder[1], Yuzhi Wang[1], Sonia Bhayani[1], Ji Qi[2], Monica Van Till[2], Mahin Mirza[2], Anna Johnson[2], Sara Perkins[1], Sabrina Noyes[3], Alon Weizer[2], Lewis Johnson[4], Amit Patel[1], Alice Semerjian[5], Brian R. Lane[3,6], Craig Rogers[1]

and for the Michigan Urological Surgery Improvement Collaborative

[1]Vattikuti Urology Institute, Henry Ford Health, Detroit, [2]Department of Urology, University of Michigan Medical School, Ann Arbor, [3]Corewell Health Hospital System, Grand Rapids, [4]Bronson Urology and Continence Specialists, Kalamazoo, [5]IHA Urology, St. Joseph Mercy Hospital, Ann Arbor, and [6]Michigan State University College of Human Medicine, Grand Rapids, MI, USA

References

1 **Tabayoyong W, Abouassaly R, Kiechle JE et al.** Variation in surgical margin status by surgical approach among patients undergoing partial nephrectomy for small renal masses. *J Urol* 2015; 194: 1548–53

2 **Khalifeh A, Kaouk JH, Bhayani S et al.** Positive surgical margins in robot-assisted partial nephrectomy: a multi-institutional analysis of oncologic outcomes (leave no tumor behind). *J Urol* 2013; 190: 1674–9

3 **Shah PH, Moreira DM, Okhunov Z et al.** Positive surgical margins increase risk of recurrence after partial nephrectomy for high risk renal tumors. *J Urol* 2016; 196: 327–34

4 **Maurice MJ, Zhu H, Kim SP, Abouassaly R.** Reexamining the association between positive surgical margins and survival after partial nephrectomy in a large American cohort. *J Endourol* 2016; 30: 698–703

5 **Yossepowitch O, Thompson RH, Leibovich BC et al.** Positive surgical margins at partial nephrectomy: predictors and oncological outcomes. *J Urol* 2008; 179: 2158–63

6 **Patel AK, Rogers CG, Johnson A et al.** Initial observation of a large proportion of patients presenting with clinical stage T1 renal masses: results from the MUSIC-KIDNEY statewide collaborative. *Eur Urol Open Sci* 2021; 23: 13–9

7 **Xia L, Pulido JE, Chelluri RR et al.** Hospital volume and outcomes of robot-assisted partial nephrectomy. *BJU Int* 2018; 121: 900–7

8 **Perez-Ardavin J, Sanchez-Gonzalez JV, Martinez-Sarmiento M et al.** Surgical treatment of completely endophytic renal tumor: a systematic review. *Curr Urol Rep* 2019; 20: 3

Correspondence: Craig G. Rogers, Vattikuti Urology Institute, Henry Ford Health, 2799 W Grand Blvd, Detroit, MI 48202, USA.

e-mail: crogers2@hfhs.org

Abbreviations: cT1RM, clinical stage T1 renal masses; IQR, interquartile range; MUSIC-KIDNEY, Michigan Urological Surgery Improvement Collaborative-Kidney mass: Identifying and Defining Necessary Evaluation and therapY; PN, partial nephrectomy; PSM, positive surgical margin; QI, quality improvement; R.E.N.A.L., Radius, Exophytic/Endophytic, Nearness, Anterior/Posterior, Location.

Supporting Information

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

Figure S1. Practice-level rate of PSMs after PN for the nine practices that have ≥10 PNs. Each bubble represents a single MUSIC practice; the size of each circle correlates with the number of cases.