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ORIGINAL ARTICLE

Practice patterns and outcomes of urgent versus elective ureteroscopy in a statewide surgical collaborative

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Abstract

Purpose Urgent indications for nephrolithiasis treatment include obstruction with intractable pain or renal impairment without untreated infection. Patients and hospitals may benefit from urgent primary ureteroscopy. We aimed to examine variation in urgent ureteroscopy utilization and associated outcomes.

Methods Using Reducing Operative Complications from Kidney Stones (ROCKS), we identified all ureteroscopy's between 2016 and 2019. Cases were classified by acuity (elective versus urgent). We assessed practice/urologist variation in urgent ureteroscopy performance. We characterized patients demographic, operative and outcomes data, making bivariate comparisons with elective ureteroscopy to understand implications of urgent surgery. We performed multilevel modeling to understand factors associated with unplanned healthcare encounters after urgent ureteroscopy.

Results 12,859 cases were identified from 33 practices and 204 urologists, 10,854 (84.4%) elective and 2005 (15.6%) urgent. Urgent ureteroscopy was performed on younger patients (53 vs 57, $p < 0.001$), with higher rates of ureteral stones (72.8% vs 56.8%, $p < 0.001$). Urgent ureteroscopy rates varied widely by practice (2–70%) and urologist (0–98%). Urgent ureteroscopy had higher stenting rates (77.4% vs 72.5%, $p < 0.001$), stone free rates (66% vs 58.4%, $p < 0.001$), and postoperative ED visits (11% vs 7.2%, $p < 0.001$). There were no differences in intraoperative complications or unplanned hospitalizations. Factors predictive of ED visits in urgent ureteroscopy included concomitant ureteral/renal stone location (OR = 1.53, CI = 1.05–2.23, $p = 0.035$).

Conclusions In Michigan elective ureteroscopy is performed 5 times more frequently than urgent ureteroscopy with wide variation. Urgent ureteroscopy demonstrated low morbidity. Urgent ureteroscopy produced modestly higher stone free rates with a slightly increased frequency of unscheduled ED visits particularly for ureteral stones.

Keywords Nephrolithiasis · Ureteral stent · Ureteroscopy · Quality improvement

Abbreviations

USD	Urinary Stone Disease
AUA	American Urological Association
MUSIC	Michigan Urological Surgery Improvement Collaborative
ROCKS	Reducing Operative Complications from Kidney Stones
ED	Emergency Department
SFR	Stone Free Rate
CCI	Charlson Comorbidity Index
EAU	European Association of Urology

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Introduction

Surgical intervention is indicated for urinary stone disease (USD) in patients with worsening renal function, high-grade obstruction, bilateral obstruction, solitary kidney,

abnormal anatomy, large stone burden, and/or failed previously attempted conservative management [1]. According to the American Urological Association (AUA) guidelines, patients eligible for ureteroscopy with stone treatment that have obstruction and evidence of infection should have collecting system drainage established urgently [1]. Thus, delaying definitive management until urinary drainage is accomplished and the infection is treated. For other urgent ureteroscopy indications, including renal impairment, severe pain or inability to tolerate oral intake, the use of primary ureteroscopy with stone treatment is less established.

Collecting system drainage is the standard treatment for urinary infection and obstruction due to the risk of sepsis [1, 2], but definitive management may be delayed for reasons other than untreated infection. Patient safety concerns, expected odds of spontaneous stone passage, timing of presentation, resource availability, urologist availability and presenting practices may contribute to the decision to delay definitive stone treatment. However, it has been suggested that delayed definitive treatment may be unnecessary [3]. Patients, physicians, and hospitals may benefit from standardized urgent primary ureteroscopy to reduce morbidity, limit costs and improve patient quality of life by limiting the number of procedures required and indwelling stent time [4, 5]. While appealing, the safety and efficacy of this approach to treatment unfortunately lacks robust guiding evidence. Moreover, little is known about the current application and utilization of urgent ureteroscopy.

We, thus, used data from the Michigan Urological Surgery Improvement Collaborative's (MUSIC) Reducing Operative Complications from Kidney Stones (ROCKS) registry to understand the current utilization and outcomes of urgent ureteroscopy. We investigated the rates, clinical characteristics, practice and urologist variation, and outcomes of urgent ureteroscopy in hopes of understanding the safety and feasibility of this practice as compared to elective ureteroscopy in the broad urological clinical landscape in the state of Michigan. We hope that these data could help urologists in determining which patient's urgent ureteroscopy may be most appropriately performed.

Methods

Data source

MUSIC was established in 2011 in partnership with Blue Cross Blue Shield of Michigan. The ROCKS initiative was started in 2016 and currently comprises 38 community and academic urology practices in the state. ROCKS maintains a clinical registry of ureteroscopy and shockwave lithotripsy procedures performed by these practices and urologists in hospitals and ambulatory surgery centers, regardless of insurance type or status. Trained abstractors prospectively and independently record standardized data elements including patient, stone, procedural and postoperative care data 60 days after the procedure in a web-based registry by chart review, as described previously [6]. Stone size is determined by maximal diameter on preoperative imaging and location is determined by report on preoperative imaging. Case acuity is defined by time between ureteroscopy and emergency department (ED) visit with urgent cases are defined as ureteroscopy performed within 48 h. Intraoperative complications, unplanned healthcare encounters within 30 days and imaging results within 60 days of the procedure are recorded. Complication is defined by operative report review and stone free rate (SFR) is defined as the absence of residual stone on postoperative imaging. Each MUSIC practice has obtained an exemption or approval by the local institutional review board for participation in the collaborative.

Study population

All ureteroscopy performed on patients ≥ 18 years old by participating practices from June 2016 to December 2019 were identified. Patients with synchronous bilateral procedures, concomitant non-stone related surgery, staged ureteroscopy or ureteroscopy as a secondary procedure after percutaneous nephrolithotomy were excluded. Cases were classified according to urgent versus elective acuity.

Outcomes and statistical analysis

We characterized both urgent and elective cases across a range of demographic, clinical and surgical measures. We characterized patient demographic, operative and outcomes data and made bivariate comparisons between urgent versus elective cases. Demographic factors included age, gender and insurance type. Clinical factors included body mass index, Charlson comorbidity index (CCI) [7], urine culture (positive, negative, not performed), presence of preoperative hydronephrosis, presence of an indwelling stent (presented), preoperative alpha-blocker therapy, preoperative antiplatelet therapy, stone size ($\leq 5, > 5$ to $\leq 10, > 10$ mm), stone location (renal, ureteral, both), and surgeon urgent case volume (< 5, 5–9, or ≥ 10 urgent procedures). We further examined stone location within the ureter, including: ureteropelvic junction, upper/proximal/mid ureter, lower/distal ureter and ureterovesical junction. Surgical factors included the occurrence of an intraoperative complication, intraoperative ureteral stent placement, and discharge medications (alpha-blockers, opioids). Outcome measures included occurrences of an unplanned clinic visit, postoperative ED visit, unplanned postoperative hospitalization, receipt of

postoperative imaging and SFR. Categorical variables were compared using chi-square tests, and continuous variables were compared using a t-test or Wilcoxon rank-sum.

We assessed overall rates, as well as practice and urologist frequency in the performance of urgent ureteroscopy. Variation in practice and urologist performance of urgent ureteroscopy was evaluated.

We performed multivariable logistic regression with fixed effects of age, gender, insurance, antiplatelet/anticoagulation, preoperative alpha-blocker, urine culture results, preoperative hydronephrosis, stone size, stone location, stent placement, alpha-blocker prescription, and surgeon urgent case volume and a random intercept for correlation within practice and urologist to understand factors associated with postoperative ED visits for urgent ureteroscopy cases. We performed 2-sided significance testing and with a type-I error rate of 0.05. Statistical analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, NC).

Results

A total of 12,859 ureteroscopies from 33 practices and 204 urologists were identified. 2005 (15.6%) were urgent and 10,854 (84.4%) were elective. Bivariate analysis in Table 1 demonstrates that urgent cases, compared to elective, were performed on younger patients (53 vs 57, $p < 0.001$) with lower CCI, lower rates of positive urine studies (9.8% vs 12.8%, $p < 0.001$), smaller stone sizes, higher proportions of ureteral stones overall (72.8% vs 56.8%, $p < 0.001$), higher proportions of lower/distal ureteral (35.0% vs 23.4%, $p < 0.001$) and ureterovesical junction (20.2% vs 8.2%, $p < 0.001$) stone locations, and with preoperative hydronephrosis (89.1% vs 69.4%, $p < 0.001$). There was no difference in intraoperative complications, although urgent cases had a higher rate of ureteral stent placement (77.4% vs 72.5%, $p < 0.001$). Patients treated with urgent URS had higher SFR rates (66% vs 58.4%, $p < 0.001$), yet also experienced higher post-surgical ED visit rates (11% vs 7.2%, $p < 0.001$). No difference in unplanned hospitalizations or office visits were seen between cohorts.

Urgent ureteroscopy rates distributed by practice and urologist (Fig. 1), ranged from 2.3 to 70.0% and 0.0 to 97.7%, respectively. Multivariable analysis of ED visits by urologist specific urgent case volume comparing high volume (≥ 10 urgent cases) versus low volume (< 10 urgent cases) revealed no significant association (OR = 1.53, CI = 0.91–2.59, $p = 0.113$).

Factors associated with ED visits for patients who underwent urgent ureteroscopy included concomitant ureteral and renal stone location (OR = 1.53, CI = 1.05–2.23, $p = 0.035$) compared to ureteral stone location only. Preoperative hydronephrosis was found to decrease the risk of postoperative ED visits (OR = 0.58, CI = 0.35–0.97, $p = 0.039$) (Table 2).

Discussion

We evaluated clinical and operative factors, prevailing practice patterns and outcomes associated with urgent ureteroscopy among diverse practices in the state of Michigan. Our work has several key findings. First, current practice favors elective ureteroscopy more than 5 to 1, compared to urgent acuity. Second, urgent ureteroscopy was performed at higher rates for patients with distal ureteral stones and negative urine studies. Third, wide variation exists in practice-/urologist-specific use of urgent primary treatment. Fourth, urgent URS was demonstrated to be effective with comparably low intraoperative morbidity to elective cases with increased frequency of unscheduled ED visits without a significant difference in unplanned hospitalization rates. Finally, any ureteral stone location increases the risk of a postoperative ED visit. Collectively, these findings suggest that urgent primary ureteroscopy is a feasible strategy to avoid multiple in person patient encounters.

In the COVID-19 era, primary definitive management of acute USD presentation could be advantageous in reducing potential human exposure in the long term [8]. AUA guidelines recommend urgent decompression in the setting of infection and calculus causing obstruction is based upon data comparing medical treatment alone versus medical treatment plus surgical decompression [2]. European Association of Urology (EAU) urolithiasis guidelines include anuria with renal obstruction as an indication for urgent decompression [9]. Both societies offer little guidance to inform when urgent ureteroscopy can be performed safely. Perhaps not surprisingly, we found that urgent ureteroscopy comprised only 1 fifth of all ureteroscopies. This is consistent with prior data indicating that approximately 25% of ureteroscopies for ureteral stones were performed urgently [10]. Also previously demonstrated, our analysis revealed that distal ureteral stones (lower/distal ureter) were significantly more likely to be treated urgently [11]. The clinical rational for these findings remains elusive but may be related to urologist comfort with flexible ureteroscopy.

The wide variation observed in our analysis reveals a lack of consensus or ability to perform urgent ureteroscopy. Despite a lack of recommendations, prior work has demonstrated the safety and feasibility of urgent ureteroscopy for ureteral stones with acceptable efficacy [4, 10, 11]. Furthermore, a model predicting treatment success based upon preoperative clinical factors has previously been reported [12]. However, safety is likely the main urologist concern

Table 1 Demographics, clinical characteristics and outcomes of elective versus urgent ureteroscopy in MUSIC

	Urgent	Elective	*p* value
Total cases (%)	2005 (15.6%)	10,854 (84.4%)	< 0.001
Age, median (IQR)	53 (40–64)	57 (45–68)	< 0.001
Gender			0.02
- Male	1026 (51.2%)	5249 (48.4%)	
- Female	979 (48.8%)	5605 (51.6%)	
Insurance type			0.015
- None	61 (3.1%)	234 (2.2%)	
- Private	1202 (60.4%)	6389 (59.2%)	
- Public	727 (36.5%)	4179 (38.7%)	
BMI			0.9
- < 25	382 (20.6%)	2069 (20.5%)	
- 25–30	555 (29.9%)	3167 (31.4%)	
- > 30–35	455 (24.5%)	2395 (23.7%)	
- > 35–40	271 (14.6%)	1318 (13.1%)	
- ≥ 40	192 (10.4%)	1150 (11.4%)	
Charlson comorbidity index			0.003
- 0	1484 (74.1%)	7643 (70.4%)	
- 1	280 (14.0%)	1772 (16.3%)	
- ≥ 2	238 (11.9%)	1438 (13.3%)	
UA/Urine culture			< 0.001
- Positive	196 (9.8%)	1383 (12.8%)	
- Negative	1479 (74.2%)	7312 (67.7%)	
- Not performed	318 (16.0%)	2103 (19.5%)	
Preoperative hydronephrosis	1731 (89.1%)	6901 (69.4%)	< 0.001
Stent prior to surgery	239 (12.0%)	4882 (45.1%)	< 0.001
Antiplatelet drug prior to surgery	130 (6.7%)	859 (8.1%)	0.041
Largest stone size (mm), median (IQR)			< 0.001
- ≤ 5	869 (44.7%)	3298 (31.7%)	
- > 5 to ≤ 10	950 (48.8%)	5277 (50.7%)	
- > 10	126 (6.5%)	1833 (17.6%)	
Stone location			< 0.001
- Renal (total)	159 (8.1%)	2807 (27.0%)	
- Ureter (total)	1436 (72.8%)	5898 (56.8%)	
: Ureteropelvic junction	167 (8.3%)	1022 (9.4%)	0.12
: Upper/proximal/mid ureter	606 (30.2%)	3379 (31.1%)	0.42
: Lower/distal ureter	702 (35.0%)	2534 (23.4%)	< 0.001
: Ureterovesical junction	405 (20.2%)	889 (8.2%)	< 0.001
- Both	378 (19.2%)	1687 (16.2%)	
Intraoperative complication	34 (1.7%)	131 (1.2%)	0.073
Stent placed at time of surgery	1550 (77.4%)	7849 (72.5%)	< 0.001
Discharged with alpha-blockers	1100 (60.8%)	4993 (55.0%)	< 0.001
Discharged with opioids	1090 (60.7%)	5189 (58.1%)	0.036
Postoperative ED visit	219 (11.0%)	773 (7.2%)	< 0.001
Postoperative hospitalization	77 (3.9%)	342 (3.2%)	0.11
Unplanned postoperative office visit	43 (2.2%)	213 (2.0%)	0.59
Postoperative imaging	698 (34.8%)	4202 (38.7%)	0.001
Stone free rate	502 (66.0%)	2589 (58.4%)	< 0.001

IQR Interquartile range, *BMI* Body mass index, *ED* Emergency department

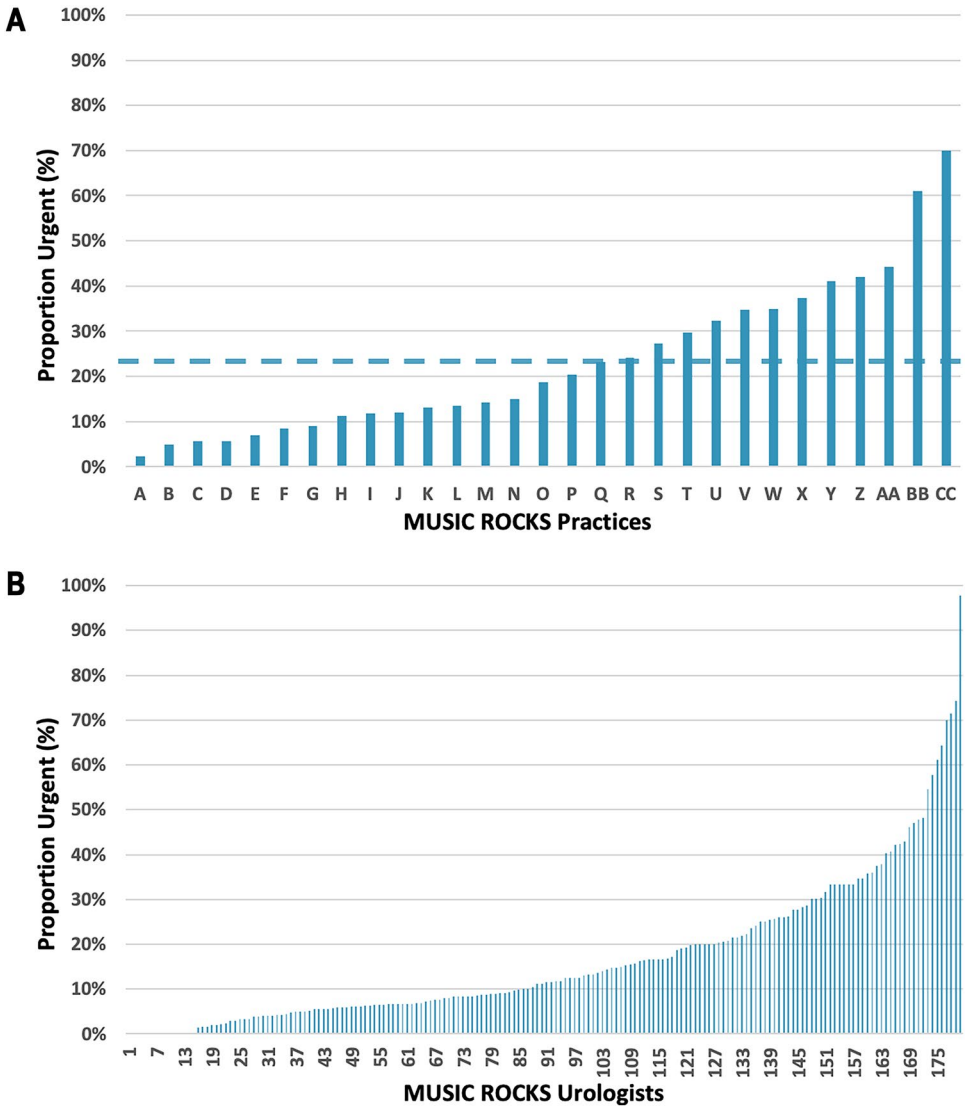

Fig. 1 **A** Variation in rate of urgent ureteroscopy by practice in MUSIC with ≥ 10 ureteroscopy cases (dashed line indicating mean rate). **B** Variation in rate of urgent ureteroscopy by urologist in MUSIC with ≥ 5 ureteroscopy cases

preventing wide utilization of urgent ureteroscopy. Another consideration for the variability in practice is resource availability. Prior work has demonstrated that shockwave lithotripter, not holmium laser, ownership is a significant factor when selecting treatment modality for patients with USD [13]. It is unknown if laser ownership versus 3rd party management and/or available personnel contribute to our results in practice/urologist utilization. The expanded use of these scoring systems that incorporate safety and efficacy outcomes may help to decrease the variability of urgent ureteroscopy utilization and provide guidance for the care of these patients. Further understanding of facility, personnel and equipment availability is required to understand what impact that has on the utilization of urgent ureteroscopy.

Ureteroscopy is a highly effective procedure for appropriately selected patients [1]. A metanalysis of 4 studies comparing emergent versus delayed ureteroscopy was similarly supportive of the clinical success of urgent ureteroscopy observed in our examination [11]. In the prior meta-analysis, SFRs of > 90% with no significant difference in the need for auxiliary procedures compared to delayed ureteroscopy were reported [11]. While our results indicate comparable SFRs, urgent cases had significantly higher success than elective cases. These results are potentially explained by the increased percentage of ureteral stones in the urgent cohort as well as MUSIC ROCKS strict SFR criteria. In addition to surgical success, morbidity should help guide clinician treatment decisions. Ureteroscopy is a common procedure with a low rate of serious complications, however, serious morbidity is possible with one of the most feared being sepsis [1]. Sepsis occurs in 5% of ureteroscopy cases with preoperative stent placement, positive urine culture and increased procedure time being risk factors for this outcome [14]. While ED visits were significantly higher in our urgent cohort, we are reassured by the lack of significant difference in hospitalization rates. This disparity indicates that many of these ED

Table 2 Multivariate analysis assessing the odds an ED visit associated with urgent ureteroscopy

	Adjusted odds ratio	95% CI	*p* value
Age (unit change from mean)	0.99	0.98–1.00	0.074
Gender			
- Female (vs Male)	1.29	0.92 –1.81	0.137
Insurance			0.209
- None (vs Public)	0.45	0.15–1.33	
- Private (vs Public)	0.79	0.56–1.12	
Antiplatelet/anticoagulation therapy			
- No (vs Yes)	0.87	0.46–1.66	0.674
Urine culture			0.047
- Negative (vs Positive)	0.83	0.48–1.44	
- Not performed (vs Positive)	0.30	0.11– 0.80	
Pre-stented			
- Yes (vs No)	0.77	0.41–1.44	0.409
Stone size (mm)			0.278
- < 5 (vs > 10)	0.74	0.39–1.43	
- 5–10 (vs > 10)	0.62	0.33–1.19	
Stone location			0.031
- Renal (vs Ureter)	0.67	0.33–1.39	
- Both (vs Ureter)	1.53	1.05–2.23	
Stent placement			
- Yes (vs No)	1.11	0.74–1.67	0.602
Alpha-blocker prescribed			
- Yes (vs No)	2.03	1.36–3.03	0.001

visits were not clinically severe and potentially avoidable. Interestingly, ureteral stone location and both ureteral and renal stone location increased the odds of a postoperative ED visit. Urgent indications for USD are typically sequelae of ureteral obstruction and thus is surprising that their treatment would lead to higher rates of unplanned care than those with renal stones. This is possibly due to limited preoperative counseling opportunity resulting in a lack of surgery specific patient education.

Our registry includes a variety of practices across the state of Michigan which enables better representation of practice patterns. The large cross-sectional nature of practices geographically dispersed across Michigan likely helps to minimize this effect. Our clinical registry does not analyze granular data related to surgical time of day, laboratory findings other than urine studies, strict surgical indication or clinical reasoning, nor practice details such as laser ownership or personnel availability. Additionally, we do not capture the clinical reasoning as to why the patients had an indwelling ureteral stent nor how long the stent was indwelling prior to ureteroscopy. The design does not allow for distinction between, truly emergent or urgent patient scenarios. As a clinical registry, data abstraction from chart review may be incomplete, or data may be omitted secondary to lack of system integration. In MUSIC, routine data validation audits are conducted by the coordinating center staff to ensure its accuracy.

Limitations notwithstanding, our work has several implications. Current practice favors elective ureteroscopy, more than 5 to 1, compared to urgent acuity with wide variation in practice- and urologist-specific utilization. Urgent ureteroscopy was performed at higher rates for patients with distal ureteral stones and was demonstrated to be significantly more effective with comparably low intraoperative morbidity. Urgent ureteroscopy, however, was associated with an increased postoperative ED visits without a difference in unplanned hospitalizations. The National Institute of Clinical Excellence (NICE) within the United Kingdom, states that clinicians should "offer surgical treatment to adults with ureteric stones and renal colic within 48 h of diagnosis or readmission, if pain is ongoing or the stone is unlikely to pass"[15]. Our results add to this body of work given that urgent URS was demonstrated to be safe and effective. Urgent ureteroscopy in the setting of acute renal colic secondary to obstructive urolithiasis may obviate the possibility of spontaneous stone passage but has potential advantage of avoiding multiple in person care encounters. Therefore, its use must be a shared decision between the urologist and the patient, recognizing that each clinical situation is unique.

Conclusion

In the state of Michigan, conventional treatment with ureteral stenting and elective ureteroscopy is performed greater than fivefold more frequently than urgent ureteroscopy. Current practice and urologist specific variation in urgent ureteroscopy utilization is wide. Urgent ureteroscopy demonstrated a comparably low morbidity to elective ureteroscopy despite higher percentages of stones located in the ureter and patients with hydronephrosis at presentation. Urgent ureteroscopy produced modestly higher SFRs with a slightly increased frequency of unscheduled ED visits that must be contrasted with the lack of a second scheduled procedure characteristic of delayed management.

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Author contributions All authors have made a substantial contribution to the concept or design of the article; or the acquisition, analysis, or interpretation of data for the article; AND drafted the article or revised it critically for important intellectual content; AND approved the version to be published; AND agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Data availability The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Conflict of interest None of the authors have any relevant conflicts of interest to disclose.

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