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RESEARCH

The impact of preoperative ureteral stent duration on retrograde intrarenal surgery results: a RIRSearch group study

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Abstract

A JJ stent placed before retrograde intrarenal surgery (RIRS) may ease the procedure. However, it is important to note that a prolonged duration of double J stent (DJS) placement before RIRS may increase the risk of postoperative urinary tract infection (UTI). Various publications have established this association, although the duration of the DJS before surgery is scarce. Our study investigates the relationship between the pre-stenting period and postoperative UTI and establishes a cut-off period to minimize this risk. We included a total of 500 cases with preoperative DJS prior to RIRS. The patients were divided into five groups according to their preoperative stenting duration (Group 1: 0–15 days; Group 2: 16–30 days; Group 3: 31–45 days; Group 4: 46–60 days; Group 5: >60 days). Demographic and clinical data of the patients, stone properties, operation data, perioperative and postoperative complications (including fever and UTI), hospitalization time, and stone-free rates (SFR) were compared. The groups contained 53, 124, 102, 63, and 158 patients. The demographics of the patients in each group were similar. There was no statistically significant difference between DJS duration, perioperative/postoperative complications, and SFR, except for the ureteral access sheath (UAS) insertion rate. (**p = 0.001**). The postoperative fever/UTI rate was the lowest in Group 1 (**p = 0.046**) compared to other durations. Stent duration does not impact SFR. Longer stents enhance UAS insertion success but increase postoperative infection risk. Our results suggest that RIRS should be performed within two weeks, ideally 20 days following stent insertion, to minimize postoperative infection risk.

Keywords Retrograde intrerenal surgery · Postoperative urinary tract infection · Preoperative JJ stent · Duration

Introduction

Retrograde intrarenal surgery (RIRS) has become a preferred technique for treating upper urinary tract stones smaller than 2 cm [1]. The efficacy and safety of RIRS in treating upper urinary tract stones have been enhanced by advancements in laser technology and the introduction of new flexible ureteroscopes (URS) with reduced diameters [2]. Retrograde intrarenal surgery has to be performed on a heterogeneous group of patients. Prior to RIRS, some of the patients had JJ stents. There may be many reasons for this situation. Patients might have an obstructive urinary system that a JJ stent has to overcome, or surgeons might prefer to use a JJ stent to enhance UAS insertion during the RIRS [3]. Even the inability to insert a UAS during RIRS might be a reason to use a JJ stent and postpone the surgery. In conclusion, many RIRS procedures were conducted on patients who had stenting before the surgical intervention.

Postoperative urinary tract infection (UTI) is one of RIRS's most frequent complications. It may also lead to urosepsis, which might be a mortal complication [4]. Many studies focused on the risk factors for infection after RIRS. The presence of a JJ stent before the RIRS was reported as a risk factor for postoperative fever. Although this relationship has been documented in several studies, there is minimal data about the risk analysis of the duration of the JJ stent before the surgery. In a study focusing on this subject, Hanna et al. reported that prolonged stent duration increased

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postoperative infection rates [5]. However, they did not analyze the duration of stenting with postoperative infection.

Our study aimed to evaluate the relationship between the duration of the pre-stenting period and postoperative UTI and determine a cut-off period to eliminate this possible risk.

Material and method

After receiving approval from the local ethics committee (number: 2023.69.04.05), data from the patients who underwent RIRS between March 2016 and March 2023 in 7 referral centers was retrospectively analyzed. The RIRSearch group database, formed prospectively, was used in this retrospective study. The patients who had JJ stents during RIRS were included in the study. Patients younger than 18, patients with renal anomalies, patients with solitary kidneys, and patients without JJ stents were excluded from the study. Preoperative stenting was applied for any reason, such as patients with ureteral obstruction, patients with renal colic or infection, and patients who had failed UAS insertion at a previous surgery.

The patients were divided into five groups according to their preoperative stenting duration. Group 1 comprised patients whose stenting was made 0–15 days before surgery. Group 2 consisted of patients who had stenting 16–30 days before surgery. Group 3 is composed of patients who had JJ stents 31–45 days prior to RIRS. Group 4 patients had JJ stenting 46–60 days before surgery, and Group 5 patients had JJ stenting more than 60 days before surgery.

Demographic and clinical data of the patients (age, gender, body mass index, Charlson comorbidity index), stone properties (stone burden, stone density, stone localization), operation data (operation time, UAS insertion rate), perioperative and postoperative complications, hospitalization time, and stone-free rates (SFR) were compared. All patients were evaluated preoperatively using the same approach: informed written consent, a detailed anamnesis, physical examination, serum creatinine level, urinalysis, urine culture, and non-contrast computed tomography (NCCT). Using NCCT images, the volume and density of stones were calculated [6]. All surgeries were performed under general anesthesia. As a standard practice, prophylactic second-generation cephalosporin (intravenous 1 gram of Cephazolin) antibiotics were administered around one hour before the surgical procedure. The RIRS surgical technique has been described in previous RIRSearch Study Group studies [6] and is similarly performed by each surgeon. In the first postoperative month, an NCCT was performed to determine SFR. Fragments ≤ 2 mm were determined to be stone-free. The Clavien-Dindo systems were used to report postoperative complications. Urinary tract infection/postoperative fever was defined as a body temperature $\geq 38^{o}$ within 72 h after surgery.

Statistical analysis

Frequency/percentage and median/interquartile range were reported for categorical and continuous variables. The normality of the variables was examined using the Kolmogorov-Smirnov test. The Chi-square and Fisher exact tests were used to compare categorical variables, while the Kruskal-Wallis and Mann-Whitney U tests were used to compare continuous parameters. Multivariable analysis was carried out using a logistic regression test. The Roc curve and the area under the curve were used to determine the cut-off points. The SPSS Statistics version 29 (IBM, Armonk, NY, USA) program was used for all statistical analyses. A p-value of less than 0.05 was statistically significant.

Results

A total of 500 patients were included in the study. The groups contained 53, 124, 102, 63, and 158 patients, respectively. The comparison of the patient's demographic and clinical properties with stone-related variables is shown in Table 1, which were similar between the groups. The SFR was similar between the groups ($p = 0.548$). Ureteral access sheath insertion rates increased with the preoperative JJ stent duration ($p = \mathbf{0.001}$). The mean operation time was observed to be significantly longer for patients whose stenting duration was more than 60 days. ($p = \mathbf{0.001}$). Although the difference was not statistically significant, the hospitalization time was the longest in group 5, which had a stenting duration of more than 60 days. ($p = 0.646$) (Table 2).

The groups' perioperative and total complication rates were similar (0.468 and 0.221, respectively). When we analyzed postoperative complications according to postoperative fever, we observed an increased rate of postoperative fever with the prolongation of preoperative JJ stent duration. The postoperative fever rate increased as the preoperative JJ stent duration increased. The difference between groups 1 and 2 was much more significant, which showed that postoperative fever rates were higher when the preoperative JJ stent duration exceeded 15 days.

The postoperative complication rate increased as the preoperative JJ stent duration increased ($p = 0.421$). A total of 13 patients had Clavien-Dindo grade 3, and 5 patients had grade 4 complications (Table 2). The patients who presented with Grade 3 Clavien-Dindo complications were eight patients who required replacement of JJ stents because of retrograde stent migrations that caused renal colic in the early postoperative period; four patients with stone-street

Table 1 Comparison of five groups' patients' clinical and stone-related parameters

Number of Cases	Group 1 (0–15 days)	Group 2 (16–30 days)	Group 3 (31–45 days)	Group 4 (46–60 days)	Group 5 (> 60 days)	*p*
	53	124	102	63	158	
Age (mean ± SD)	51.1 ± 13.8	46.9 ± 14.0	49.8 ± 14.2	49.0 ± 13.4	51.9 ± 14.3	0.053
Gender (n, %)	30 (56.6%)	89 (71.8%)	66 (64.7%)	38 (60.3%)	102 (64.6%)	0.448
Male	23 (43.4%)	25 (28.2%)	36 (35.3%)	25 (39.7%)	56 (35.4%)	
Female						
BMI (kg/m^2) (mean ± SD)	33.6 ± 3.5	27.4 ± 4.7	26.9 ± 3.9	27.4 ± 4.7	27.1 ± 4.0	0.919
Mean duration of stenting ± SD (days)	11.7 ± 2.7	24.3 ± 4.0	37.8 ± 4.3	52.7 ± 4.6	96.9 ± 29.3	**0.001**
Previous SWL history for the same stone(s) (n, %)	11 (20.8%)	43 (34.7%)	22 (21.6%)	14 (22.2%)	45 (28.5%)	0.094
CCI (n, %)	19 (35.8%)	56 (45.2%)	47 (46.1%)	33 (52.4%)	65 (41.1%)	0.463
0–1	34 (64.2%)	68 (54.8%)	55 (53.9%)	30 (47.6%)	93 (58.9%)	
≥2						
Preoperative serum creatinine level (mg/dL) (mean ± SD)	0.96 ± 0.25	1.03 ± 0.62	0.99 ± 0.44	0.92 ± 0.25	1.03 ± 0.46	0.611
Stone Location (n, %)	1 (1.9%)	5 (4.0%)	1 (1%)	2 (3.2%)	5 (3.2%)	0.229
Upper Calyx	1 (1.9%)	7 (5.6%)	9 (8.8%)	6 (9.5%)	7 (4.4%)	
Middle Calyx	8 (15.1%)	26 (21.0%)	28 (27.5%)	16 (25.4%)	41 (26.0%)	
Lower Calyx	16 (30.2%)	23 (18.5%)	21 (20.6%)	10 (15.9%)	25 (15.8%)	
Renal Pelvis	13 (24.5%)	43 (34.7%)	19 (18.6%)	16 (25.4%)	39 (24.7%)	
Upper Ureter	14 (26.4%)	20 (16.2%)	24 (23.5%)	13 (20.6%)	41 (25.9%)	
Multiple Location						
Stone density (Hounsfield Unit (mean ± SD)	1024.3 ± 259.4	956.3 ± 255.7	966.1 ± 306.3	922.3 ± 272.4	983.0 ± 318.7	0.560
Stone Volume (mm^3) (mean ± SD)	897.0 ± 608.0	893.7 ± 517.0	781.4 ± 653.9	861.0 ± 339.4	713.7 ± 685.8	0.910
Postoperative serum creatinine level (mg/dL) (mean ± SD)	0.99 ± 0.32	0.88 ± 0.29	1.02 ± 0.50	0.94 ± 0.25	0.93 ± 0.45	0.076

Table 2 Comparison of perioperative/postoperative data 1: Kruskal Wallis, 2: Chi Square

	Group 1 (0–15 days)	Group 2 (16–30 days)	Group 3 (31–45 days)	Group 4 (46–60 days)	Group 5 (> 60 days)	*p*
Stone-free rate (n, %)	41 (77.4%)	95 (76.6%)	73 (71.6%)	47 (74.6%)	112 (70.9%)	0.548
Ureteral access sheath insertion rate (n, %)	36 (67.9%)	94 (75.8%)	93 (91.2%)	60 (95.2%)	154 (97.5%)	**0.001**
Operation Time (min.) (mean ± SD)	67.4 ± 26.3	57.2 ± 21.1	68.5 ± 29.6	70.6 ± 31.9	75.0 ± 31.4	**0.001**
Hospitalization Time (min.)	1.0 (1.0–1.0)	1.0 (1.0–1.0)	1.0 (1.0-1.3)	1.0 (1.0–1.0)	1.0 (1.0–1.0)	0.646
median, (IQR)	1.7 ± 2.3	1.5 ± 1.4	1.7 ± 2.7	1.4 ± 1.1	1.9 ± 2.6	
mean ± SD						
Perop Complication (n, %)	3 (5.7%)	15 (12.1%)	6 (5.9%)	5 (7.9%)	13 (8.2%)	0.468
Postop Complication (n, %)	2 (3.8%)	16 (12.9%)	12 (11.8%)	9 (14.3%)	20 (12.7%)	0.421
Clavien grade 1 (n, %)	1 (50%)	9 (56.3%)	1 (8.3%)	0 (0%)	5 (25%)	
Clavien grade 2 (n, %)	1 (50%)	3 (18.7%)	8 (66.7%)	3 (33.3%)	10 (50%)	
Clavien grade 3 (n, %)	0 (0%)	2 (12.5%)	2 (16.7%)	6 (66.7%)	3 (15%)	
Clavien grade 4 (n, %)	0 (0%)	2 (12.5%)	1 (8.3%)	0 (0%)	2 (10%)	
Postoperative Fever/Urinary Tract Infection	1 (1.9%)	11 (8.9%)	11 (10.8%)	7 (11.1%)	18 (11.4%)	**0.046**
Total complication rate (n, %)	5 (9.4%)	27 (21.8%)	15 (14.7%)	13 (20.6%)	30 (19.0%)	0.221

that needed early surgical intervention; one patient with bladder perforation that required early surgical repair postoperatively; and one patient with urethral stenosis that was managed with endoscopic methods. All grade 4 Clavien-Dindo complications ($n = 5$) were postoperative urosepsis that needed intensive care unit management; there was no mortality in any case.

As we determined the significant difference in postoperative fever between group 1 and the other groups, we reanalyzed our data to compare the clinical and demographic properties of the patients to avoid a possible bias. This analysis found no clinical or demographic difference between the total number of patients in Group 1 and the other groups (Table 3). It was found that postoperative fever was the only statistically significant difference between these two groups (**p = 0.046**).

We conducted a ROC analysis to identify an optimal cut-off time for preoperative JJ stent duration associated with postoperative fever. Following the logistic regression and ROC curve analysis, we detected a cut-off duration of 20

Table 3 Comparison of the first 15 days of DJS duration and longer group

Number of Cases	Group 1 (0–15 days)	Others (> 15 days)	*p*
	53	447	
Age (mean ± SD)	51.1 ± 13.8	49.6 ± 14.2	0.466
Gender (n, %)	30 (56.6%)	295 (66.0%)	0.223
Male	23 (43.4%)	152 (34.0%)	
Female			
BMI (kg/m^2) (mean ± SD)	33.6 ± 3.5	27.2 ± 4.2	0.172
Previous SWL history for the same stone(s) (n, %)	11 (20.8%)	124 (27.7%)	0.382
CCI (n, %)	19 (35.8%)	201 (45.0%)	0.242
0–1	34 (64.2%)	246 (55.0%)	
≥2			
Preoperative serum creatinine level (mg/dL) (mean ± SD)	0.96 ± 0.25	1.0 ± 0.39	0.947
Stone Location (n, %)	1 (1.9%)	13 (2.9%)	0.297
Upper Calyx	1 (1.9%)	29 (6.5%)	
Middle Calyx	8 (15.1%)	111 (24.8%)	
Lower Calyx	16 (30.2%)	79 (17.7%)	
Renal Pelvis	13 (24.5%)	117 (26.2%)	
Upper Ureter	14 (26.4%)	98 (21.9%)	
Multiple Location			
Stone density (Hounsfield Unit) (mean ± SD)	1024.3 ± 259.4	963.1 ± 292.5	0.316
Stone Volume (mm^3) (mean ± SD)	1110.0 ± 841.9	1034 ± 838.4	0.427
Operation Time (min.) (mean ± SD)	67.4 ± 26.3	67.9 ± 29.3	0.991
Postoperative serum creatinine level (mg/dL) mean ± SD	0.99 ± 0.32	0.99 ± 0.41	0.831
Perop Complication (n, %)	3 (5.7%)	39 (8.7%)	0.604
Postop Complication (n, %)	2 (3.8%)	44 (9.8%)	0.208
Total complication rate (n, %)	5 (9.4%)	74 (16.6%)	0.232
Stone-free rate (n, %)	41 (77.4%)	327 (73.2%)	0.622
Hospitalization Time (min.) median, (IQR)	2.0 (1.35–1.89)	1.0 (1.49–1.93)	0.168
Postoperative Fever/Urinary Tract Infection	1 (1.9%)	47 (%10.5)	**0.046**

days, which was associated with an increase in postoperative infection rates (AUC: 0.561, $p < 0.166$, 95% CI: 0.481–0.642) (Fig. 1).

Discussion

Retrograde intrarenal surgery is progressively being used as the primary therapeutic approach for individuals with upper urinary tract stones [7]. The placement of a UAS in RIRS has been shown to enhance operational results, such as reducing surgical time and postoperative infection rates. This may be attributed to the UAS diverting the irrigation fluid stream outside, reducing the need for intermittent bladder drainage during the process [8]. Placing a UAS is an important step in this surgery, and sometimes, this step may cause problems, such as ureteral injuries in narrow ureters or ureters with strictures. According to Traxer et al., preoperative JJ stenting was associated with a significant reduction in the probability of ureteral damage, about sevenfold [9]. Preoperative JJ stenting is believed to facilitate UAS replacement with passive dilatation [10].

It is crucial to consider the possible impact of preoperative JJ stenting. A ureteral stent has been linked to several urinary tract symptoms, including flank pain, hematuria, and urgency. These symptoms may significantly influence the overall quality of life for up to 80% of patients. [11]. Therefore, it is crucial to determine the JJ stent duration that will be sufficient to perform the ideal operation while exposing the patient to these disturbing and uncomfortable situations for the least amount of time. Unfortunately, there are no studies in the literature that demonstrate this duration. Our study found that long-term stent duration did not change the preoperative and postoperative outcomes of RIRS.

Zhang et al. found no statistically significant differences in operational outcomes between the groups that had stenting and those that did not. The study includes complications and stone-free rates (73.2% vs. 71.0%, $p = 0.854$) [12]. Lee et al. found the same results: no differences between the short- and long-term preop JJ stenting and no stenting groups regarding stone-free rate, perioperative complications, or

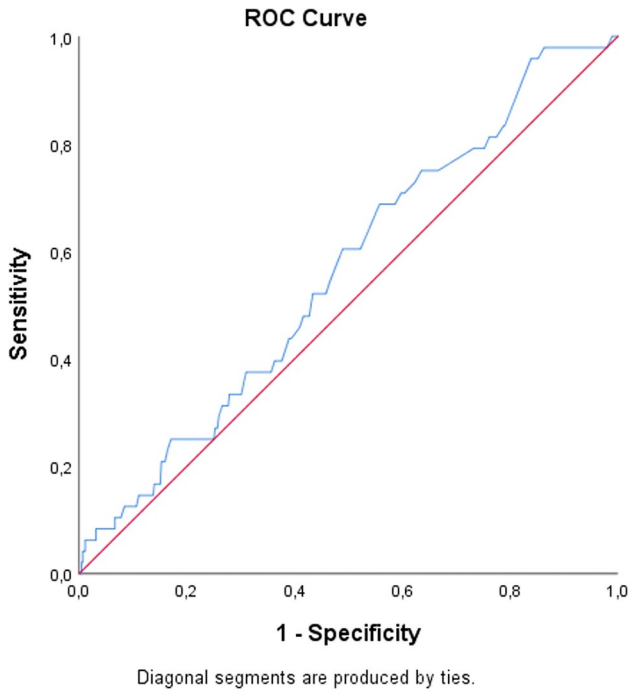

Fig. 1 ROC analysis of the infection rates with JJ stent durations

postoperative complications. However, this study's short-term duration was seven days [10]. Additional studies also examined the effects of JJ stenting prior to ureteroscopic procedures, and no correlation was seen between preoperative stenting and a higher incidence of complications [13–15]. Perlmutter et al. [16] observed that passive dilatation of the ureter via preoperative JJ stenting may enhance the success rate of ureteroscopic lithotripsy, but it was not statistically significant. In their study, Fabrizio et al. evaluated the impact of preoperative JJ stenting on passive ureteral dilatation. Their findings did not indicate any further effects on SFR [17]. However, again, no details about the duration of JJ were given in these studies.

In our study, the UAS insertion rate increased as the stent lasted longer. The study by Lee et al. [10] found that preoperative JJ stenting reduced perioperative ureteral balloon dilation. They suggested that preoperative stenting might sufficiently dilate the intramural segment of the ureter. This fact may also impact our study's insertion rates. There may be no correlation between prolonged stent duration and ureteral dilatation, but there is currently no evidence to show this is also true for the ureteral orifice.

In our study, patients with JJ periods exceeding 16 days showed a statistically significant prolongation of the operation duration. However, no additional factors related to patient or stone characteristics influenced the observed outcome. One possible explanation for this phenomenon is as follows: although the insertion of a UAS may be facilitated after the insertion of a JJ stent, the subsequent tasks of detecting the stone and performing laser lithotripsy may become more challenging due to the increased edema in the kidney caused by the presence of a foreign object. Progressive edema makes it harder to find and precisely target stones inside these swollen tissues. This makes lithotripsy less effective and extends the length of the surgery.

Some studies investigate the relationship between JJ stent duration and postoperative infection and conclude that there is no difference [14]. However, a bunch of studies have revealed that there is a relationship. These results are controversial. Although data show that a preoperative JJ stent increases the risk of infection, there is no clear relationship between the duration of this stent and the infection it will cause. As a result of these studies, different conclusions were obtained regarding the optimal stent duration in terms of infection. For ureteroscopy, Nevo et al. [18] and Hanna et al. [5] emphasized that surgery should be performed within 30 days following JJ stent placement to reduce postoperative infection. Bhanot et al. recommended minimizing the stent dwelling time (as short as possible) and not stating a specific day [19]. Similarly, in the pediatric group, it has been shown that there is no difference in SFR between the pre-stented group and the stentless group. However, the risk of postoperative infection is higher in the presented group. Pal et al. [20] recommended maintaining a shorter indwelling period for ureteral stents, ideally within six weeks, to decrease bacterial colonization. In our study, after the 20^{th} day, the risk of postoperative infection increased statistically significantly. Lojanapiwat found that bacterial colonization often occurs during internal ureteral stent installation, particularly when the stent remains in place for two weeks [21]. In a study by Rahman et al., they stated that the colonization rate of stents removed after six weeks was found to be 71.4%, which was significantly higher compared to the rates of 33.3% seen in the 4–6-week group and 23.5% in the group removed before four weeks ($p < 0.001$) [22]. Al-Marhoon et al. revealed in their study that, for both genders, a stent length of less than 90 days was substantially linked to a reduced risk of complications, including infectious ones [23].

There are several limitations inherent in our study. Firstly, we used a retrospective design. Secondly, the operation time differed significantly between the groups, which might have affected the results. Correcting this data by matching or using another method was impossible. Thirdly, the patients in this research were prone to presenting with complex circumstances, such as the presence of big or impacted complex stones and the coexistence of other medical diseases and comorbidities. Since all institutions serve as specialized centers for the

referral and treatment of stone diseases, some stent durations seemed long. Patients may be exposed to the irritative symptoms caused by the stent during these extended periods. However, it could not be prevented because a certain period would pass between the placement of the stent and the surgery in these centers. Particularly in group 5, some cases with extremely long JJ stent durations led to statistical significance. Additionally, since the total infection rate in the patient population was low, the area under the curve in the ROC analysis may have been relatively small. In addition, it should be noted that none of the patients in the study underwent stone composition or stone culture analyses. Therefore, patients with infection stones or those with infection in stone culture may have impacted the incidence of postoperative infection problems, even if they did not have infection stones. Despite these, we could draw essential conclusions from our study because it included patient groups with long-term JJ dwelling times.

Conclusions

Stent dwelling time does not affect the SFR. However, a longer stent duration means a higher postoperative infection risk, even though it increases the success of UAS placement. If preoperative JJ stenting is optional, our research may provide valuable insights for patients and clinicians when deciding on its duration. Based on the findings of our study, RIRS should be performed within the first two weeks, optimally 20 days after stent placement, to reduce postoperative infection risk. Additional large-scale prospective randomized controlled trials are necessary to determine the impact of preoperative ureteral stent placement and duration further.

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Data availability No datasets were generated or analysed during the current study.

Declarations

Ethical approval A written informed consent was obtained from participants to participate in the study. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Study approval statement This study protocol was reviewed and approved by [Tekirdag Namik Kemal University, Non-interventional Clinical Trials Ethical Committee], approval number [2023.69.04.05], date [04.25.2023].

Scientific responsibility statement The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

Competing interests The authors declare no competing interests.

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