World Journal of Urology (2022) 40:1377–1389
https://doi.org/10.1007/s00345-022-03935-2

INVITED REVIEW

Role of pre-operative ureteral stent on outcomes of retrograde intra-renal surgery (RIRS): systematic review and meta-analysis of 3831 patients and comparison of Asian and non-Asian cohorts

Y. X. T. Law[1] · J. Y. C. Teoh[2] · D. Castellani[3] · E. J. Lim[4] · E. O. T. Chan[2] · M. Wroclawski[5,6] · G. M. Pirola[7] · C. Giulioni[3] · E. Rubilotta[8] · M. Gubbioti[7] · S. Scarcella[3] · B. H. Chew[9] · O. Traxer[10,11] · B. K. Somani[12] · V. Gauhar[13]

Received: 13 December 2021 / Accepted: 7 January 2022 / Published online: 24 January 2022

Abstract

Purpose To evaluate the outcomes of pre-stented (PS) versus non-pre-stented (NPS) patients who have undergone retrograde intrarenal surgery (RIRS) for renal calculi with subgroup analysis of Asian and non-Asian cohorts.

Methods Protocol is registered in PROSPERO, CRD42021261123. Eligible studies identified from four electronic databases. Meta-analysis was done to enumerate the outcomes of RIRS in between PS and NPS. Secondary sub-analysis was done to look for differences in outcomes in Asian and non-Asian cohorts.

Results Fourteen studies involving 3831 patients (4 prospective, 10 retrospective studies) were included. PS patients experienced higher success rates of ureteral access sheath (UAS) insertion than NPS (RR 1.09, 95% CI 1.05–1.13, $p<0.00001$). PS patients had lower risk of ureteral injuries from UAS placement (RR 0.69, 95% CI 0.50–0.96, $p=0.03$). No significant differences in intra- and postoperative complications between two groups were found. Stone-free rate (SFR) outcomes for residual fragment (RF) cut-off of <1 mm and <4 mm favoured the PS patients (RR 1.10, 95% CI 1.04–1.17, $p=0.002$ for <4 mm, RR1.10, 95% CI 1.02–1.19, $p=0.02$ for <1 mm). In the subgroup analysis, PS Asian patients had similar SFR as NPS patients for SFR(<4 mm) but non-Asian population showed better outcomes in the PS patients for SFR(<4 mm) (RR 1.31, 95% CI 1.13–1.52, $p=0.0005$).

Conclusions This meta-analysis suggests that pre-stenting results in a higher success for UAS placement, minimising intraoperative ureteric injury, with higher overall SFR for any RF cut-off in PS cohorts. In non-Asian cohort, significant differences occurred at SFR <4 mm but not for SFR <1 mm. No difference was seen in our Asian cohort for any SFR cut-off in both PS and NPS patients.

Keywords Stent · Meta-analysis · Retrograde intra-renal surgery · Outcome studies · Kidney calculi · Asian

Abbreviations

CI	Confidence intervals
MD	Mean difference
mm	Millimeters
NPS	Non-pre-stented
PS	Pre-stented
RF	Residual fragments
RIRS	Retrograde intra-renal surgery
RR	Risk ratios
SFR	Stone-free rates
UAS	Ureteral access sheath

✉ Y. X. T. Law
terencelaw83@gmail.com

Extended author information available on the last page of the article

Introduction

The prevalence of urolithiasis is influenced by genetic, ethnic, dietary, climatic factors and varies globally [1–3].

American Urological Association and European Urological Association Guidelines recommend retrograde intrarenal surgery (RIRS) as one of the first line options for stones which are sized up to 20 mm (mm) [4, 5]. To improve stone-free outcomes after RIRS, studies have advocated for stent placement prior to the procedure with an intention to first dilate the ureter and to facilitate subsequent insertion of the ureteral access sheath (UAS) [6]. This is to shorten operative times and minimise the risk of complications. Pre-stenting also carries additional costs and may negatively impact patient quality of life due to stent-related symptom [7].

The Achilles heel to a RIRS procedure is ureteral access. As per literature, the normal ureteral diameter in adults, estimated using computed tomography scans, can be heterogenous and ranges from 1.8 mm to 8 mm [8–10]. A study demonstrated that the mean normal ureteral diameter in Americans was 1.8 mm with an upper normal limit of 3 mm [9]. A Korean study, however, demonstrated a larger mean normal ureteral diameter of 3.4 mm with an upper limit of 4 mm in Korean patients [11]. Hypothetically, if there is indeed a ethnic difference then this could translate into differences in approach for ureteral access in RIRS and maybe outcomes across different populations.

Our objective in this study is to perform a systematic review of the literature to evaluate the difference in outcomes and complications for RIRS in pre-stented (PS) and non-pre-stented (NPS) patients. We also wanted to assess for any differences in studies reporting on Asian and non-Asian patients. Since, there is inconclusive proof if ureteral diameter is different in different ethnicity we also wanted to assess if there were differences in outcomes of RIRS in Asian and non-Asian patients in these studies.

Methods

Aim of the review and literature search

We performed a systematic review to assess the differences in the incidence of operative outcomes and complications arising from RIRS in two distinct patient groups—PS patients versus NPS patients. The primary outcomes included success rates of UAS placement and stone free rate (SFR). Secondary outcomes analysed were complications including ureteral injuries due to UAS and postoperative sepsis. A subgroup analysis was performed for Asian and non-Asian studies. This systematic review was performed in accordance to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. A comprehensive literature search was performed on June 11, 2021, using the National Health Service Economic Evaluation Database, EMBASE, MEDLINE, and Cochrane Central Controlled Register of Trials (CENTRAL). Medical Subject Heading (Mesh) terms and keywords such as "Kidney Calculi", "Nephrolithiasis", "Ureteroscopy", "Lithotripsy" and "Stent" were used with no date limits imposed. Non-English, animal and paediatric studies were also excluded. The search strategy is presented in the Appendix. Additional articles were sought from the reference lists of the included articles. The review protocol was registered in PROSPERO (ID CRD42021261123).

Selection criteria

The PICOS (Patient Intervention Comparison Outcome Study type) model was used to frame and answer the clinical question. Patient: patients undergoing RIRS for renal calculus; intervention: patients who were pre-stented before surgery; comparison: patients who were not-pre-stented before surgery; outcome: operative and complication related outcomes; study type: randomized clinical trials, prospective and retrospective studies. We gathered data on the following: intraoperative complications, including ureteral injuries and postoperative complications including postoperative sepsis. Additionally, data was gathered for successful insertion rates of UAS, duration of surgical procedures and SFR for residual fragments (RF) (<1 mm and <4 mm). A subgroup analysis was performed for Asian and non-Asian studies.

Study screening and selection

Two independent authors screened all retrieved records using the Covidence Systematic Review Management® application. A third author resolved discrepancies. Studies included were based on PICOS eligibility criteria. Prospective, retrospective and randomized studies were included. Case reports, meeting abstracts, editorials, and letters to editors were excluded. The full text of the screened papers was selected if found to be relevant to the topic of this review. The search was further expanded by performing a manual search based on the references of the full-text relevant papers.

Data synthesis and statistical analysis

Meta-analyses were performed when there were two or more studies reporting the same outcomes under the same definition. The incidences of SFR, success rates of UAS insertion and complications were pooled using the Cochran-Mantel–Haenszel Method and expressed as Risk Ratios (RR), 95% Confidence Intervals (CI), and p values [12]. RR more than 1 (one) indicates increased success rates and increased risk of the complication in pre-stented patients. Operation durations were pooled using the inverse variance of the mean difference (MD), 95% CI, and p values. Analyses were two-tailed, with a significance threshold set at $p<0.05$ and a 95% CI. Study heterogeneity was assessed utilizing the I^2 value. Substantial heterogeneity was defined as an I^2 value $\geq 50\%$ or a Chi-square p value ≤ 0.10. If Chi-square p value was >0.1 or I^2 value $<50\%$, a fixed effects model was used [13]. If Chi-square p value was ≤ 0.1 or I^2 value $\geq 50\%$, a random-effect model was used. Meta-analysis was performed using the Review Manager (RevMan) 5.4 software by Cochrane Collaboration. The risk of bias was assessed using the Cochrane Risk of Bias tool; and ROBINS-I for non-randomized studies [14, 15].

Results

The literature search retrieved 1443 papers, of which 109 duplicates were removed. Of the remaining 1334 papers, 1265 records were further excluded after review of the title and abstracts. The full texts of the remaining 69 studies were examined and 55 papers were excluded as the content was irrelevant to this analysis. Finally, 14 studies including 4 prospective non-randomized arm studies and 10 retrospective studies, were identified for meta-analysis [16–29]. Figure 1 shows the PRISMA flow diagram.

Study characteristics

A total of 3831 patients were involved in the 14 studies: 1741 were PS and 2090 were NPS patients. The type of population in the studies was as follows: 1 global, 8 Asian and 5 non-Asian populations. Definitions of SFR reported in the studies varied from the absence of any stone fragment to RF sized < 1 mm, < 2 mm or < 4 mm. For our study purpose, we evaluated SFR < 4 mm and < 1 mm. Table 1 demonstrates the characteristics of the 14 studies included in this meta-analysis.

Quality assessment

Figure 2 demonstrates the details of quality assessment, as measured by the Cochrane Collaboration risk-of-bias tool. One non-randomised study exhibited a low risk of bias for all quality criteria, while thirteen studies showed a moderate risk of bias. The most common risk factor for quality

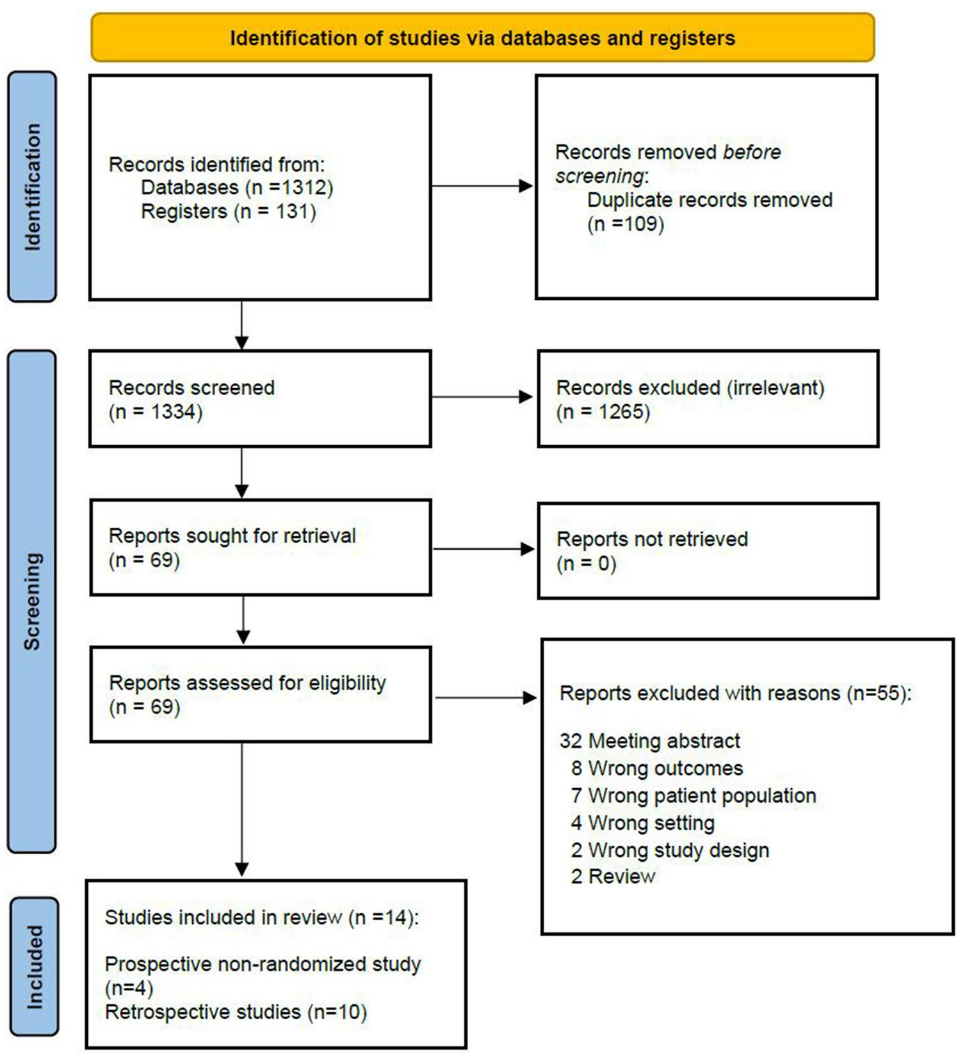

Fig. 1 PRISMA diagram

Table 1 Baseline characteristic of the studies

Studies	Type of study	Population type	Origin of study	Definition of stone free rates	Age		BMI		Gender		Stone Size		Number of patients pre-stented (n)	Number of patients non- pre-stented (n)	Total patients included (n)
					Mean (SD) of the pre-stented	Mean (SD) of the non-pre-stented	Mean (SD) of the pre-stented	Mean (SD) of the non-pre-stented	Number of female pre-stented (n)	Number of female non-pre-stented (n)	Mean (SD) of pre-stented (n)	Mean (SD) of non-pre-stented (n)			
Assimos [16]	Non-randomized prospective trials	Global	Spain Israel Turkey Australia Egypt Greece Chile UK Canada Netherlands Denmark China India Italy France USA German Japan	≤ 1 mm at computed tomography scan	51.7 (15.1)	50.5 (14.7)	28.3 (7.4	27.5 (6.8)	205	447	N.A	N.A	590	1002	1592
Bai [17]	Retrospective study	Asian	China	< 4 mm at Computed Tomography scan	42.3 (median) range 19–80	42.0 (median) range 17–80	N.A	N.A	67	35	15.0 (median) range 8–21	14.4 (median) range 8.1–21	203	103	306
Chen [18]	Non-randomized prospective trials	Asian	China	Absence of any stone or < 4 mm	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	43	43	86
Chu [19]	Retrospective study	Non-Asian	USA	Absence of stone fragments or < 2 mm	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	9	14	23

Table 1 (continued)

Studies	Type of study	Population type	Origin of study	Definition of stone free rates	Age		BMI		Gender		Stone Size		Number of patients pre-stented (*n*)	Number of patients non- pre-stented (*n*)	Total patients included (*n*)
					Mean (SD) of the pre-stented	Mean (SD) of the non-pre-stented	Mean (SD) of the pre-stented	Mean (SD) of the non-pre-stented	Number of female pre-stented (*n*)	Number of female non-pre-stented (*n*)	Mean (SD) of pre-stented (*n*)	Mean (SD) of non-pre-stented (*n*)			
Jessen [20]	Retrospective study	Non-Asian	Sweden Spain Denmark Greece Germany Italy	Absence of any stone	N.A	N.A	N.A	N.A	N.A	N.A	1.11 (0.84)	1.21 (0.81)	103	150	253
Kawahara [21]	Non-randomized prospective trials	Asian	Japan	0 mm, < 2 mm or < 4 mm in diameter	57 (median) range 27–78	61 (median) range 37–86	N.A	N.A	6	14	29.4 (median) range 15–47	26.9 (median) range 15–44	25	36	61
Lee [22]	Retrospective study	Asian	Korea	Absence of stone fragments or ≤ 1 mm on postoperative imaging at 1–4 weeks after discharge	N.A	57.1 (15)	N.A	24.6 (4)	142	99	N.A	12.4 (6.3)	345	215	560
Netsch [23]	Retrospective study	Non-Asian	Germany	Absence of any stone fragments by endoscopic examination as well as by retrograde pyelography at the end of the procedure	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	20	20	40
Pan [24]	Retrospective study	Asian	China	Absence of any residual stones at computed tomography scan	55.0 (11.8)	55.1 (13.0)	24.6 (3.5)	23.9 (4.0)	17	16	17.7 (4.8)	15.7 (4.4)	40	36	76

Table 1 (continued)

Studies	Type of study	Population type	Origin of study	Definition of stone free rates	Age		BMI		Gender		Stone Size		Number of patients pre-stented (*n*)	Number of patients non- pre-stented (*n*)	Total patients included (*n*)
					Mean (SD) of the pre-stented	Mean (SD) of the non-pre-stented	Mean (SD) of the pre-stented	Mean (SD) of the non-pre-stented	Number of female pre-stented (*n*)	Number of female non-pre-stented (*n*)	Mean (SD) of pre-stented (*n*)	Mean (SD) of non-pre-stented (*n*)			
Sung [25]	Retrospective study	Asian	Korea	The complete free rate of 0 mm and a clinical free rate of < 4 mm	56.7 (14.0)	54.6 (14.6)	24.4 (2.9)	23.3 (8.7)	32	19	15.27 (10.85)	14.47 (8.43)	73	49	122
Tonyali [26]	Retrospective study	Non-Asian	Turkey	Absence of stones or < 2 mm on radiograms within a month after the procedure using direct endoscopic vision or computed tomography	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	22	78	100
Werthemann [27]	Non-Randomized prospective trials	Non-Asian	Germany	Complete stone removal, clinically irrelevant residual fragments and required retreatment based on retrograde pyelography	N.A	N.A	N.A	N.A	N.A	N.A	N.A	N.A	99	18	117
Yuk [28]	Retrospective study	Asian	Korea	0 mm or < 4 mm,	57.5 (14.1)	57.6 (13)	24.6 (2.9)	24.7 (3.3)	57	156	13.8 (9.7)	14.3 (9.9)	113	226	339
Zhang [29]	Retrospective study	Asian	China	Absence of any stone or ≤ 4 mm	51.4 (12.8)	47.6 (13.2)	24.2 (3.6)	23.7 (3.1)	24	38	18.1 (8.1)	18.4 (7.7)	56	100	156

Fig. 2 Bias table

assessment was the risk of bias in classification of interventions, followed by bias in selection of the reported results as most of the studies were non-randomised prospective or retrospective in design.

Operation outcomes

Operation duration

Data pooled from seven available studies of 2693 patients (1058 PS) describing operative duration showed no significant difference between PS and NPS patients [mean difference (MD) 0.04, 95% CI − 2.91–2.98, $p = 0.98$; Fig. 3A].

Stone-free rates

For SFR (< 4 mm RF), 3093 patients (1792 PS) were included from a total of 14 studies (1 global, 8 Asian and 5 non-Asian studies). SFR (< 4 mm RF) was overall higher in the PS group (RR 1.10, 95% CI 1.04–1.17, $p = 0.002$), as well as the PS group in the non-Asian cohort based on subgroup analysis of 533 patients (300 PS) in five non-Asian studies (RR 1.31, 95% CI 1.13–1.52, $p = 0.000$). No statistical significance noted for the SFR (< 4 mm RF) in the PS patients in the Asian cohort based on subgroup analysis of the 1817 patients (898 PS) in the eight Asian studies (Fig. 3B).

For SFR (< 1 mm RF), 3234 patients (1166 PS) were included from a total of 9 studies (1 global, 5 Asian and 3 non-Asian studies). The SFR (< 1 mm RF) was statistically significant in the overall PS group (RR 1.10, 95% CI 1.02–1.19, $p = 0.02$) versus NPS patients. The subgroup analysis show no statistical differences for PS VS NPS in the Asian (1006 total; 480 PS) and non-Asian studies (410 total; 269 PS). (Fig. 3C).

Successful ureteral access sheath insertion

The pooled meta-analysis from six available studies of 957 patients (345 PS) describing UAS insertion suggest significantly higher success rates of UAS insertion in PS patients (RR 1.09, 95% CI 1.05–1.13, $p < 0.00001$, Fig. 3D).

Intraoperative complications

Four studies of 2471 patients (993 PS) compared the intraoperative complications for PS patients versus NPS patients, and showed no difference between the 2 groups (RR 0.78, 95% CI 0.53–1.17, $p = 0.23$, Fig. 4A).

Ureteral injuries due to UAS placement

The pooled meta-analysis from six available studies of 1711 patients (887 PS) showed a significantly higher risk of ureteral injuries in NPS patients (RR 0.69, 95% CI 0.50–0.96, $p = 0.03$, Fig. 4B).

Postoperative complications

The pooled meta-analysis from ten available studies of 2664 patients (1692 PS) for PS patients versus NPS patients suggests there is no difference between the 2 groups (RR 0.83, 95% CI 0.59–1.16, $p = 0.28$, Fig. 5A). Subgroup analysis revealed no statistical differences in the Asian and non-Asian studies (Fig. 5A).

Postoperative sepsis

The pooled meta-analysis from six available studies of 1672 patients (830 PS) for PS patients versus NPS patients revealed no differences between the 2 groups (RR 0.83, 95% CI 0.38–1.81, $p = 0.64$, Fig. 5B).

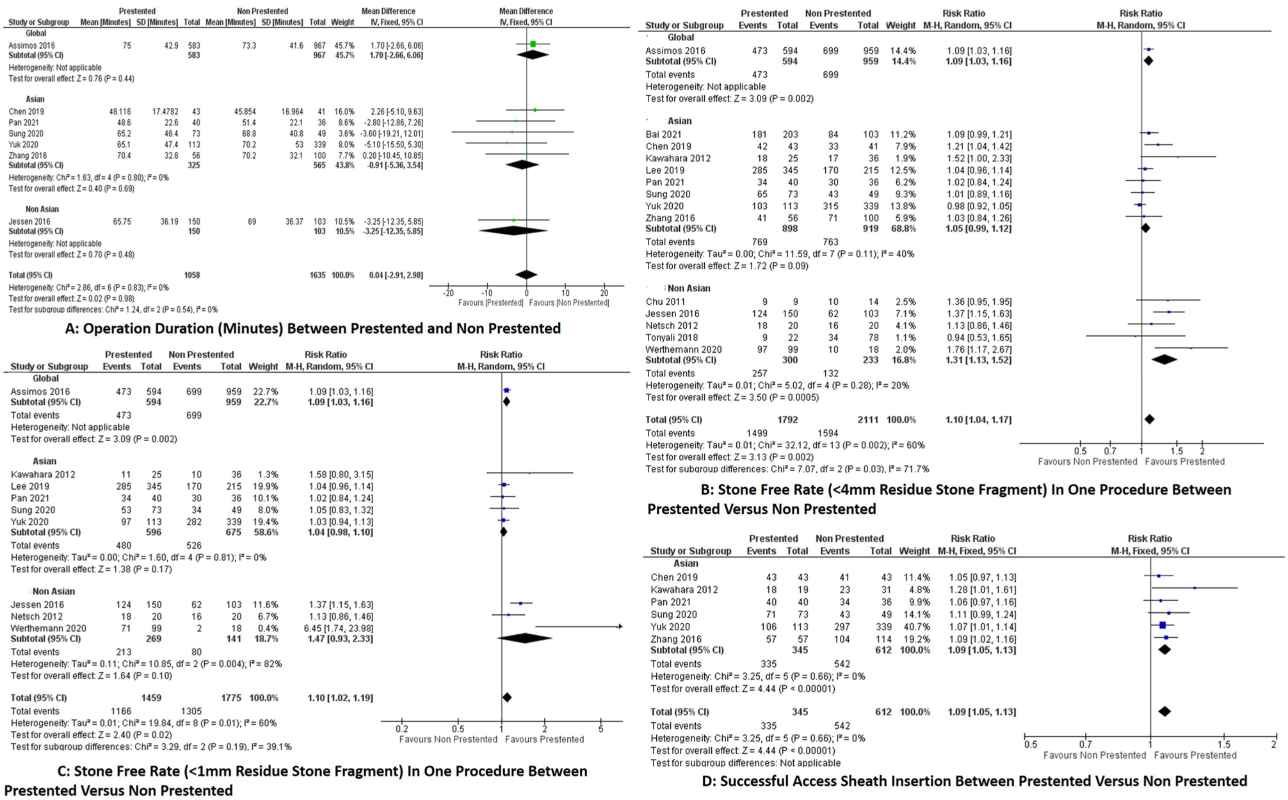

Fig. 3 **A** Forest plot of operation duration (minutes) between pre-stented and non-pre-stented; **B** forest plot of stone free rates (< 4 mm residue stone fragment) in one procedure between pre-stented versus non-pre-stented; **C** forest plot of stone free rates (< 1 mm residue stone fragment) in one procedure between pre-stented versus non pre-stented; **D** forest plot of successful access sheath insertion between pre-stented versus non-pre-stented

Discussion

Ureteral stenting is most commonly used for decompression of the upper tract urinary tract obstruction and post ureteroscopy. The American Urological Association and European Urological Association Guidelines currently recommend RIRS as one of the first-line interventions for renal stone up to 20 mm [4, 5]. Although De Connick et al. have shown that pre-stenting is not a mandate a Ureteric access sheath UAS, it helps to facilitate multiple entries, basket extraction of stones and lower intra renal pressures [30]. Intuitively, flexible ureteroscopy should be easier in PS patients as this causes passive ureteral dilatation which helps to facilitate UAS insertion. Ureteral stenting is also common when a UAS placement is unsuccessful. Traxer et al. have also shown in the Clinical Research Office of the Endourological Society global ureteroscopy study that infectious complications are much lesser in patients who are PS and UAS is used [31]. In our meta-analysis, we confirmed that PS patients had a higher success rate of UAS insertion and SFR compared to NPS patients as a whole in both Asian and non-Asian studies.

Atraumatic placement of a UAS is a salient first step for most urologists performing flexible ureteroscopy. Traxer et al. showed that insertion of a UAS can lead to complications [32]. In this study, 13.3% patients sustained ureteric injures which involved the mucosa and/or smooth muscle when a 14 fr UAS was used. Despite this, UAS has an important role in flexible ureteroscopy as it lowers intra renal pressure, facilitates stone extraction and helps improve vision during laser lithotripsy of large stones [33]. Whether, UAS can improve SFR, shorten operative time, decrease hospitalization stay and minimise complications is debatable as shown by Huang et al. [34]. Several strategies have been employed to improve success rates of UAS insertion—these include applying a hydrophilic coating to the UAS, optical ureteric dilatation with a semi-rigid ureteroscope, use of alpha blockers and preoperative ureteral stenting [25, 35, 36]. Of these, pre-stenting is the most commonly practiced [37]. In an Asian study by Lee et al., the incidence of ureteral injury in PS and NPS patients was 3.8% and 7.0%, respectively [22]. Our findings confirm that pre-stenting was associated with a significantly higher success rate of UAS insertion in this group (RR 1.09, 95% CI 1.05–1.13, $p < 0.00001$), facilitating lower

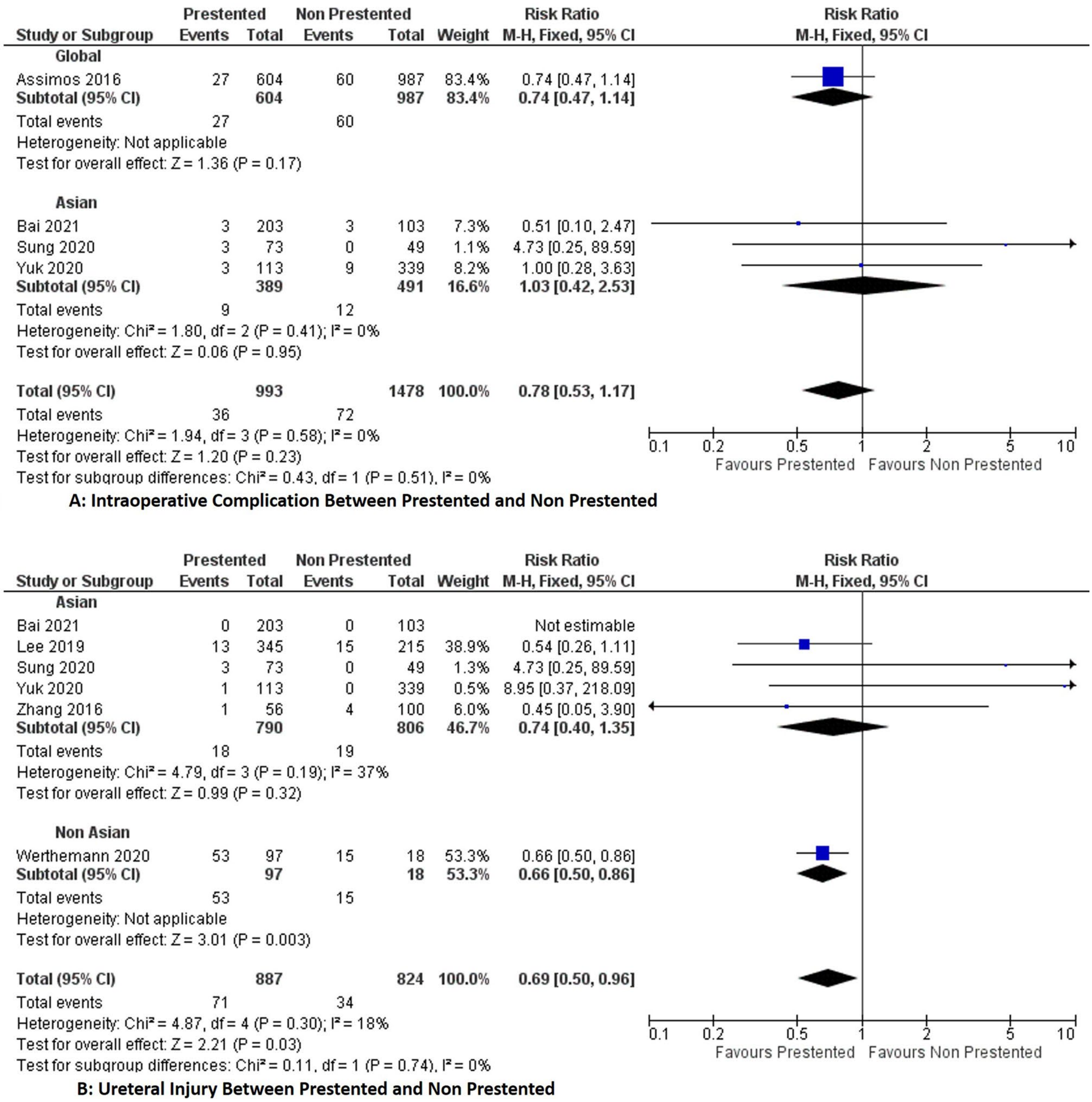

Fig. 4 **A** Forest plot of intraoperative complication between pre-stented and non-pre-stented, **B** forest plot of ureteral injury between pre-stented and non-pre-stented

rates of ureteral injury in PS patients (RR 0.69, 95% CI 0.50–0.96, $p = 0.03$).

Traditionally, the average ureteral diameter in adults has been considered to be between 1.5 and 6 mm and its narrowest part is at the level of the intramural ureter [38]. However, it has been hypothesised that ureteric diameters may vary with ethnicity, yet this had not been validated. The challenge lies in doing a dedicated study correlation using a single means of radiological investigation across different ethnicity. To our knowledge, no such study is available. That said, it is still commonly thought that the ureter size is smaller in the Asian population. This might convert in a higher failure rate for flexile ureteroscopy if pre-stenting was not performed. Song et al. have shown that Korean patients had a mean normal ureter diameter of 3.4 mm with a standard deviation of 0.61 mm [11]. Similarly, Wong et al. also demonstrated that the Malaysian population had a mean abdominal ureter diameter of 4.19 mm with a standard deviation of 1.27 mm,

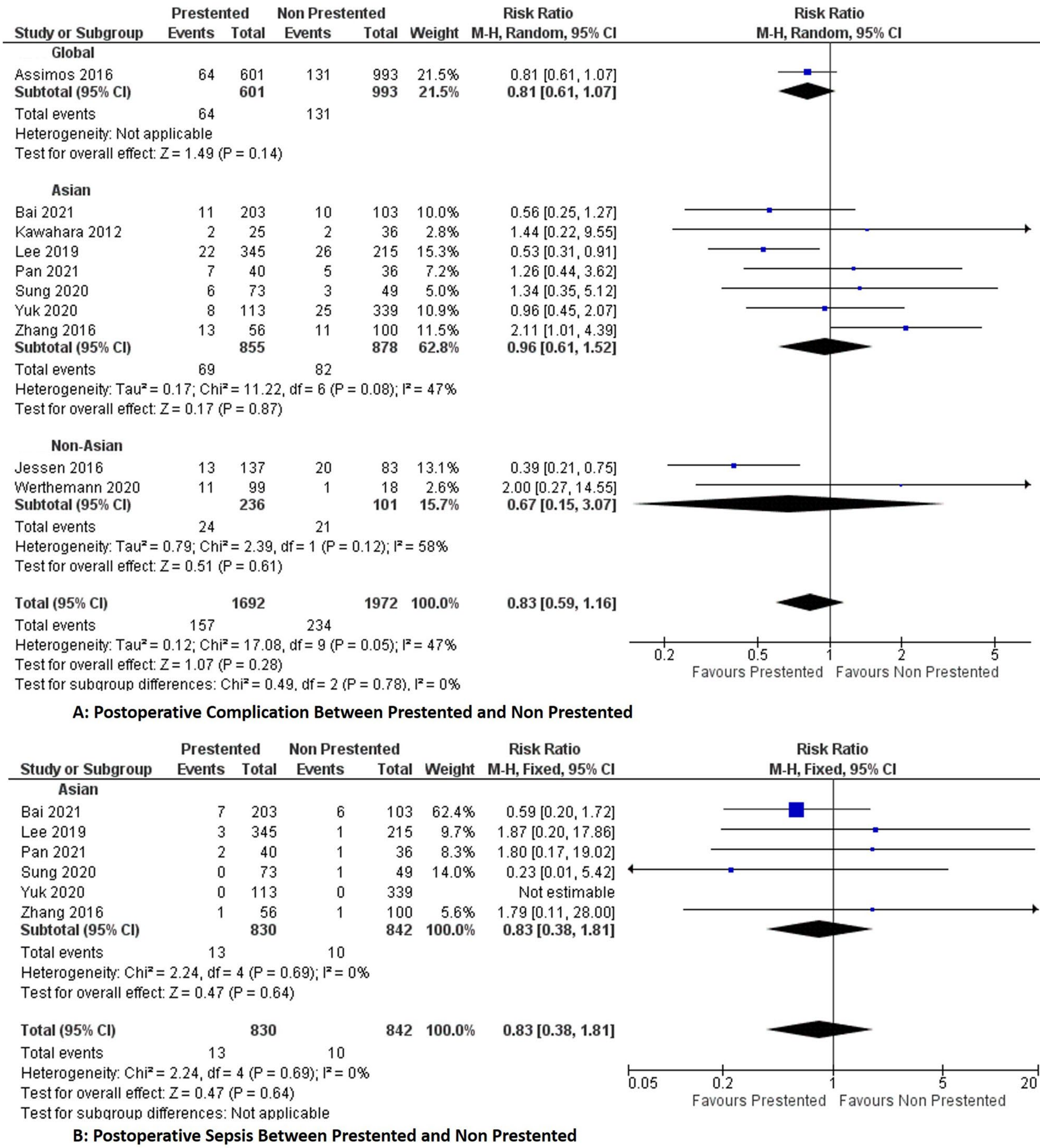

Fig. 5 **A** Forest plot of postoperative complication between pre-stented and non-pre-stented, **B** postoperative sepsis between pre-stented and non-pre-stented

and the mean pelvic ureteric diameter of 4.45 mm, with a standard deviation of 1.37 mm [39]. Both studies indirectly implied that both diameters were smaller in Asian ureters. However, a study performed in the United States of America showed that the mean normal ureteral diameter was overall smaller at 1.8 mm with a standard deviation of 0.9 mm, with 96% of included patients having a diameter smaller than 3 mm [9]. In addition, a computed tomography study in an African population found that the mean computed tomography ureteral diameter was 4.3 mm, with no significant age and gender difference [10]. The authors proposed 7 mm as the upper limit of normal calibre. This size was in line with

Caucasian population or Caucasian studies, where 8 mm was considered the normal ureteral [40, 41]. A smaller ureteral diameter was found in adult Indian in a cadaveric study, which the authors found that the mean diameter was 3.1 mm with a range of 2.4–3.6 mm [42]. Our study showed that pre-stenting was significantly more effective at achieving SFR for < 4 mm RF (RR 1.10, 95% CI 1.04–1.17, $p = 0.002$) but this correlated only in a subset analysis and favoured the non-Asian population studies (RR 1.31, 95% CI 1.13–1.52, $p = 0.0005$) The SFR in PS patients was also significantly higher in small RF < 1 mm (RR 1.10, 95% CI 1.02–1.19, $p = 0.02$) but there was no difference during subgroup analysis of the Asian and non-Asian populations.

A common concern is that pre-stenting may increase the incidence of postoperative infections and sepsis. A retrospective study of 1256 patients who underwent flexible ureteroscopy by Nevo et al. revealed an overall sepsis rate of 2.8% within 48 h of surgery [43]. In the study, pre-stenting was identified as a risk factor for post-operative sepsis (the risk of sepsis in NPS patients being 1.2%, compared with 4.7% in PS patients). The authors had shown that the risk of sepsis increased with longer stent dwell-times before definitive surgery; indeed, the risk of sepsis increased to 9.2% in patients who had a stent in situ for more than 3 months. Lee et al. evaluated 560 patients comparing the effect of preoperative ureteral stenting duration on flexible ureteroscopy outcomes [22]. Patients with indwelling stents were divided into two groups according to the length of stent placement before flexible ureteroscopy (less or more than 7 days). The authors described higher rates of Clavien grade II complications, such as urinary tract infections and pyelonephritis, in the non-pre-stented group (7.2%) with a lower prevalence in patients with short stent placement (1.8%) compared to those with long stent placement (4%). However, these differences did not reach statistical significance ($p = 0.061$). In our meta-analysis, post-operative complications and urosepsis did not significantly differ between the PS and NPS groups but data concerning stent dwell-times were not available. Ethnicity was not contributory.

Joshi et al. revealed that stenting is related to pain and irritative urinary symptoms [44]. Damiano et al. performed a randomized study shown that patients without stenting had a significantly high visual analog pain scale and more readmission for pain compared to patients with stenting after ureteroscopic management of urinary calculi [45]. Jeong et al., however, did not find any significant in pain between 45 patients who are randomized to stenting or no stenting after ureteroscopic management of ureteral calculi [46]. Interestingly, a study on factors associated with post-operative pain after RIRS for renal calculus, revealed the presence of stenting pre and post operatively did not affect postoperative pain [47]. In view of these mixed results, we intended to explore whether pre-stenting has any impact on pain experienced post operatively. In our studies, only Lee et al. reported 2 PS patients and 2 NPS patients experience pain while Kawahara et al. have no patients complaining of pain post operatively [21, 22]. 2 more studies did reported patients with pain post operatively but the results are mixed with patients with ureteral stones or patients with fever post-operatively [23, 24]. Hence, the lack of data precluded us from being able to carry out a meta-analysis.

Limitations

This meta-analysis was able to definitively demonstrate the operative outcomes and complications in the two specific patient groups (PS versus NPS only). However, it has its limitations. None of the fourteen studies included were randomized control trials so there is a need of randomised studies to offer high-quality evidence regarding this topic. There was heterogeneity in the composite studies, unavailability of data on the dwell period of stents, and differences in size and position of the renal calculi. No data on the grade of UAS ureteral injury was available in Asian and non-Asian studies. These limitations hampered the capacity for extrapolation. Furthermore, with small study numbers of 8 Asian and 5 non-Asian studies, there is room for further qualitative measurements of outcomes. We had also worked on an assumption that all study individuals were inherently Asian ethnicity in the Asian only studies and vice versa in non-Asian groups. Finally, we could not analysis the reason for PS (infection, obstruction or delayed surgery due to failure of UAS placement), making a final conclusion regarding the impact of PS on postoperative sepsis unreliable.

Conclusions

Whilst many parameters define a good outcome in RIRS, our meta-analysis suggests that pre-stenting can result in a higher success for UAS placement whilst minimising intra-operative ureteric injury. The ideal cut-off for a RF is still debatable, our meta-analysis suggests a higher overall SFR for any RF cut-off in PS cohorts. Urologist should aim for a 1 mm RF cut-off as was the trend in our meta-analysis.

In the non-Asian studies, this was of significance for < 4 mm RF and not for < 1 mm RF. Our subgroup analysis of Asian study cohorts could not show any difference in SFR for any cut-off in both PS and NPS patients. Randomised control trials may determine if ethnicity does indeed influence outcomes of RIRS.

Acknowledgements We are grateful for the useful insights and expertise provided by the Team of worldwide endourological researchers (TOWER)

Author contributions GV and LYXT conceived the study. LYXT, TJYC, CD, and GV designed the study protocol. LYXT led the development of the manuscript. LYXT performed statistics. LYXT, TJYC, CD, LEJ, CEOT, WM, PGM, GC, RE, GM, SS and GV performed data extraction and analysis. CD, TJYC, CBH, TO, SBK and GV reviewed the paper for critical intellectual content. All authors participated in manuscript writing, review, and approval of the final version of the manuscript for submission.

Declarations

Conflict of interest The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Research involving human participants and/or animals Not applicable.

Informed consent Not applicable.

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Authors and Affiliations

Y. X. T. Law[1] · J. Y. C. Teoh[2] · D. Castellani[3] · E. J. Lim[4] · E. O. T. Chan[2] · M. Wroclawski[5,6] · G. M. Pirola[7] · C. Giulioni[3] · E. Rubilotta[8] · M. Gubbioti[7] · S. Scarcella[3] · B. H. Chew[9] · O. Traxer[10,11] · B. K. Somani[12] · V. Gauhar[13]

J. Y. C. Teoh
jeremyteoh@surgery.cuhk.edu.hk

D. Castellani
castellanidaniele@gmail.com

E. J. Lim
eejeanlim@gmail.com

E. O. T. Chan
ericaotchan@gmail.com

M. Wroclawski
urologia.marcelo@gmail.com

G. M. Pirola
gmo.pirola@gmail.com

C. Giulioni
carlo.giulioni9@gmail.com

E. Rubilotta
emanuele.rubilotta@aovr.veneto.it

M. Gubbioti
marilena.gubbiotti@gmail.com

S. Scarcella
simoscarc@gmail.com

B. H. Chew
Ben.chew@ubc.ca

O. Traxer
traxer.olivier@gmail.com

B. K. Somani
bhaskarsomani@yahoo.com

V. Gauhar
vineet_gauhar@nuhs.edu.sg

[1] Department of Urology, National University Hospital, National University Health System, Singapore, Singapore

[2] S.H. Ho Urology Centre, Department of Surgery, Faculty of Medicine, The Chinese University of Hong Kong, Hong Kong, China

[3] Urology Division, Azienda Ospedaliero-Universitaria Ospedali Riuniti di Ancona, Università Politecnica Delle Marche, Ancona, Italy

[4] Department of Urology, Singapore General Hospital, Singapore, Singapore

[5] Department of Urology, Hospital Israelita Albert Einstein, São Paulo, Brazil

[6] BP-a Beneficência Portuguesa de São Paulo, São Paulo, Brazil

[7] Department of Urology, San Donato Hospital, Arezzo, Italy

[8] Department of Urology, A.O.U.I. Verona University, Verona, Italy

[9] Department of Urologic Sciences, University of British Columbia, Vancouver, Canada

[10] Service d'Urologie, Sorbonne Université, Paris, France

[11] Service d'Urologie, AP-HP, Hôpital Tenon, Paris, France

[12] Department of Urology, University Hospital Southampton NHS Trust, Southampton, UK

[13] Department of Urology, Ng Teng Fong General Hospital, Singapore, Singapore