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ORIGINAL PAPER

Meta-analysis of postoperatively stenting or not in patients underwent ureteroscopic lithotripsy

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Abstract The aim of this study was to evaluate the necessity for stenting after ureteroscopic lithotripsy. We performed a systematic research of Medline, Embase, Cochrane central registration for RCTs concerning the comparison between stented and non-stented post-ureteroscopic procedures for stone removal and reference lists of the included study were also screened. 15 trials were included and data related was extracted and analyzed in meta way. No difference was detected in stone free rate and stricture formation between the two groups ($P = 0.69$; $P = 0.67$). Participants with stents had higher risk of being infected than those without, RR = 1.72, but with no difference. Stent related lower urinary symptoms were more frequently experienced by stented patients, dysuria (RR = 5.24, $P = 0.003$); hematuria (RR = 7.28, $P = 0.001$); loin voiding pain (RR = 5.24, $P = 0.003$). Postoperative pain score were also higher in patients with stent in the early period after surgery with mean difference 0.95 ($P = 0.002$). With additional time needed for the placement of stent, the operative time in stented patients were 3.36 min longer than those without stenting ($P = 0.02$). The additional cost for longer operative room stay, together with the sent and cystoscopic stent removed conditionally, and made the cost for stented patients much higher. No difference were detected in length of hospital stay between both groups ($P = 0.22$), the stented patients were even of lower rate pay unplanned hospital visit (RR = 0.81, $P = 0.55$). Stenting did not improve the outcome of patients who underwent ureteroscopic lithotripsy, but associated with increased complication rate. Routinely stenting after ureteroscopic procedure for stone removal was not necessary; however, it still should be reserved conditionally.

Keywords Ureter stone · Ureteroscopic lithotripsy · Stenting · Lower urinary tract symptom

Introduction

Currently extracorporeal shock wave lithotripsy (ESWL) and ureteroscopy are the most common surgical management procedures applied in clinical practice. Although the ESWL has been accepted worldwide as the golden standard to remove stone in the urinary tract, ureteroscopy is being recognized as an additional method for treating urinary calculi. Though invasive, with the development of smaller and more flexible ureteroscopes and more effective novel intracorporeal lithotripters, it is now possible and safe to perform ureteroscopy in most patients. Originally it has been used to treat stones in the upper urinary tract and as well as those in the lower tract recently [1, 2].

Following the ureteroscopy, most urologist routinely insert a stent after the stone removal; this practice is based on the premise that stent placement may prevent or reduce the incidence of postoperative colic secondary to ureteral edema caused by balloon dilation or stone manipulation [3]. Routine stenting has also been thought to promote the passage of residual stone fragment and subsequently lower the risk of stricture formation [4]. However, ureteral stenting may be associated with significant patient morbidity which adversely affects the patients' life quality. Urinary symptoms related to indwelling ureteral stent are not rarely encountered in clinical practice. Many reports have

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suggested that as many as 50% of patients experienced stent related symptoms, including irritative voiding symptoms, loin pain, hematuria. Stent migration, infection, pyelonephritis and ureteral trauma due to the placement of stent have also been well described [3]. Encrustation of indwelling stent can occur in about 15% of patients at the fourth week after placement and rise to 75% after 3 months [5]. When facing with much rare complications, including stent fragmentation and knotting of the proximal end of the stent, more invasive procedures are required, therefore, risking the patients at further complications [6, 7]. Another life-threatening complication associated with ureteral stenting is ureteroarterial fistula formation which will lead to uncontrollable hemorrhage [8]. Stent placement also increase the cost of patient care, furthermore, secondary cystoscopy is required to remove the stent unless a pull string is routinely used at the distal end of the stent.

Ureteroscopy is now performed with much smaller endoscopes and better intracorporeal lithotripters, such as holmium laser, so that iatrogenic ureteral trauma during endoscopic procedures has been reduced and ureteral dilation is no longer universally required. Although many studies have suggested that patients with stent placement after ureteroscopic procedures have more significant urinary symptoms, loin pain and more narcotics than those without stents, the necessity of stenting after ureteroscopy is still questionable. Even the latest AUA/EUA guidelines on urolithiasis reported that stenting after ureteroscopy is optional. A previous review in 2007 reported uncertainty on this issue; however, it did not focused on ureteroscopic lithotripsy and only 9 studies were included [9]. Since that results of many RCTs performed after 2007 were available, it is necessary to perform a systematic review of available data and provide solid evidence for future guidelines.

Materials and methods

Search strategy

We have performed a systematic electronic search of the most widely used database (Medline, Embase) and the Cochrane central register of controlled trials through mid January 2011.

Electronic searches

Taking the search strategy of Medline for example:

#1 ((randomized controlled trial [pt]) or (controlled clinical trial [pt]) or (randomized [tiab]) or (placebo [tiab]) or (drug therapy [sh]) or (randomly [tiab]) or (trial [tiab]) or (groups [tiab])) and (humans [mh]),
#2 "tamsulosin "[Substance Name]
#3 "Tamsulosin hydrochloride"
#4 ("Ureterolithiasis"[Mesh] OR "Ureteral Calculi"[Mesh])
#5 "ureteral stone"
#6 "ureteral stones"
#7 ((#4) OR #5) OR #6
#8 (#2) OR #3
#9 ((#1) AND #7) AND #8

The other two databases were searched using the similar keywords according to their search rules. All identified studies were restricted in English.

Searching other resources

All reference lists of included studies, identified review articles and relevant trials were screened for the possible studies not identified by our electronic search. All the procedures were done by two reviewers (Song and Liao) independently.

Selection of studies

To be included, studies must be randomized controlled trials comparing stenting with no stenting after ureteroscopic procedures in adults in the setting of ureteral calculi that required interventions. Studies included patients who were undergoing diagnostic or therapeutic ureteroscopy for ureteral transitional cell carcinoma or infections were excluded. Identified studies were assessed for eligibility for inclusion in the review by scrutinizing the titles, abstracts and keywords of every record retrieved. If possible, the complete version was obtained for the unclear one. The whole process was done by two reviewers (Song AND Liao) independently, and discrepancies were solved by consensus.

Data extraction and management

Three reviewers (Liao, Yin, Liu) independently extracted details of randomization, allocation concealment, blinding, intention-to-treat analysis, completeness of follow-up and data on patients. Other data was extracted from each study on the possible condition: inclusion and exclusion criteria; stone position, stone size, type of ureteroscope and intracorporeal lithotripsy device, postoperative pain rated by patients on a validated scale, lower urinary tract symptoms, stenting associated complications, need for analgesia, unplanned medical visits or admission to hospital, mean hospital stay, mean return to normal activity time; mean cost and healthy related quality of life. When important data were not reported, we tried to contact the authors.

Whenever possible, included studies were classified according to the stone position and stone size. Relative risks (RR) were calculated for dichotomous data and mean difference with 95% confidence intervals for continuous data. Heterogeneity between the trial results was tested using a standard Chi-square test. Irrespective of the *P* value for the heterogeneity of included studies, a random-effect model was used. All analyses were performed using the review manager software version 5.0. *P* value <0.05 was considered significant for overall effect.

Assessment of risk of bias in included studies

Two reviewers (Liao, Song) independently assessed study quality using the checklist developed by us on the basis of quality assessing items provided by Cochrane organization. Discrepancies were resolved by discussion and arbitration by a third party if necessary. They assessed the details of randomization; allocation concealment; blinding of investigators, participants, and outcome assessors; intention to treat analysis; selective outcome report, completeness of follow-up, comparable basic characteristics. Based on the quality components, studies were subdivided into the following three categories: (A) all quality components adequate: low risk of bias; (B) one or more of the quality components unclear: moderate risk of bias; (C) one or more of the quality components inadequate: high risk of bias.

Results

Search result

73 studies were identified originally and the search process was demonstrated in Fig. 1, we excluded 61 after reviewing the title, abstract and eventually the full text following the principle of PICO (patients, intervention, comparison and outcome) formulated by Cochrane collaboration, leaving 12 trials for further analyses. Additionally, we included three trials by screening the reference lists of included studies. Therefore, 15 studies were left for the review.

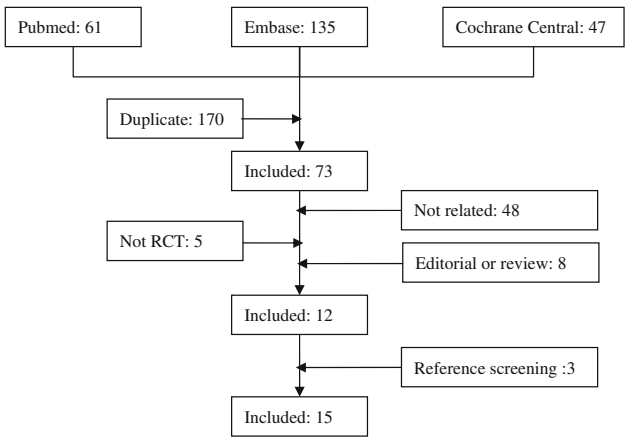

Fig. 1 Screening process of included studies

Characteristics of included studies

All included 15 trials were RCTs and reported to be published in 2001–2010 [2, 10–23] (Table 1); however, not all matched the best standard required for RCTs for lack of clear description of their methods. Only five trials described the process of randomization and allocation concealment, and with description of intention-to-treat analysis in six trials. There were six studies considered the blinding, of which four blinded the patients and two blinded both the doctors and the patients. Finally only two studies were considered to be A level (Table 2).

All studies included had similar patient recruitment criteria and 1,496 patients were included in all (Table 3). Chen [13] excluded the patients with polyps but it is not being considered in trials performed by Wang [21]. The upper limit of stones included were 2 cm and three studies explicitly defined the stone size no larger than 15 mm. Ten trials included patients irrespective of the site of the stones in the ureter, and the other five studies only focused on the lower part of the ureter defined as the portion below the inferior border of sacroiliac joint presented on the KUB film. There was no significant discrepancy in stone size between the patients stented or not in all trials, but one [17] with the stented was 9.9 ± 3.2 mm and the non-stented was 8.4 ± 3.1 mm. In the surgical procedure, only Hussein [18] reported the ureteral orifice dilation was routinely performed before the introduction of ureteroscopy and no ureter dilation in nine trials, leaving the rest with ureteral orifice dilation on the condition of necessity. The ureteroscope applied was rigid or semi-rigid with the size varied from 6 to 10.5Fr and most of the intracorporeal lithotripsy device were holmium laser, electrohydraulic lithotripsy and pneumatic lithotripsy, with one trial exception done by Netto [12] using the ultrasonic lithotripsy. Participants with intra-operative ureteral perforation or any other complications requiring stenting after the ureteroscopic procedures were specifically underlined and excluded from all trials. The stent size reported varied from 4.7 to 7Fr, and the stenting duration varies postoperatively 3 days to 4 weeks. They were reportedly removed by cystoscopy in five trials and by drangler or cystoscopy in two studies.

Outcome measures

The stone free rate and ureter strictures were the primary efficacy outcome measures and stent related complications were the primary safety outcome measures including postoperative pain, lower urinary tract symptoms and urinary

Table 1 Basic information of included studies

Author	No. patients		Ureteral dilation	Type of ureteroscope	Intracorporeal lithotripsy device	Stone retraction device	Stent removal	Follow-up	Conclusion
	Stented	Non-stented							
Borboroglu [10]	53	54	If required	Semirigid 6–9.5Fr	YAG laser; Electrohydraulic lithotripsy	3–4.5Fr ureteroscopic basket	Drangler or cystoscopic;	48 h; 1, 4 weeks	Stenting is not necessary
Denstedt [11]	28	28	No	Semirigid 6.9Fr; flexible 7.5Fr	Holmium laser; Electrohydraulic lithotripsy	No	NR	1,612 weeks	Stenting is not necessary
Netto [12]	133	162	No	7.5Fr rigid	Ultrasonic lithotripsy	Basket	Drangler or cystoscopic;	3–12 months	Stenting is not necessary
Chen [13]	30	30	No	6Fr rigid	Electrohydraulic lithotripsy	No basket or stone retractor	NR	3, 7 days; 4 weeks	Stenting is not necessary
Cheung [14]	29	29	No	Semirigid (6.5/7Fr)	Holmium laser	Basket if required	Cystoscope	1, 3, 10 days; 2–3 months	Stenting is not necessary
Srivastava [15]	26	22	If required	Semirigid 8.5F	Pneumatic lithotripsy	Basket if required	NR	3 weeks	Stenting is not necessary
Jeong [16]	23	22	If required	8.5F rigid	Electromechanical lithotripter	Stone forceps or basket	NR	7, 28 days	Stenting is not necessary
Al-Ba'adani [17]	40	45	If required	Semirigid 8–11Fr	Pneumatic lithoclast	Dormia forceps lithoclass	NR	Not clear	Stent should be limited to those with ureteric injury, bigger sizes and prolonged operative time
Hussein [18]	28	28	18Fr balloon	Ureteroscope (8.2Fr)	Pneumatic lithotripsy	Dormia baskets and stone graspers	NR	1, 3, 6 months	Stenting is not necessary
Kenan [2]	21	22	No	Semirigid 8/9.8Fr	Pneumatic lithotripter	Additional forceps application (AFA) if required	Cystoscope	3 months	Stenting is not necessary
Shao [19]	58	57	NO	Semirigid 8/9.8Fr	Holmium laser	No	Cystoscope	12 weeks	Stenting is not necessary
Ibrahim [20]	110	110	If required	Semirigid 7 to 10.5Fr	Holmium laser; ballistic energy	Dormia basket or forceps	NR	25 ± 9 months	Stenting is not necessary
Wang [21]	71	67	No	7.0F semirigid	Pneumatic lithotripsy	Basket	NR	1 day; 6, 12 weeks	Stent should be limited in ureteral edema or polypoid change with pyuria
Xu [22]	55	55	No	7Fr semirigid	Holmium laser	Forceps if required	Cystoscope	48 h; 1, 3 weeks; 3 months	Stenting is not necessary
Cevik [23]	30	30	No	8F semirigid	Pneumatic lithotripsy	Grasping forceps; Basket catheters.	Cystoscope	3 months	Stenting is not necessary

NR not reported

Table 2 Quality evaluation of included studies

Author	Randomization	Allocation concealment	Blinding	Intention-to-treat analysis	Completeness of follow-up	Basic line comparable	Selective outcome report	Quality Level
Borboroglu [10]	Yes	Yes	Patients, doctor	Yes	Yes	Yes	No	A
Denstedt [11]	Yes	Yes	Not clear	Yes	Yes	Yes	No	B
Netto [12]	Not clear	Not clear	Not clear	Not clear	Yes	Yes	No	B
Chen [13]	Not clear	Not clear	Not clear	Not clear	Yes	Yes	No	B
Cheung [14]	Not clear	Not clear	Not clear	Not clear	Yes	Yes	No	B
Srivastava [15]	Yes	Yes	Not clear	Not clear	Yes	Yes	No	B
Jeong [16]	Not clear	Not clear	Not clear	Not clear	Yes	Yes	No	B
Al-Ba'adani [17]	Not clear	Not clear	Not clear	Not clear	Yes	Not in stone size	No	B
Hussein [18]	Not clear	Not clear	Patients	Not clear	Yes	Yes	No	B
Kenan [2]	Not clear	Not clear	Not clear	Not clear	Yes	Yes	No	B
Shao [19]	Not clear	Not clear	Patients	Yes	Yes	Yes	No	B
Ibrahim [20]	Yes	Yes	Patients, doctor	Not clear	Yes	Yes	No	B
Wang [21]	Yes	Yes	Patients	Yes	Yes	Yes	No	A
Xu [22]	Not clear	Not clear	Patients	Yes	Yes	Yes	No	B
Cevik [23]	Not clear	Not clear	Not clear	Yes	Yes	Yes	No	B

tract infection. Items including operative time, length of hospital stay, unplanned hospital visit, analgesic requirement, cost, recovery to normal activity and health-related quality of life were considered as the secondary outcome measures.

Primary outcome measures

Stone free rate and stricture formation. All authors but Jeong [16] explicitly demonstrated the stone free rate at the end of the follow-up. Of the 14 studies, 11 studies reported 100% stone free rate in stented group [12, 13, 15, 18–22], with one more study in non-stented group [17]. Even in those studies with incomplete stone passage, the stone free rate was still as high as 97% [14, 23]. There was no difference in the stone free rate between both groups, with $P = 0.69$; RR = 0.71, 95% CI [0.13–3.87] (Fig. 2). Cevik reported those who were not stone free were successfully treated by shockwave lithotripsy (SWL); and the patient in the non-stented group who was not stone free after ureteroscopic lithotripsy did not have stent placement before SWL [23]. Stricture formation during the follow-up was mentioned in 11 trials [2, 10–12, 14, 15, 19–23], 8 trials reported that no stricture were detected. Even for the trials with reported stricture [12, 14, 20], the stricture rate was 0.91–6.90% in stented group, and 1.82–17.24% in non-stented group. There was no discrepancy in the proportion of participants developing ureteral strictures with stents or not, with $P = 0.44$; RR = 0.72, 95% CI [0.16–3.33]. For those patients with stricture formation, Ibrahim [20] reported that all were successfully treated with laser endoureterotomy and fixation of a ureteral Double-J stent for 3 weeks.

Stent related complications

Lower urinary tract symptoms. The most prevalent lower urinary tract symptoms were painful voiding, frequency, urgency, hematuria and urinary tract infection and they were analyzed in all 15 included trials at various lengths of follow-up. Combined analysis of applicable data demonstrated that participants with stent were at a much higher risk in developing dysuria (RR = 5.24, 95% CI [1.75–15.66]; $P = 0.003$) and hematuria (RR = 7.28, 95% CI [2.20–24.06]; $P = 0.001$) (Fig. 3). There were also a higher rate of loin voiding pain (RR = 5.24, 95% CI [1.75–15.66]; $P = 0.003$) and urgency/frequency (RR = 4.34, 95% CI [1.87–10.08]; $P = 0.0006$) in those with stents postoperatively. No difference was detected in postoperative fever rate between both groups (RR = 0.95; 95% CI [0.45–1.99]; $P = 0.88$), however, all authors but Shao [19] clear explained the reason that was acute pyelonephritis and they were treated with intravenous antibiotics for 1 week in the emergency room. Data from other trials, although not suitable to be used for meta-analysis, all showed that lower urinary tract symptoms were more prevalent in the stented group with a statistically significant difference. Even in two trials using visual analog scores to evaluate postoperative symptoms, the score of stented group was much higher than that of the non-stented group at the first week; but not

Table 3 Basic information of included patients

Author	Mean age (year)		Stone position		Stone size (mm)		Stone free rates (%)		Stent size
	Stented	Non-stented	Stented	Non-stented	Stented	Non-stented	Stented	Non-stented	
Borboroglu [10]	39.8 ± 13.7	42.5 ± 14.6	Lower part	Lower part	6.6 ± 1.5	6.6 ± 1.8	100	100	NR
Denstedt [11]	49 ± 15	54 ± 15	Upper: 20; mid: 5; lower: 4	Upper: 23; mid: 3; lower: 3	NR	NR	100	100	NR
Netto [12]	Median: 43	Median: 39	Upper: 10; mid: 20; lower: 103	Upper: 8; mid: 20; lower: 134	Distal: 0.93; mid: 0.91; lower: 0.83	Distal: 0.86; mid: 1.46; lower: 0.96	100	100	NR
Chen [13]	44.6 ± 10.5	38.8 ± 11.8	Upper: 4; v 2; lower: 24	Upper: 4; mid: 2; lower: 24	6.26 ± 1.39	6.17 ± 1.44	100	100	7Fr
Cheung [14]	51.2 ± 15.3	53.1 ± 13.0	Upper: 6; mid: 2; lower: 21	Upper: 12; mid: 5; lower: 12	9.8 ± 3.7	9.6 ± 4.7	97	97	6Fr
Srivastava [15]	36.12 ± 10.66	32.05 ± 8.49	Lower part	Lower part	7.58 ± 1.92	7.82 ± 1.53	100	100	6Fr
Jeong [16]	50.5	42.9	Upper: 4; mid: 2; lower: 17	Upper: 1; mid: 0; lower: 21	7.1	5.3	NR	NR	7Fr
Al-Ba'adani [17]	34.35 ± 13.36	34.36 ± 15.53	Upper: 1; mid: 4; lower: 40	Upper: 4; mid: 2; lower: 19	9.9 ± 3.2	8.4 ± 3.1	97.50	100	6Fr
Hussein [18]	39.4 ± 11.2	37.8 ± 9.6	Lower part	Lower part	12.6 ± 0.9	13.1 ± 0.9	100	100	NR
Kenan [2]	35.28 ± 9.0	36.09 ± 9.7	Lower part	Lower part	13.28 ± 2.5	12.90 ± 2.4	100	100	4.8 Fr
Shao [19]	47.0 ± 10.9	45.3 ± 13.2	Mid: 16; lower: 42	Mid: 12; lower: 45	9.5 ± 2.5	9.3 ± 2.4	100	100	4.7Fr
Ibrahim [20]	36 ± 9	39 ± 11	Lower part	Lower part	13.3 ± 3.3	12.4 ± 2.9	100	100	6Fr
Wang [21]	54.3	54.6	Upper: 9; mid: 26; lower: 36	Upper: 6; mid: 22; lower: 39	10.1	9.9	100	100	7Fr
Xu [22]	38.69 ± 6.00	40.04 ± 5.15	Mid: 46; lower: 9	Mid: 44; lower: 11	11.19 ± 2.11	11.46 ± 2.24	100	100	4.8Fr
Cevik [23]	44.1 ± 15.2	46.5 ± 12.5	Mid: 8; lower: 22	Mid: 7; lower: 23	9.1 ± 4.5	7.5 ± 2.1	97	97	4.8F

NR not reported

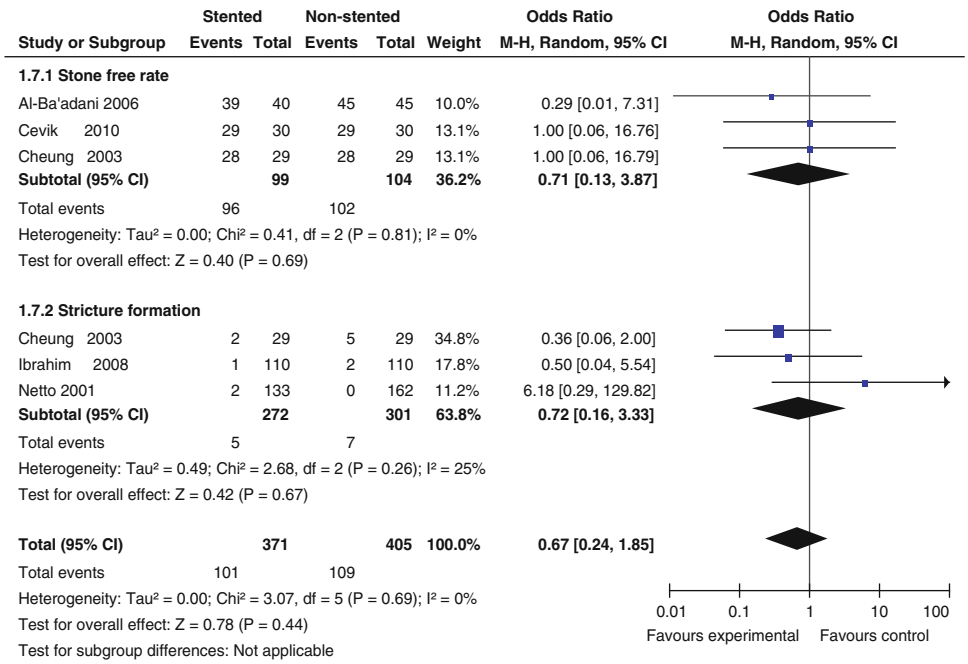

Fig. 2 Primary efficacy outcome measures

in 6 and 12 weeks [2, 10, 19, 20] for stents were removed 1–2 weeks after the ureteroscopic procedures.

Urinary tract infection. There were 5 trials reported on urinary tract infection [11, 13, 14, 19, 21] and it was indicated by urine analysis postoperatively. The meta-analysis showed no discrepancy in both groups (RR = 1.72, 95% CI [0.40–7.29]; $P = 0.46$] (Fig. 4). Chen [13] reported that participants with stent had significantly more pyuria in the first 3 days postoperatively and more newly onset in those with stents. However, no difference was found in the first week and all subsided in 28 days.

Postoperative pain. Postoperative pain score were measured in 12 trials and all authors used 10 cm visual analog pain scale, with zero meant no pain and 10 represented the severe pain with intolerability. However, the check point was at different intervals of right after the procedure to 12 weeks later. Therefore, most of their reporting data can not be analyzed in meta way, only three trials reported the pain on the first day after the ureteroscopy [14, 15, 21]. In these studies whose result could not being included for meta-analysis, postoperative pain was significantly severe in stented group in the first postoperative period and it gradually subsided with no discrepancy in the 6–12 weeks [11, 21]. Another two studies demonstrated contra-dictionary results that Kenan [2] reported the mean postoperative pain score was statistically similar in both groups ($P > 0.05$) and Hussein [18] reported that at days 1 and 3 the mean visual analog pain score in stented group was lower than in non-stented group even the difference was statistically not significant. In our result, the mean difference between stented and non-stented group in postoperative pain score was 0.95 (95% CI [0.34–1.56]; $P = 0.002$) (Fig. 5), and confirmed the conclusion of most trials that postoperative pain score in stented group was greater than the non-stented in early postoperative period.

Secondary outcome measures

Operative time. Most of the authors found the operation with stenting took longer time [2, 11, 15–20, 22, 23]. This is reasonable that the placement of the stent required additional time. The result of meta-analysis also confirmed the finding of 3.36 min longer, with significant difference ($P = 0.02$; 95% CI [0.55–6.17]) (Fig. 6). The data reported by Jeong [16] could not be taken into meta-analysis with 2.8 min longer in participants with stents, but another study reported that no difference with 23.6 versus 24.9 min in stented and non-stented group, respectively [21].

Length of hospital stay. Of the 15 trials, 4 studies considered the length of hospital stay and the majority of the participants were discharged at the same day of surgery [2, 17, 20, 23]. Combined analysis of these four studies showed a longer hospital stay in patients with stents of 1.7 h ($P = 0.22$, 95% CI [−1.04 to 4.45]) (Fig. 7).

Unplanned hospital visit. 44 patients experienced unplanned hospital visit after discharging, of which, 19 were stented and 25 were non-stented. Of the explicitly described postoperative complications requiring unplanned hospital stay, 13 were for pain control, 10 for infection, one for stent migration and postoperative omitting, respectively. All were treated conservatively but 2 patients in non-stented group were stented for pain control and stent removed for the one with stent migration. The pooled

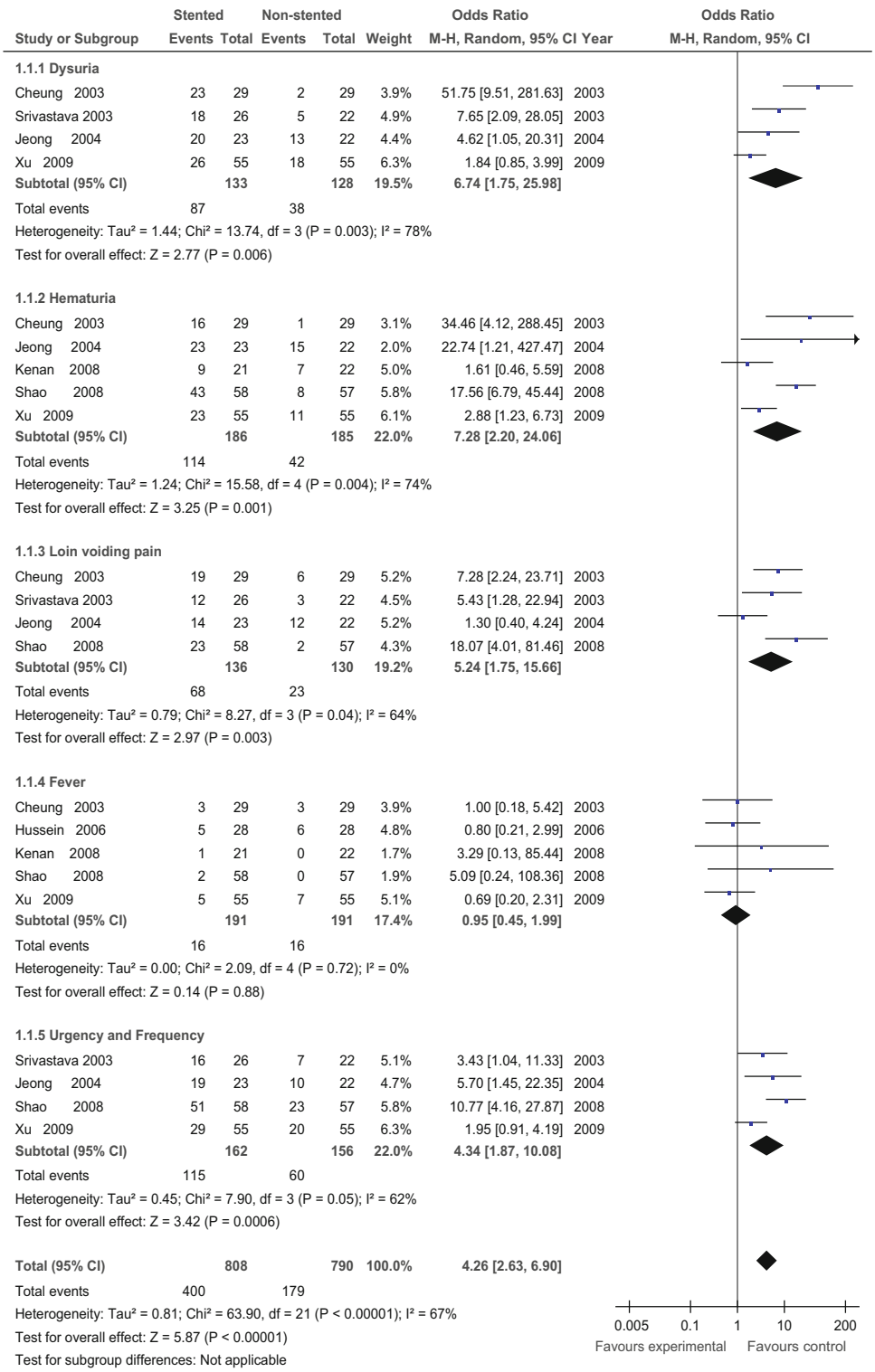

Fig. 3 Stent related lower urinary symptoms

analysis showed no difference in both groups (RR = 0.81, 95% CI [0.41–1.63]; $P = 0.55$) (Fig. 8).

Analgesic requirement. Five trials reported on the analgesic requirement after ureteroscopic procedure [10–13, 15, 17], only two found significant difference in narcotic use between both groups [10, 17], with participants need analgesia in stented group were 35 and in non-stented were 16 [17].

Recover to normal activity and healthy related quality of life. The questionnaire evaluated the impact of stents

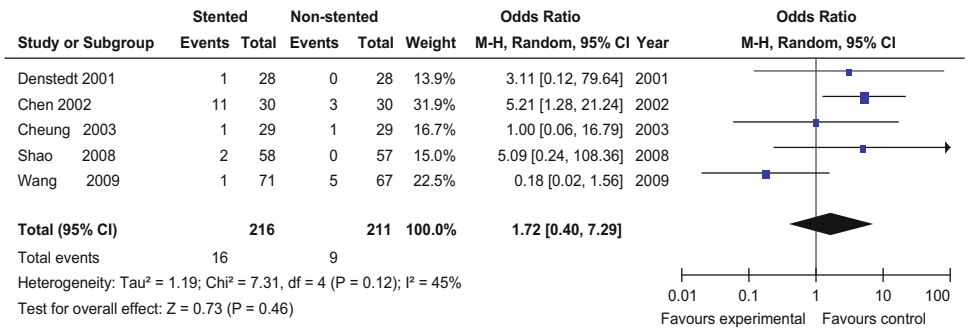

Fig. 4 Urinary infection

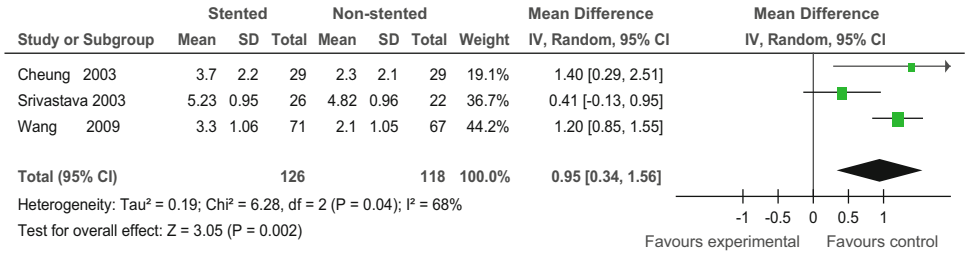

Fig. 5 Postoperative pain on the first day

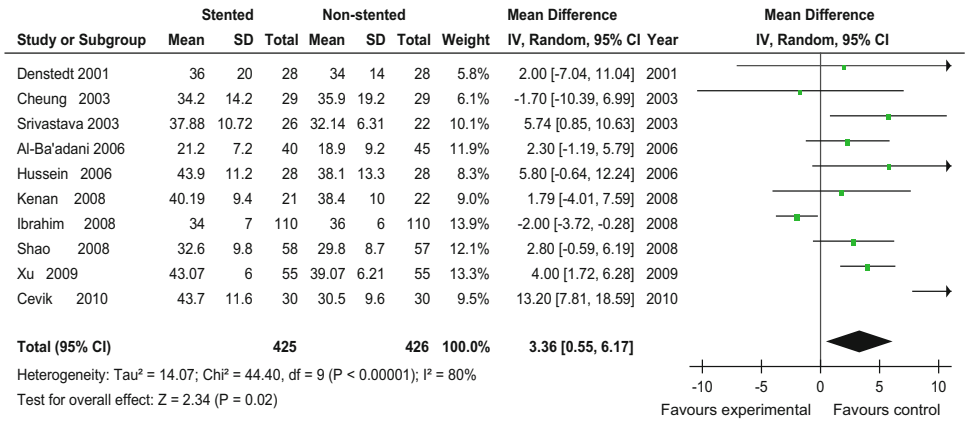

Fig. 6 Operative time

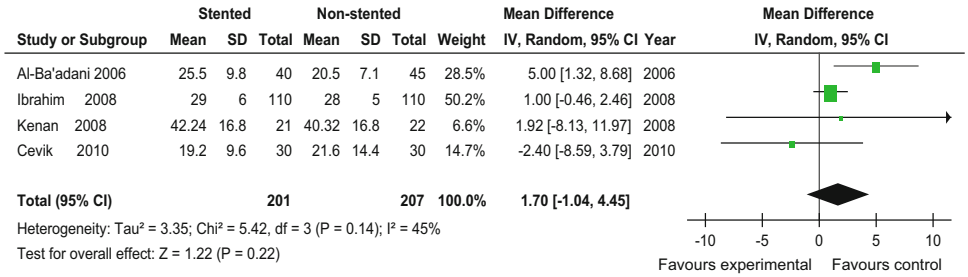

Fig. 7 Length of hospital stay

on quality of life (QOL) was evaluated in the second week after the operation by Shao [19], with 4.5 ± 1.0 versus 1.6 ± 1.1 ($P < 0.0001$) in stented and non-stented group (higher score indicating worse QOL). Chen [13] reported that 25 (82.5%) in the stented group patients returned to normal physical activity on the following day, 4 (13.2%) after 2 days and 1 (3.3%) after 3 days. Of the non-stented group 24 (79.2%) returned to normal physical activity the following day, 4 (13.2%) after 2 days and 2 (6.7%) after 3 days. Another study done by Ibrahim also reported the mean time recover to normal activity was 7 ± 4 and 8 ± 5 without statistical difference ($P = 0.48$).

Cost. There were three studies reported on health economics of stenting. Although the three studies were undertaken in different countries with contrasting economic development, it was the consensus that the cost were higher in stented group than non-stented ($3,727.82 vs. $2,445.31 in Brazil, 2001; additional $114 in China, 2008; additional $950 in Turkey, 2010) [2, 18, 22].

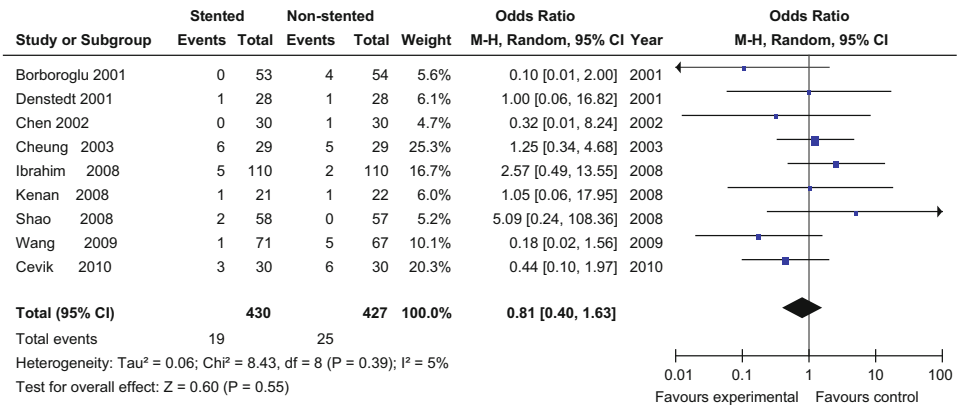

Fig. 8 Unplanned hospital visits

Discussion

Ureteral stenting after ureteroscopic lithotripsy was a common practice among urologists attempting to prevent postoperative complications. This practice is based on the premise that stent placement may prevent or reduce the incidence of postoperative colic secondary to ureteral edema caused by balloon dilation or stone manipulation [3]. Routine stenting has also been thought to promote the passage of residual stone fragment and subsequently lower the risk of stricture formation [4]. Urinary symptom related to indwelling ureteral stent are not rarely encountered in clinical practice and many previous studies have demonstrated 50% of patients experience stent related symptoms [3]. With the development of small caliber ureteroscopes, routine balloon dilation of the ureter before the introduction of the ureteroscope is seldom required. This fact, together with the improvement in novel intracorporeal lithotripter resulting smaller calculi fragments, the long rooted concept that postoperative routine stenting is being questioned.

Summary of main results

Many observational studies have shown that routine stenting was not necessary after uncomplicated ureteroscopic procedures for distal ureteral stone removal [24, 25]. A case control study done by Hollenbeck found same result in ureteral tract irrespective of the upper or middle part [26]. All our included studies were of the same conclusion that post-ureteroscopic stenting was not mandatory for stone removal and stone position was not specified in most studies, especially on the condition of uncomplicated procedure and without balloon dilation of the ureteral orifice. This conclusion even could be extended to the stone as large as 2 cm. In the specific condition, manipulation of stones in bilharzial ureter was less risky due to its natural thick wall and luminal dilation, this made stenting routinely after ureteroscopy a questionable issue [18]. In the condition of impacted stone, routine placement of a ureteral stent was not mandatory in patients without intraoperative complications such as perforation and severe trauma [23].

In this systematic review, we found that there was no difference in stone free rate and postoperative stricture formation in stented and non-stented participants. Stenting after ureteroscopic lithotripsy is associated with increased lower urinary tract symptoms such as dysuria, frequency and urgency, or irritative voiding flank pain. In the aspect of postoperative pain, stented patients were of higher pain score on the first day after the operation and it subsided gradually into painlessness in 6–12 weeks with no difference in both groups. Even implants were thought to be a risk factor for infection; the participants with stents were at a higher risk of being infected, no difference was detected.

We also evaluated the aspects related to operation procedure considered as secondary outcome. No significant discrepancy between the groups with and without stents in length of hospital stay, unplanned hospital visit. Because additional time was required for stents placement, the operative time was 3.36 min longer. In the western countries, operative cost was measured by minutes. Because of the longer operative time together with the cost of stent and cystoscopic removal conditionally, more cost was required with 114 dollars even in China. When considering the recovery, both groups were of similar time returning to normal activity, but patients with stents were of poorer life quality.

Although 15 included studies were proclaimed RCTs, only two matched the best standard required for a good clinical trial and the majority was considered with middle level quality. Not all trials were of the similar included criteria for all aspects such as stone size and specific characteristics of stone and ureter. After randomization, participants with intra-operative complications were excluded from analysis in some trials, indicating potential reporting bias still should be considered. There was a lack of standardization of procedures performing as well. For example, different ureteroscope size, balloon dilation of the

ureter orifice, and varied intra-corporeal lithotripter were intra-heterogeneous of included studies. Discrepant outcome follow-up period, stenting durations and pre- or post-operative pharmacy therapy were another source of heterogeneity. Another flaw of this review was that all included studies were of small sample size and most of them were of short follow-up period.

Applicability of evidence

As stenting after ureteroscopic procedures for stone removal may cause so many complications and increased cost without improving patients' outcome, it should not be performed routinely. This proposal has been advocated in the latest AUA/EUA guidelines on urolithiasis, we recommended that this procedure should be omitted in clinical practice. Although all these results did not favor the routine stenting after ureteroscopic procedures for ureteral calculi, it still should be reserved to those with ureteric injury, bigger stone sizes and prolonged operative time. When there is ureteral edema or polypoid change with pyuria, ureteral stents should be indwelled to avoid severe postoperative complications as well. However, this recommendation should be interpreted with caution. Although all included studies were proclaimed RCTs, only two matched the best standard required, other studies were potentially flawed in study design, lack of standardization of outcome measures. Another consideration in the application of our recommendation was the medical atmosphere of different countries. As a latest article in Lancet reported that the Chinese doctors were under threat because of tense relationship with patients. Many Chinese doctors preferred to stent after ureteroscopic procedures routinely for avoiding potential disputes or court issues [27].

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