Outcomes of ureteroscopy and internal ureteral stent for pregnancy with urolithiasis: a systematic review and meta-analysis

URS or DJ stent for pregnancy urolithiasis

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ABSTRACT

Objectives

To investigate the outcomes of internal ureteral stent versus ureteroscopy (URS) treatments for pregnant women with urolithiasis.

Data Sources

Relevant studies published from January 1980 to April 2020 were identified through a systematic literature search in MEDLINE, EMBASE, Web of Science and the Cochrane Library.

Methods of Study Selection

A total of 453 studies were initially identified. Pregnant women in any pregnancy stages who underwent D-J stent insertion only or ureteroscopy operation for urolithiasis treatment were included. The number of related participants in each group of study should be more than 10. This systematic review have been registered on the PROSPERO website (CRD42020195607).

Results

A total of 25 studies were identified with 131 cases undergoing serial stenting and 789 cases undergoing URS operation. The pooled operation success rate was 97% for D-J stent insertion, and 99% for URS. Only a few patients passed stone spontaneously after serial D-J stenting. The pooled SFR in URS operations was about 91%. For internal ureteral stent therapy, the rate of normal fertility outcome was 99%, but the pooled incidence of complications was about 45%. For the URS treatment group, the rate of normal fertility outcome was 99%, and the pooled incidence of complications was about 1%. However, the pooled premature and abortion incidence rate of two group were the same as less than 1%, and the same as this in serious complication incidence rate.

Conclusions

Although internal ureteral stent may cause more slight complications, both ureteroscopy operation and internal ureteral stent showed less side effective on fertility results in pregnancy with symptomatic urolithiasis. Evidence suggests that URS therapy may have a greater advantage for pregnancy with urinary stones when the condition permit. As it is proved safe and effective, internal ureteral stent could be considered at emergency or other special situations.

Keywords: Pregnancy; Urolithiasis; Double-J stent; Ureteroscopy; Fertility outcome.

INTRODUCTION

The incidence rates of pregnant women with symptomatic urinary tract stones is reported as range from 1 in 2000 to 1 in 200[1]. Symptomatic urolithiasis can lead to renal colic, urinary tract infection and ureteral obstruction posing significant morbidity and potentially mortality not only to mother but also to child. The main risks are pre-term delivery and premature rupture of membranes, which brings serious health risks to the fetus[2, 3]. It is important for the urologists and obstetricians to be aware of the management of this condition.

When managing a pregnant patient with urolithiasis, conservative management is favoured where possible. Surgical intervention are available for those that do not improve with conservative measures [4]. Ureteroscopy (URS) and internal ureteral stent are the most widely used in pregnancy with symptomatic urolithiasis[5]. Insertion of double-J (D-J) stent till definitive treatment in the postpartum period is a temporising measure and related studied is not so many. And with continued advancements in endoscopic technology and endourological techniques, URS seems to be considered as first-line treatment in the management of ureteric stones in pregnancy. However, although the latest 2020 European Association of Urology (EAU) guideline has recommended URS as reasonable alternative option [6], there is still lack of evaluation of evidence-based medicine in comparison between URS and internal ureteral stent. This systematic review and meta-analysis tried to update the outcomes of internal ureteral stent and URS treatments for pregnant women with urolithiasis and make a comparison.

METHODS

We performed the systematic review according to a predetermined protocol and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P) guidelines[7]. We had registered our systematic review on the PROSPERO website (www.york.ac.uk/inst/crd, registration number: CRD42020195607). Two reviewers independently undertook the literature search (X.J. and B.L.), assessment for eligibility (X.J. and B.L.), data extraction (Y.S. and W.T.), and qualitative assessment (D.W. and Y.X.). Any inconsistencies between the two reviewers were reviewed by a third reviewer (L.Z.) and resolved by consensus. By consensus among all three reviewers (X.J., B.L. and L.Z.), if data sources were duplicated in more than one study, only the original study was included in the meta-analysis.

PICOS definition of this study:

Participants: Pregnant women with urolithiasis whatever which pregnancy stage they were.

Intervention: D-J stent insertion only.

Comparators (controls): URS operation for lithotripsy/stone extraction/exploration.

Outcome: Fertility results and complications .

Study design: RCTs and observational studies (case-control, cross-sectional and cohort) were included in this systematic review and meta-analysis.

Eligibility criteria: 1). Pregnant women in any pregnancy stages who underwent D-J stent insertion only or ureteroscopy operation for urolithiasis treatment were included. 2). Studies published between January 1980 and April 2020 were eligible for evaluation. 3). The number of related participants in each group of study should be more than 10.

Studies were excluded if they: 1). Article type including review, comment, letter, guideline, or meta; 2). Related data of pregnancy or interventions was lack; 3). Photographic skill, equipment evaluation or diagnosis criteria of urolithiasis in pregnancy; 4). Research for neonates; 5). Physiologic hydronephrosis without stone disease; 6). Extracorporeal shock wave lithotripsy, percutaneous nephrostomy, or other treatments for pregnancy with urolithiasis.

Search strategy

We conducted a literature search using PubMed (MEDLINE), Embase, Web of Science and the Cochrane Library which were published from January 1980 to April 2020. The Medical Subject Heading (MeSH) terms were used in conjunction with the following keywords for our search: (Pregnanc* or Pregnancy or Pregnant or Gestation* or Pregnant woman or Mother*)**AND** (Urinary Calcul* OR Urinary Calculi OR Urinary Calculus OR Urinary Stone* OR Urinary Tract Stone* OR Ureteral Calcul* OR Ureteral Calculi OR Ureteral Calculus OR Kidney Calcul* OR Kidney Calculi OR Kidney Calculus OR Nephrolith OR Renal Calcul* OR Renal Calculi OR Renal Calculus OR Kidney Stone* OR Staghorn Calcul* OR Staghorn Calculi OR Staghorn Calculus OR Urinary Lithiasis) **AND**

(Ureteroscopies OR Ureteroscopic OR Ureteroscopic Surgical OR Ureteroscopic Surgical Procedure* OR Ureteroscopic Surgery OR Ureteroscopy) **AND** (Double-J stent OR Ureteral stent OR Ureteral double-J stent OR Ureteral D-J stent OR Double J ureteral stent OR D-J ureteral stent OR stent OR D-J stent). Full search strings are presented in **Table S1**. References from relevant articles, editorials, conference abstracts, letters, and reviews were thoroughly reviewed to identify additional studies. Full manuscripts of every article with a relevant title and abstract were then reviewed for eligibility.

Data extraction and qualitative assessment

Two reviewers (Y.S., W.T.) independently extracted the following study-level characteristics from each eligible study: first author, year of publication, country where the study was conducted, journal, study period, age, trimester, diagnose method, stone location and size, anesthetic method, intervention and sample size, operation success rate, stone free rate (SFR), fertility outcome, complications and follow-up pattern. Two groups were set as different treatment procedures: internal ureteral stent (D-J stent) therapy group and URS group. Fertility outcomes included normal delivery, cesarean section, premature labour, abortion and others which were listed in tables below. Final fertility results were used to assess treatments, and only premature labour and abortion were considered as serious fertility outcomes which meant failed in saving fetus. Fertility outcomes and complications were also assessed with Clavien-Dindo classification which as showed in **Table S2**. Clavien-Dindo III-V was regarded as serious complications.

We applied the Newcastle-Ottawa Scale (NOS) quality assessment tool to evaluate the quality of the selected observational studies. This tool was used to measure the key aspects of the methodology in selected studies with regard to design quality and the risk of biased estimates based on three design criteria: 1) selection of study participants; 2) comparability of study groups; and 3) assessment of outcome and exposure with a star system (with a maximum of 9 stars). We judged studies that received a score of 7-9 stars to be at low risk of bias, studies that scored 4-6 stars to be at medium risk, and those that scored 3 or less to be at high risk of bias. A funnel plot was used to assess the publication bias. Any disagreement on the data extraction and quality assessment of the studies were resolved through comprehensive discussion (D.W., Y.X. and L.Z.).

Statistical analysis

Study-specific prevalence rate estimates were combined using a random-effects model, that considers within-study and between-study variations. Corresponding 95% Confidence Interval (CIs) were extracted directly from articles where available. The statistical heterogeneity among studies was evaluated using Cochran's Q test and I^2 statistic, with values of 25%, 50%, and 75% representing low, moderate, and high heterogeneity, respectively. The criterion for identifying heterogeneity was a *P* value less than 0.05 for the Q test.

An estimation of publication bias was evaluated by the Beggs funnel plot, in which the SE of log (OR) of each study was plotted against its log (OR). An asymmetrical plot suggests possible publication bias. Egger's linear regression test assessed funnel plot asymmetry, a statistical approach to identify funnel plot asymmetry on the natural logarithm scale of the rates. All statistical analyses were performed using Stata (version 14.2; StataCorp LP, College Station, Texas). All *P* values were two-sided, and $P < 0.05$ was considered as statistically significant.

RESULTS

Selection of studies

A detailed PRISMA flow diagram of literature search and inclusion criteria were shown in **Figure S1**. A total of 453 studies were initially identified with this literature search (123 from Pubmed, 147 from Embase, 144 from Web of Science and 29 from Cochrane Library).198 studies were excluded due to duplication and 208 were excluded after screening the titles and abstracts. 22 other studies were excluded after full-text review. Finally, a total of 25 studies were identified as eligible for systematic review and meta-analysis.

The published time span of twenty-five studies included was year 1995-2018, and the research period of cases was between 1984 to 2016. Common information of publications was showed in **Table 1**. Briefly, among these studies, 1 from Norway[8] ,1 from Italy[9], 2 from America[10], 1 from Brazil[11], 1 from Pakistan[12], 4 from Egypt[13, 20, 27, 29], 5 from China[14, 22, 28, 30, 32], 6 from Turkey[15-18, 21, 25], 2 from Iran[23, 31], 1 from Iraq[24] and 1 from Romania[26]. The age range was from 16 to 41, and urolithiasis occurred in the second trimester most. Ultrasound was the most commonly used diagnostic method.

The most common sites of calculi were as follows: distal ureter, medium ureter, proximal ureter. The average stone size was between 6-17mm.

Subgroup analysis and meta-analysis

There were 2 studies involving D-J stent insertion only[10, 24], 19 studies involving URS operation[8, 9, 11-21, 23, 25, 26, 29-31], and 4 involving both[22, 27, 28, 32]. A total of 131 cases undergoing internal ureteral stent only and 789 cases undergoing URS operation. Common results were showed in tables and occurrence rates (ORs) were calculated and compared by meta-analysis.

Detailed data of internal ureteral stent therapy was showed in **Table 2**. The most commonly used anesthesia was local anesthesia. The pooled operation success rate was 97% [**Figure 1**, 95% CI, 0.94-1.01]. Only one related study[22] mentioned stone passing spontaneously in 3 patients, which reported as an accident situation. The pooled ORs of normal fertility outcome was 99% [**Figure 2**, 95% CI, 0.99-1.01] and the pooled ORs of adverse pregnant outcome (premature and abortion) was less than 1% [**Figure 3**, 95% CI, 0-0.02]. The pooled ORs of overall complications was about 45% [**Figure 4**, 95% CI,0.19-0.70], but the pooled ORs of serious complications (Clavien-Dindo III-V) was less than 1% [**Figure 5**, 95% CI,0-0].

Detailed data of URS therapy was showed in **Table 3**. General anesthesia and spinal anesthesia were widely used in this situation. The pooled operation success rate was 99% [**Figure 1**, 95% CI, 0.98-1]. The pooled SFR was about 91% in all [95% CI, 0.88-0.95]. The pooled ORs of normal fertility outcome was 99% [**Figure 2**, 95% CI, 0.99-1], the pooled ORs of adverse pregnant outcome was less than 1% [**Figure 3**, 95% CI, 0.01-0.02]. The pooled ORs of overall complications was about 1% [**Figure 4**, 95% CI, 0.01-0.02], and the pooled ORs of serious complications (Clavien-Dindo III-V) was less than 1% [**Figure 5**, 95% CI,0-0].

Meta-analysis results indicated that there was no evidence of statistical heterogeneity between two treatments on operation success rate (**Figure 1**, I^2=12.1%, P=0.280), normal fertility outcome (**Figure 2**, I^2=0.0%, P=0.989) and adverse pregnant outcome (**Figure 3**, I^2=0.0%, P=1.000). However, overall complications of internal ureteral stent therapy was more common than that in URS operation group (**Figure 4**, I^2=91.0%, P < 0.001). We also

analyzed pooled ORs of serious complications in two treatments (**Figure 5**). There was no evidence of significant statistical heterogeneity among studies (I^2=0.0%, P=1.000).

Qualitative assessment and publication bias

The NOS tool was used to conduct a qualitative assessment of the selected studies to review the quality of the studies and detect possible bias (**Table 4** and **Table 5**). Of the 25 studies, 8 were at low risk of bias (7-9 stars). 16 studies were at medium risk (4-6 stars) mainly due to bias from representativeness of case or controls, control definition and comparability. 1 study was high risk (3 stars) mainly due to bad representativeness, lack of control and unclear control exposure. The funnel plot showed certain publication bias in the studies included in the meta-analysis (Begg's test with P<0.001) (**Figure 6**).

DISCUSSION

From the best of our knowledge, that this study is the first systematic review to investigate and compare between the outcomes of the ureteroscopy and serial D-J stenting therapy in pregnancy with urolithiasis. To determine the efficacy and safety of two treatments, we analysed the relative information as much detail as possible. This meta-analysis contained 25 studies with total 920 cases of urolithiasis during pregnancy. This meta-analysis contains studies selected from several countries as stated above. As showed in **Table 1**, most studies come from Asia continent (15 studies), followed by Africa continent (4 studies), Europe continent (3 studies) and America continent (including North and South America, 3 studies). So this review could represent human races of different skin colors. The results showed the operation success rates are almost same in internal ureteral stent and URS (97% vs 99%, P=0.280). Internal ureteral stent showed more complications than that in URS (45% vs 1%, P < 0.001), however, most complications were slightly or could be handled (serious complication rates were all less than 1% in two groups, P=1.000) and there is no statistical difference in normal delivery rate between two treatments (99% vs 99%, P=0.989). In summary, both ureteroscopy operation and internal ureteral stent are safe and effective for pregnancy with symptomatic urolithiasis.

Urolithiasis in pregnancy is the most common cause of non-obstetric reason for hospital admission, 80–90% of which are diagnosed in the 2nd or 3rd trimester of their pregnancy when the disease becomes symptomatic[33-36]. As a majority of calculi could be passed with

treatment of intravenous fluids and analgesia, the first-line treatment of urolithiasis in pregnancy is conservative management. This is recommended by both the latest European Association of Urology (EAU) and the American Urological Association (AUA). However, if complications develop and may even affect fetal safe, or the patient does not feel adequate relief, more aggressive treatment should be considered. Shock wave lithotripsy is absolutely contraindicated in pregnancy because of potential fetal death[37]. Percutaneous nephrostomy (PCN) drainage is also not an appropriate choice as it raises risk of septic complications and imposes additional burden of an external drain[38]. The common utilization of prone position and fluoroscopy limited PCN in pregnancy as well[39]. Therefore, internal ureteral stent and URS are the most common treatments in clinic for the pregnant patient.

After failed in initial conservative treatment, insertion of D-J stent might be a safe choice. Serial stenting for pregnancy with urolithiasis was common used in clinic but there were not many related studies. After scanning articles in the past 30 years, only 6 related articles were included in this meta-analysis[10, 22, 24, 27, 28, 32]. Historically, serial stenting was considered as the gold standard surgical treatment for pregnancy with urolithiasis as it was less invasive and could be performed under local anesthesia[40]. This amount of anesthetic drugs and fewer surgical traumas was safer for the fetus[24]. And its effect of relieving obstruction and pain, maintenance of pregnancy was proved as this meta-analysis suggested. But there were still some negative opinions. On the one hand, serial stenting may be poorly tolerated by some pregnant women as it caused pain and reducing quality of life. On the other hand, insertion of D-J stent was a temporary measure, the D-J stents need a regularly replacement. And due to the increased concentration of calcium and urate in urine during pregnancy, which cause more prone to encrustation, these invasive operations need more frequency[20, 41]. With the increase of invasive operations, complications such as UTI, stent migration were increased[27, 32, 42], and the cost raised as well[39]. Actually, our meta-analysis had demonstrated the pooled ORs of complications after serial stenting was about 45%. However, the pooled ORs of serious complications (Clavien-Dindo III-V) after serial stenting was less than 1%. And there is no evidence that serial stenting treatment was harmful for pregnancy as the pooled ORs of adverse pregnant outcome was less than 1% . Internal ureteral stent was proved to be safe for pregnant woman and fetus in all.

Not the same as internal ureteral stent operation, URS for treating urolithiasis in pregnancy were studied by many urologists, as 23 papers were included in this meta-analysis as

mentioned above[8, 9, 11-23, 25-32]. It is common that anesthesia methods were including general anesthesia and spinal anesthesia after scanning the papers included. Although there were risks in anesthesia and surgery, development in technology provided a guarantee for perioperative safety. After systematic analysis, we calculated that the pooled ORs of complications was about 1% and the pooled ORs of normal fertility outcome was 99%. Another advantage of URS was the high SFR which arrived 91%. High stone clearance rates and low complication rates made URS be recommended by the 2020 EAU guideline.

In the latest 2020 EAU guideline[6], URS looks like a better selection for pregnancy with urolithiasis compared with internal ureteral stent, and stent insertion therapy is only mentioned for symptomatic moderate-to-severe hydronephrosis during pregnancy. It seemed that ureteral stent insertion is not a proper treatment for pregnant women with urolithiasis. But the success of an URS operation must base on detailed preoperative preparation and stringent obstetric care. At emergency or lack of obstetric care condition, internal ureteral stent may be better choice as it is also safe and effective in all. And it could gain time for URS later. Moreover, for pregnancy who did not want to take general anesthesia before childbirth, ureteral stent insertion seemed to be the only choice for relieving symptomatic urolithiasis. Urologist and obstetrician should work together to ensure the safety of pregnancy and fetus.

There were several inherent limitations in this meta-analysis. First, most of the included studies were retrospective study. This might cause inevitable methodological defects in these studies, including data bias, insufficient baseline comparisons, and insufficient data collection. Urolithiasis during pregnancy is not a rare disease, but for urologists, it is not easy to handle both urolithiasis condition and obstetric care; and after failed in initial conservative treatment, it may be considered as an emergency to handle rapidly. Thus well-designed RCTs were difficult to accomplish. Secondly, performance bias should also be considered. Although various centres have performed similar operations, the medical equipment and medical teams were different. Surgery is a complex process; these differences may also lead to different outcome. What's more, there was unavoidable bias when the data were pooled. Therefore, further well-designed, prospective studies are required, and those studies should take into account selection bias, performance bias and the issue of confounding. Finally, funnel plot showed certain publication bias in included articles, but considering the number

of included article was small, we reserved all studies. Despite these limitations, this updated meta-analysis provides an important clinical reference for the urolithiasis during pregnancy.

CONCLUSION

Although internal ureteral stent may cause more slight complications, both ureteroscopy operation and internal ureteral stent showed less side effective on fertility results in pregnancy with symptomatic urolithiasis. Evidence suggests that URS therapy may have a greater advantage for pregnancy with urinary stones when the condition permit. As it is proved safe and effective, internal ureteral stent could be considered at emergency or other special situations.

DECLARATIONS

Transparency declaration

The corresponding authors affirm that this manuscript is an accurate account of the study proposed with no important aspects omitted, and that any discrepancies from the study as planned and registered will be explained upon the completion of the proposed study.

Author contributions

D.W. and L.Z. contributed to the conception of the study; X.J. and B.L. contributed significantly to analysis and assessment for eligibility; Y.S. and W.T. performed the data extraction; D.W. and Y.X. contributed the qualitative assessment; X.J. and L.Z wrote the manuscript, helped perform the analysis with constructive discussions.

Ethical approval

Ethics approval is not required for this study because it is a systematic review and meta-analysis by using the published available data.

Details of funding

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Conflict of interest

The authors have declared that no competing interests exist.

Statement of independence of researchers form funders

Not applicable.

Patient involvement

No patients were involved in the design or analysis of this study.

Data sharing statement

All data relevant to the study are included in the article or uploaded as supplementary information.

Figure legends/captions

Figure 1. Meta-analysis about operation success rate in D-J stent therapy group and URS group.

Figure 2. Meta-analysis about normal fertility outcome in D-J stent therapy group and URS group.

Figure 3. Meta-analysis about adverse pregnant outcome (premature and abortion) in D-J stent therapy group and URS group.

Figure 4 Meta-analysis about overall complications in D-J stent therapy group and URS group.

Figure 5. Meta-analysis about Clavien-Dindo III-V complications in D-J stent therapy group and URS group.

Figure 6. Funnel Plot for Publication Bias.

Figure S1. PRISMA flow diagram of study selection for meta-analysis

Table 1. Summary of characteristic for studies included in the meta-analysis.

Table 2. Summary of details for D-J stent therapy group.

Table 3. Summary of details for URS group.

Table 4. Newcastle-Ottawa Scale review for cohort studies from systematic review.

Table 5. Newcastle-Ottawa Scale review for case-control and cross-sectional studies from systematic review.

Table S1. Search strategy and results.

Table S2. Complications and their Clavien-Dindo Classification.

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Table 1. Summary of characteristic for studies included in the meta-analysis

First author	Year	Country , Continent	Journal	Period	Age range	Trimester	Diagnosis method	Stone location (No.)	Stone size, mm (mean/SD,range)
Ulvik[8]	1995	Norway, Europe	Journal of Urology	September 1984-December 1994	27 (20-41)	4-14 weeks in 3; 15-28 weeks in 9; 29-37 weeks in 12	KUB 1 positive in 6; US 3 positive in 21 (hydronephrosis 21 in 21)	Not mentioned	Not mentioned
Scarpa[9]	1996	Italy, Europe	Journal of Urology	3-years period	24 (16-30)	20-34	US\symptoms\urinalysis	Not mentioned	Not mentioned
Parulkar[10]	1998	America , North America	Journal of Urology	January 1984-November 1995	27 (<18y 2; 18-20y 4; 20-30y 43; 30-40y 21)	First trimester in 3; second trimester in 23; third trimester in 44	US 40 positive in 65; IVP 5 positive in 5	Not mentioned	US 0.7 (0.4-1.6); IVP 0.55 (0.4-0.7)
Lemos[11]	2002	Brazil , South America	International Braz J Urol	Not mentioned	28 (20-34)	18 (12-34)	US 12 positive in 12; ureteroscopy 13 positive in 14	Proximal ureter in 1; medium ureter in 4; distal ureter in 12; 1 missed	6 (4-12)
Rana[12]	2009	Pakistan, Asia	Urology	1997 - 2007	22 (18-27)	20 (14-34) First trimester in 1; second trimester in 11; third trimester in 7	US in 11; KUB in 1	Proximal ureter in 11; distal ureter in 8;	11 (8-18)
Elgamasy[13]	2010	Egypt, Africa	BJU International	June 2003- June 2008	25.9 (18-38)	25.9 (24-30)	US 12 positive in 15; RU 14 positive in 15,	Proximal ureter in 2; medium ureter in 2; distal ureter in 10;	Not mentioned
Liu[14]	2011	China, Asia	Journal of Huazhong University of Science and Technology-Medical Sciences	January 2004 - December 2009	26.7 (18-37)	23.45 (4-38)	US in 24	6 bilateral; 8 left; 10 right (surgery group)	Not mentioned
Polat[15]	2011	Turkey, Asia	Urological Research	2007-2009	25 (19-34)	30 (23-35) second trimester in 8; third trimester in 8	US in 11	Proximal ureter in 5; distal ureter in 6;	9.45 (5-12)
Atar[16]	2012	Turkey, Asia	International Journal of Surgery	December 2010-July 2011	26 (19-40)	24 (16-33)	US for 8, ureteroscopy for all	Proximal ureter in 5; medium ureter in 5; distal ureter in 7; no stone in 2	8 (5-19)
Bozkurt[17]	2012	Turkey, Asia	Urological Research	April 2005-November 2010	27.8 (20-39)	24 (15-34)	US 16 positive; all 32 positive underwent URS	Proximal ureter in 8; medium ureter in 9; distal ureter in 10; no stone in 5	8 (5-19, in 16 US positive cases)
Hoscan[18]	2012	Turkey, Asia	Urology	2001-2011	24 (17-37)	26 (12-38)	URS 34 positive in 57	Proximal ureter in 8; medium ureter in 6; distal ureter in 20	7 (4-13)
Johnson[19]	2012	America, North America	Journal of Urology	Not mentioned	27	24.7	Low dose CT in 23; US in 18; MRI in 5	Not mentioned	7.8 (3-25)
Abdel[20]	2013	Egypt, Africa	Urology Annals	April 2008-March 2011	23 (19-28)	25 (16-35)	Clinical presentation and US; MRI in 3	Proximal ureter in 2; medium ureter in 5; distal ureter in 10	17 (12-21)
Bozkurt[21]	2013	Turkey, Asia	Urolithiasis	April 2005-Setemper 2011	27.41 ± 5.79	23.2 ± 4.6 (13-34)	Clinical presentation, presence of microscopic hematuria in urinalysis and US	Proximal ureter in 13; medium ureter in 13; distal ureter in 15	9.78 ± 3.47
Song[22]	2013	China, Asia	International Journal of Gynecology and Obstetrics	April 2001 - July 2012	27.2§ 27.1¶	26.5§ 26.3¶	US 23 positive in 54; MRI 25 positive in 31	Proximal ureter in 10; distal ureter in 44	13.14 (7-22)
Keshvari[23]	2013	Iran, Asia	Nephro-Urology Monthly	June 2003-April 2011	23 ± 2 (19-34)	24 ± 3 (12-36) First trimester in 2; second trimester in 26; third trimester in 16	US in 44; IVP in 2	Proximal ureter in 2; medium ureter in 10; distal ureter in 36	Not mentioned
Ngai[24]	2013	Iraq, Asia	Arab Journal of Urology	March 2008-March 2010	27.2 (18-38)	First trimester in 5; second trimester in 15; third trimester in 10	US showed hydronephrosis in 30, stone in 12	Not mentioned	Not mentioned
Adanur[25]	2014	Turkey, Asia	Archivio Italiano di Urologia e Andrologia	January 2005-December 2012	25.4 (18-41)	24.8(7-33)	US in 6 ; ureteroscopy for all	Proximal ureter in 6; medium ureter in 5; distal ureter in 8	9.2 (6-13) in 6 with US
Georgescu[26]	2014	Romania, Europe	Chirurgia	January 2006-January 2012	27.2 (20-37)	First trimester in 6; second trimester in 32; third trimester in 16	US stone 18 positive in 54	Proximal ureter in 11; medium ureter in 8; distal ureter in 14	8 (4-16)
Teleb[27]	2014	Egypt, Africa	Arab Journal of Urology	October 2006-December 2013	26.6 (SD 4.65)§ 25.5 (SD 4.26)¶	24.1 (SD 5.44)§ 25.7 (SD 4.95)¶	US 31 positive in 43	Not mentioned Middle ureter in 9§; distal ureter in 13§ Middle ureter in 7¶; distal ureter in 14¶	Not mentioned
Wang[28]	2014	China, Asia	Urology	February 2006-Setemper 2012	26 (17-39)	29(17-39) First trimester in 2; second trimester in 36; third trimester in 49	US in 79, MRI in 8,	Left side in 48, Right side in 39	8 (5-19)
Fathelbab[29]	2016	Egypt, Africa	African Journal of Urology	April 2006-October 2013	23 (19-37)	First trimester in 4; second trimester in 23; third trimester in 14	Diagnostic ureteroscopy 36 positive in 41	Proximal ureter in 7; distal ureter in 29	8.9 (5-16)
Zhang[30]	2016	China,	PLoS ONE	March 2009-	25.5±4.6 (16–	9-36	US and diagnostic	Not mentioned	8.2 ± 0.6

		Asia		Setember 2014	41)		ureteroscopy positive in 86 (only ureteroscopy in 24), negative in 31		
Abedi[31]	2017	Iran, Asia	Journal of Lasers in Medical Sciences	January 2007-June 2016	29.3	27.3 (13-31) First trimester in 9; second trimester in 24; third trimester in 12	Clinical manifestations, urinalysis and US	Poximal ureter in 5; distal ureter in 40	7.84 (5-9mm)
Tan[32]	2018	China, Asia	European Journal of Obstetrics and Gynecology and Reproductive Biology	January 2005-June 2015	26.7 ± 8.9§ 27.4 ± 10.2¶	27.5 ± 11.2§ 25.9 ± 9.7¶	US	Proximal ureter in 10; medium ureter in 12; distal ureter in 31	Not mentioned

§ means received internal ureteral stent only; ¶ means received ureteroscopy operation.

Table 2. Summary of details for D-J stent therapy group.

First author	Year	Anesthetic method	No. of operations (success rate)	SFR, %	Fertility outcome	Complications	Complications (classified)	Follow-up pattern
Parulkar[10]	1998	Local anesthesia	15 (100%)	\	Not mentioned	Stent slipping into bladder in 1, then repeaced; 5F stent blocked in 2,then replace to 7F; softer stent was needed in 1; calcified stent in 1	Clavien-Dindo III in 5	Not mentioned
Song[22]	2013	Local anaesthesia with lidocaine gel	17, 12 success (70.6%)	25 (3 passed stone spontaneously of 12)	16 delivered at term; preterm labor in 1	Stent-induced bladder irritation in 6, retained; encrusted stent problem in 4; passed a double-J stent in 1	Clavien-Dindo I in 6; Clavien-Dindo III in 5;	Not mentioned
Ngai[24]	2013	Local anaesthesia	30 (100%)	\	Not mentioned	Stent encrustation in 3; stent migration in 3; stent-related bladder irritation in 3; gross hematuria in 2	Clavien-Dindo I in 5; Clavien-Dindo III in 6	Renal function tests and US was arranged weekly in the first month, then monthly throughout pregnancy
Teleb[27]	2014	Spinal anaesthesia in 18, topical lidocaine anaesthesia with sedo-analgesia in 4	22 (100%)	\	All 22 delivered at term	Urinary tract infection in 4; irritative LUTS in 13	Clavien-Dindo I in 13; Clavien-Dindo II in 4	US and urinalysis every 4 weeks
Wang[28]	2014	Epidural anesthesia	17 (100%)	\	All 17 delivered at term	Urinary tract infection in 4; stent-related bladder irritation in 12; hemauria in 7	Clavien-Dindo I in 19; Clavien-Dindo II in 4	Obstetric care; clinical assessment, ultrasound examination and urine culture.
Tan[32]	2018	Local anesthesia	30, 25 (83.3%)	success	\	Not mentioned	Bladder irritation in 2; D-J stent drop in 1; hard removal of D-J stent in 1	Clavien-Dindo I in 3; Clavien-Dindo III in 1	Not mentioned

SFR: stone-free rate.

Table 3. Summary of details for URS group.

First author	Year	Anesthetic method	No. of operations (success rate)	Tool	SFR, %	Fertility outcome	Complications	Complications (classified)	Follow-up pattern
Ulvik[8]	1995	Epidural anesthesia in 23; spinal anesthesia in 1; pethidine intravenously in 1	25 (100%)	11.5F rigid URS in 23 and 9.5F rigid URS in 2	Not mentioned	Deliveries normal in 19; cesarean section in 2; seven weeks premature in 1; elective termination unrelated to ureteroscopy in 1; 1 unknown	Fever in 3 (treated with antibiotics); irritative bladder symptom in 1	Clavien-Dindo I in 1; Clavien-Dindo II in 3	IVP or ultrasound 3 months after delivery
Scarpa[9]	1996	Without anesthetic in 5; neuroleptic analgesia in 10	15 (100%)	7F rigid URS in 14 and 9.5F rigid URS in 1 (pulsed dye laser in 3, YAG laser in 3, ballistic lithotriptor in 2)	Not mentioned	All 15 delivered at term	0	0	Not mentioned
Lemos[11]	2002	Epidural anesthesia	14 (100%)	7F or 10F URS in 14 (11 removed stone with basket; 2 underwent ultrasonic lithotriptor)	100	All 14 delivered at term	0	0	Not mentioned
Rana[12]	2009	General anesthesia	19 (100%)	6.9F/8F semi-rigid URS with pneumatic lithoclast (5 need ureteral balloon dilator)	79	Not mentioned	0	0	Clinical assessment, ultrasound examination, and urine samples for culture and sensitivity.
Elgamasy[13]	2010	General anaesthesia in 10; spinal anaesthesia in 5	15 (100%)	9.5F URS (5 need balloon dilation; 12 Dormia basket or pneumatic lithotripter; 2 forceps; 1 no stone)	Not mentioned	14 delivered at term; 1 premature labour (36week)	D-J stent migration in 1	Clavien-Dindo III in 1	Patients were followed closely until delivery.
Liu[14]	2011	Not mentioned	24 (100%)	Not mentioned	Not mentioned	21 natural delivery; 1 abortion; 1 cesarean	Not mentioned	Not mentioned	Not mentioned
Polat[15]	2011	General anesthesia	16 (100%), 11 with complete fragmentation of the calculi; 5 with stone push-back	9.5F semi-rigid URS with lithoclast	72.73	All 16 delivered at term	0	0	Obstetric care; clinical assessment, ultrasound examination, and urine culture.
Atar[16]	2012	Spinal anesthesia in 18; general anesthesia in 1	19 (100%)	9.5F semi-rigid URS in 19 (holmium laser lithotripsy in 15 and stone forceps in 2)	Not mentioned	All 19 delivered at term	Dysuria-pain in 4; urinary infection in 1	Clavien-Dindo I in 4; Clavien-Dindo II in 1	Clinical assessment, US examination, and urine sample collection for culture and antibiogram.
Bozkurt[17]	2012	Spinal anaesthesia in 22; general anaesthesia in 7; local anaesthesia in3	32 (100%)	9.5F semi-rigid URS (balloon dilator with pneumatic lithotripsy in 8, holmium laser in 17, then extracted with forceps; 2 extracted with forceps only)	100	All 32 delivered at term	Urinary infection in 4; dysuria-pain in 2; sepsis in 1; ureteral laceration in 2	Clavien-Dindo I in 4; Clavien-Dindo II in 4; Clavien-Dindo IV in 1	Obstetric care; clinical assessment, US examination, and urine samples for culture and antibiogram.
Hoscan[18]	2012	Genaral anesthesia	57 (100%)	9.5F semi-rigid URS	85.3	Not mentioned	Urinary tract infection in 3; bladder irritation in 3; uterine contraction in 1	Clavien-Dindo I in 3; Clavien-Dindo II in 4	Obstetric care; clinical assessment, ultrasound examination, and urine culture.
Johnson[19]	2012	General anesthesia in 32; local anesthesia in 5; epidural or spinal anesthesia in 9	46 (100%), 39 with stone	Flexible scope in 8, rigid scope in 21, Both scope in 17; Lithotripsy in 24, basket extraction in 37	86	44 delivered at term; preterm labor in 2	Not mentioned	Not mentioned	Not mentioned
Abdel[20]	2013	Spinal anesthesia	17 (100%), 13 with pneumatic lithoclast,4 with dormia extraction	7.3/8 F semi-rigid URS (Storz) and 6/7.5 F semi-rigid ureteroscope (Wolf)	100	All 17 delivered at term	0	0	Clinical assessment, abdominal ultrasonography, and urine culture and sensitivity. Radiographic imaging with KUB was done in the postpartum period
Bozkurt[21]	2013	Spinal anesthesia in 34; general anesthesia in 3; other in 4	41, 37 success (90.2%)	9.5F semi-rigid URS (laser lithotripsy in 27, pneumatic lithotripsy in 6 and stone extraction in 4)	85.5	All 41 delivered at term	Laceration in 3; perforation in 1; urinary infection in 4; dysuria-pain in 6; sepsis in 1	Clavien-Dindo I in 9; Clavien-Dindo II in 4; Clavien-Dindo III in 1; Clavien-Dindo IV in 1	Clinical assessment, US and urine samples for culture and antibiogram
Song[22]	2013	Epidural anesthesia in 21	21, 18 success (85.7%)	Wolf URS and LithoClastMaster	85.7	All 21 delivered at term	Hematuria in 2; stent-induced bladder irritation in 1	Clavien-Dindo I in 3;	Not mentioned

Keshvari[23]	2013	General anesthesia	44 (100%)	8F semi-rigid URS (pneumatic lithotripsy in 34, stone extraction with grasper in 16)	100	All 44 delivered at term	0	0	Obstetric care; clinical assessment, ultrasound examination, urinalysis and urine culture
Adanur[25]	2014	General anaesthesia without using halothane and nitric oxide	19 (100%)	7.5 F or 9.5 F semi-rigid URS (holmium-YAG laser in 19, a forcep for extraction of stone fragment in 9)	Not mentioned	All 19 delivered at term	Preterm urterin conrtaction in 1 and treated with tocolysi; urinary tract ingection in 1 and treated with appropriate antibiotics	Clavien-Dindo II in 2	Not mentioned
Georgescu[26]	2014	Spinal anesthesiain 42; general anesthesia 12	54, 44 success (81.5%)	Semi-rigid URS used during first 2 trimesters (32 success from 38 patients); flexible URS (12 from 16 cases) in the last trimester	Not mentioned	All 54 delivered at term; uterine contraction in 1	Urinary tract infection developed in 4 patients; renal colic in 2; prolonged hematuria in 1; stent-induced bladder irritation in 4	Clavien-Dindo I in 6; Clavien-Dindo II in 6	Obstetric care, clinical assessment, ultrasound examination, urinalysis and urine culture.
Teleb[27]	2014	Spinal anaesthesia in 19; topical lidocaine anaesthesia with sedo-analgesia in 2	21 (100%)	9.5F semi-rigid URS (dilatation of ureteric orifice in 4, pneumatic lithoclast in 14, directly extracted stone in 7)	100	All 21 delivered at term	Urinary tract infection in 2; irritative bladder symptom in 4	Clavien-Dindo I in 4; Clavien-Dindo II in 2	US and urinalysis every 4 wks
Wang[28]	2014	Local anesthesia	64 (100%)	8/ 9.8F rigid URS (lithotripsy with Holmium:YAG laser)	81.3	All 64 delivered at term	Threatened abortion in 1; mild ureteric laceration in 1; mild bleeding in 5	Clavien-Dindo I in 6; Clavien-Dindo II in 1	Obstetric care; clinical assessment, ultrasound examination and urine culture.
Fathelbab[29]	2016	Epidural anesthesia	41 (100%)	Semi-rigid URS (pneumatic lithoclast in 22, directly extracted stone in 4)	89.7	All 41 delivered at term	Stent-related mild dysuria in 12; hematuria in 5,	Clavien-Dindo I in 17	Not mentioned
Zhang[30]	2016	General anesthesia in 72; spinal anesthesia in 45	117 (100%)	9.5F semi-rigid URS or flexible URS (pneumatic ballistic lithotripsy or Holmium:YAG laser)	84.6	All 117 delivered at term	Urosepsis in 1; threatened abortion in 12	Clavien-Dindo II in 12; Clavien-Dindo IV in 1	Obstetric care; clinical assessment, ultrasound examination, urinalysis and urine culture.
Abedi[31]	2017	Not mentioned	45 (100%)	9.5F semi-rigid URS (holmium-YAG laser)	93.3	All 45 delivered at term	Preterm urterin conrtaction in 2 and treated with tocolysi; urinary tract ingection in 2 and treated with appropriate antibiotics	Clavien-Dindo II in 4	Not mentioned
Tan[32]	2018	General anesthesia or epidual anesthesia	23, 20 success (87%)	URS lithotripsy with pneumatic lithotripsy	Not mentioned	Not mentioned	Bladder irritation in 1; sliht hematuria in 1	Clavien-Dindo I in 2	Not mentioned

URS: ureteroscopy; SFR: stone-free rate.

Table 4. Newcastle-Ottawa Scale review for cohort studies from systematic review

		Selection				**Comparability**		**Outcome**			
Study	**Country**	S1	S2	S3	S4	C1	C2	O1	O2	O3	**Total**
Liu et al. [14]	China	★	★	★	★			★	★	★	7
Bozkurt et al.[17]	Turkey	★	★	★	★			★	★	★	7
Teleb et al.[27]	Egypt	★	★	★	★			★	★	★	7

Guidelines for review

Selection:

S1, Representativeness of the exposed cohort; ★a) representative of the community (e.g. community-based colorectal cancer-screening programme or registry) or (single hospital or clinic); b) selected group of people (e.g. nurses, volunteers); d) no description of the derivation of the cohort

S2, Selection of the non-exposed cohort: ★a) drawn from the same community as the exposed cohort; b) drawn from a different source; c) no description of the derivation of the non-exposed cohort

S3, Ascertainment of exposure: ★ a) secure record (eg medical records); ★b) structured interview; c) written self-report; d) no description

S4, Demonstration that outcome of interest was not present at start of study: ★ a)yes; b) no

Comparability:

C1, ★ Study controls for one most important factor;

C2, ★ Study controls for any additional factors (1> additional factors)

Outcome:

O1, Assessment of outcome: ★a) independent blind assessment; ★b) record linkage; c) self-report; d) no description

O2, Follow-up was long enough for outcomes to occur (after delivery or longer): ★a) yes; b) no

O3, Adequacy of follow-up of cohorts: a) complete follow up - all subjects accounted for; b) subjects lost to follow up unlikely to introduce bias - small number lost > 10 %; c) follow up rate < 90% and no description of those lost; d) no statement.

Table 5. Newcastle-Ottawa Scale review for case-control and cross-sectional studies from systematic review

		Selection				**Comparability**		**Exposure**			
Study	**Country**	S1	S2	S3	S4	C1	C2	E1	E2	E3	**Total**
Ulvik et al.[8]	Norway	★	★					★		★	4
Scarpa et al.[9]	Italy	★	★					★		★	4
Parulkar et al.[10]	America	★	★	★	★			★	★	★	7
Lemos et al. [11]	Brazil	★						★		★	3
Rana et al. [12]	Pakistan	★	★					★		★	4
Elgamasy et al. [13]	Egypt	★	★					★		★	4
Polat et al. [15]	Turkey	★	★					★		★	4
Atar et al. [16]	Turkey	★	★					★		★	4
Bozkurt et al. [17]	Turkey	★	★					★		★	4
Hoscan et al. [18]	Turkey	★	★					★		★	4
Johnson et al. [19]	America	★	★					★		★	4
Abdel et al.[20]	Egypt	★	★					★		★	4
Song et al.[22]	China	★	★	★	★			★	★	★	7
Keshvari et al.[23]	Iran	★	★					★		★	4
Ngai et al. [24]	Iraq	★	★					★		★	4
Adanur et al. [25]	Turkey	★	★					★		★	4
Georgescu et al.[26]	Romania	★	★					★		★	4
Wang et al. [28]	China	★	★	★	★			★	★	★	7
Fathelbab et al. [29]	Egypt	★	★					★		★	4
Zhang et al. [30]	China	★	★	★	★			★	★	★	7
Abedi et al. [31]	Iran	★	★					★		★	4
Tan et al.[32]	China	★	★	★	★			★	★	★	7

Guidelines for review

Selection:

S1, Case definition adequacy: ★a) requires independent validation (>1 person/record/time/process to extract information, or reference to primary record source such as colonoscopy or medical/hospital records); b) record linkage or self-report with no reference to primary record; c) no description

S2, Representativeness of the cases: ★a) consecutive or obviously representative series of cases; b) potential for selection biases or not stated

S3, Selection of controls: ★a) community controls; b) hospital controls, within same community as cases; c) no description

S4, Definition of controls: ★a) no history of colorectal cancer or adenoma; b) no description of source

Comparability:

C1, ★ Study controls for one most important factor;

C2, ★ Study controls for any additional factors (1> additional factors)

Exposure:

E1, Ascertainment of exposure: ★a) secure record (e.g. medical records); ★b) structured interview where blind to case/control status; c) interview not blinded to case/control status; d) written self-report or medical record only; e) no description

E2, Same method of ascertainment for cases and controls: ★a) yes; b) no

E3, Non-response rate: ★a) same rate for both groups; b) non respondents described; c) rate different and no designation

Table S1. Search strategy and results.

	Medline Search	Results
1	(Pregnanc* or Pregnancy or Pregnant or Gestation* or Pregnant woman or Mother*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	1176995
2	(Urinary Calcul* or Urinary Calculi or Urinary Calculus or Urinary Stone* or Urinary Tract Stone* or Ureteral Calcul* or Ureteral Calculi or Ureteral Calculus or Kidney Calcul* or Kidney Calculi or Kidney Calculus or Nephrolith or Renal Calcul* or Renal Calculi or Renal Calculus or Kidney Stone* or Staghorn Calcul* or Staghorn Calculi or Staghorn Calculus or Urinary Lithiasis).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	38555
3	(Ureteroscopies or Ureteroscopic or Ureteroscopic Surgical or Ureteroscopic Surgical Procedure* or Ureteroscopic Surgery or Ureteroscopy).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	5760
4	(Double-J stent or Ureteral stent or Ureteral double-J stent or Ureteral D-J stent or Double J ureteral stent or D-J ureteral stent or stent or D-J stent).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	72387
5	1 and 2	760
6	3 or 4	77193
7	5 and 6	123
8	limit 7 to yr="1980 -Current"	123

	Embase Search	Results
1	(Pregnanc* or Pregnancy or Pregnant or Gestation* or Pregnant woman or Mother*).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	1357490
2	(Urinary Calcul* or Urinary Calculi or Urinary Calculus or Urinary Stone* or Urinary Tract Stone* or Ureteral Calcul* or Ureteral Calculi or Ureteral Calculus or Kidney Calcul* or Kidney Calculi or Kidney Calculus or Nephrolith or Renal Calcul* or Renal Calculi or Renal Calculus or Kidney Stone* or Staghorn Calcul* or Staghorn Calculi or Staghorn Calculus or Urinary Lithiasis).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	27030
3	(Ureteroscopies or Ureteroscopic or Ureteroscopic Surgical or Ureteroscopic Surgical Procedure* or Ureteroscopic Surgery or Ureteroscopy).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	10939
4	(Double-J stent or Ureteral stent or Ureteral double-J stent or Ureteral D-J stent or Double J ureteral stent or D-J ureteral stent or stent or D-J stent).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	193608
5	1 and 2	621
6	3 or 4	201303
7	5 and 6	147
8	limit 7 to yr="1980 -Current"	147

	Web of science	Results
1	TS=(Pregnanc* or Pregnancy or Pregnant or Gestation* or Pregnant woman or Mother*)	80403

2	TS=(Urinary Calcul* or Urinary Calculi or Urinary Calculus or Urinary Stone* or Urinary Tract Stone* or Ureteral Calcul* or Ureteral Calculi or Ureteral Calculus or Kidney Calcul* or Kidney Calculi or Kidney Calculus or Nephrolith or Renal Calcul* or Renal Calculi or Renal Calculus or Kidney Stone* or Staghorn Calcul* or Staghorn Calculi or Staghorn Calculus or Urinary Lithiasis)	11857
3	TS=(Ureteroscopies or Ureteroscopic or Ureteroscopic Surgical or Ureteroscopic Surgical Procedure* or Ureteroscopic Surgery or Ureteroscopy)	742
4	TS=(Double-J stent or Ureteral stent or Ureteral double-J stent or Ureteral D-J stent or Double J ureteral stent or D-J ureteral stent or stent or D-J stent)	13473
5	#1 AND #2	1622
6	#3 OR #4	13899
7	#5 AND #6	48

	Cochrane library	Results
1	Pregnanc* or Pregnancy or Pregnant or Gestation* or Pregnant woman or Mother*	80403
2	Urinary Calcul* or Urinary Calculi or Urinary Calculus or Urinary Stone* or Urinary Tract Stone* or Ureteral Calcul* or Ureteral Calculi or Ureteral Calculus or Kidney Calcul* or Kidney Calculi or Kidney Calculus or Nephrolith or Renal Calcul* or Renal Calculi or Renal Calculus or Kidney Stone* or Staghorn Calcul* or Staghorn Calculi or Staghorn Calculus or Urinary Lithiasis	11857
3	Ureteroscopies or Ureteroscopic or Ureteroscopic Surgical or Ureteroscopic Surgical Procedure* or Ureteroscopic Surgery or Ureteroscopy	742
4	Double-J stent or Ureteral stent or Ureteral double-J stent or Ureteral D-J stent or Double J ureteral stent or D-J ureteral stent or stent or D-J stent	13473
5	#1 AND #2	1622
6	#3 OR #4	13899
7	#5 AND #6	48
8	Restrict to trials	29

Table S2. Complications and their Clavien-Dindo Classification

Clavien-Dindo I
Postoperative fever without antibiotics
Passed D-J stent
Irritative bladder symptom
Ureteral laceration
Dysuria-pain
Uterine contraction without drug treatment
Stent drop
Hematuria
Clavien-Dindo II
Postoperative fever/urinary tract infection with antibiotics treatment
Stent replaced
Uterine contraction with drug treatment
Clavien-Dindo III
D-J stent migration requiring operation
Stent symptoms requiring early removal
Calcified stent requiring operation
Ureteral perforation or avulsion
Clavien-Dindo IV
Preterm labor or abortion
Urosepsis
Clavien-Dindo V
Death