

Stent diameter and stent-related symptoms, does size matter? A systematic review and meta-analysis

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Abstract

The ureteral insertion of a silicone tube was first performed in 1967. A validated ureteral stent symptom questionnaire (USSQ) is used for an objective assessment of patient-reported stent-related symptoms. As the impact of stent diameter on the incidence of stent-related symptoms is unclear, we aimed to perform a systematic review and meta-analysis comparing USSQ reported outcomes when using a 6 Fr diameter ureteric stent, versus smaller diameter stents (4.7–5 Fr) when inserted for ureteric stones. All randomized control trials and comparative studies of 6 Fr versus 4.7–5 Fr ureteric stents were reviewed. The USSQ outcomes were considered as the primary outcome measures while stent migration was considered as a secondary outcome measure. A total of 61 articles were identified of which four studies met the eligibility criteria. There was a statistically significant association between the use of wider (6 Fr) diameter stents and the incidence of urinary symptoms as measured by the urinary index score. Larger stent diameters were associated with a statistically significant increase in the pain index score. There was no statistically significant difference in the scores between the compared stent diameters with regard to work performance score, general health index score, additional problems index score, and stent migration. There were insufficient reported outcomes to perform a meta-analysis of sexual matters index score. Our meta-analysis shows that using smaller diameter ureteric stents is associated with reduced urinary symptoms and patient-reported pain. Other USSQ parameter outcomes are statistically similar in the 6 Fr ureteric stent cohort versus the 4.7–5 Fr ureteric stent cohort. Our meta-analysis was limited due to the limited number of studies and gross heterogeneity of reporting parameters in various studies. We hope a large-scale homogeneous randomized control trial will further shed more insight into the stent symptoms response to stent diameter.

Keywords: Stent diameter, stent-related symptoms, ureteric stent, urolithiasis

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INTRODUCTION

Ureteric stenting finds itself at the forefront of both elective and emergency urological practice, since the first

documented insertion in 1967.^[1] Despite commonplace use, the insertion of a ureteric stent has been found to be associated with the development of significant urinary

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symptoms, frequently with a profound impact on the patient's quality of life.^[2]

Research performed before 2003, did not utilize a validated questionnaire for the recording of patient-related stent symptoms.^[3-5] This changed with the development of a validated ureteral stent symptom questionnaire (USSQ), by Joshi *et al.*, which has allowed for an objective measurement of patient stent-related symptomatology.^[6] Inherent to the USSQ design is the inclusion of six domains: urinary symptoms (as measured by Urinary Index score), restriction of performance in work (Work Performance score), stent-related pain (Pain Index score), general health (General Health Index score), a sexual section (Sexual Matters), and additional issues (Additional Problems).

The correlation between the presence of ureteric stents and stent-related symptoms is clear. As such, significant research has been devoted to the identification of factors that may increase patient predisposition to significant stent-related symptoms. However, no particular stent design or composition has yet proven ideal,^[7] though a correlation has been found between the incidence of the distal end of ureteric stents crossing the bladder midline and the occurrence of symptoms.^[8,9]

Despite this, the impact of stent diameter on the incidence of stent-related symptoms is unclear, and we are aware of no other meta-analysis comparing the effect of small diameter versus larger diameter stents on USSQ domain scores. In view of this, we aimed to perform a systematic review and meta-analysis to compare USSQ reported outcomes when using a 6Fr diameter ureteric stent, versus smaller diameter stents (4.7–5Fr) when inserted for ureteric stones.

MATERIALS AND METHODS

This systematic review and meta-analysis were performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement standards.^[10] This review was prospectively registered in the International Prospective Register of Systematic Reviews, with the registration number CRD42021244275.

Eligibility criteria

The inclusion criteria for this study comprised of all comparative studies or randomized control trials (RCT), which compared a ureteric stent diameter of 6Fr, to a smaller diameter (4.7–5Fr). To ensure homogeneity, only studies investigating the effect of stent insertion for ureteric stones were included. Studies including stent insertion

for a different indication were therefore excluded. No exclusion was made based on patient age, or gender. Any noncomparative studies were excluded.

Outcome measures

The USSQ outcomes were considered as the primary outcome measures (Urinary Index, Work Performance, Pain Index, General Health Index, Sexual Matters, Additional Problems). The secondary outcome measure was the incidence of stent migration.

Search strategy

A comprehensive search strategy was utilized on the following electronic databases: MEDLINE, PubMed, EMBASE, CINAHL, CENTRAL, and Google Scholar. The search was completed by two independent authors, with the last search completed on the 22nd of March 2021. The literature search strategy is outlined in Appendix 1.

To assess for the suitability, each independent author screened the title and abstract of articles to assess for relevance to our study. In the event of disagreement or discrepancy in opinion, the involvement of a third independent author was sought, to seek a majority verdict.

Further screening of the references of included articles was performed, to attempt to identify further articles for inclusion and analysis.

Data extraction

Before data collection, the production of an electronic data extraction spreadsheet was performed, in accordance with the Cochrane data collection form for intervention reviews. The data extracted included: Study-specific data (primary author, year of publication, country of publication, journal, study design, study population, comparison of interest), baseline demographics of study populations (age, gender, stone size, stent indwelling time), and outcome data.

Again, two independent authors extracted the data. The involvement of a third party was sought in the event of disagreements.

Summary measures and synthesis

For each continuous variable (Urinary Index, Work Performance, Pain Index, General Health Index, Sexual Matters, Additional Problems), the chosen outcome measure was the mean difference (MD) between each group. For the dichotomous variable (incidence of stent migration), the odds ratio (OR) was selected as the summary measure. The OR is the odds of an event in the

small diameter stent group, compared to a larger stent diameter. In the analysis of stent migration, an OR of more than 1 would favor the larger stent diameter.

The Review Manager 5.3 (Rev-Man, Version 5.3. Copenhagen, 2014) software was used for data synthesis. Statistical heterogeneity was quantified using I^2 : 0%–50% interpreted as low heterogeneity, 50%–75% as moderate heterogeneity, 75%–100% as high heterogeneity. Random effects modeling was used for the analysis.

To investigate potential causes for heterogeneity, further sensitivity analysis was performed. Primary analysis was repeated, with the fixed effects model (instead of our chosen random-effects model). In addition, the risk ratio and risk difference for each dichotomous outcome were calculated. Leave-one-out sensitivity analysis was made, by repeating analysis after removing one study at a time.

RESULTS

Search results

Our comprehensive search strategy of the aforementioned electronic databases resulted in the finding of 61 articles. Ultimately, a total of 4 studies^[5,11-13] met the eligibility criteria of this review. The included studies reported a total of 391 patients, of whom 190 had a 6Fr diameter stent inserted, and 201 had a 4.7–5Fr diameter stent.

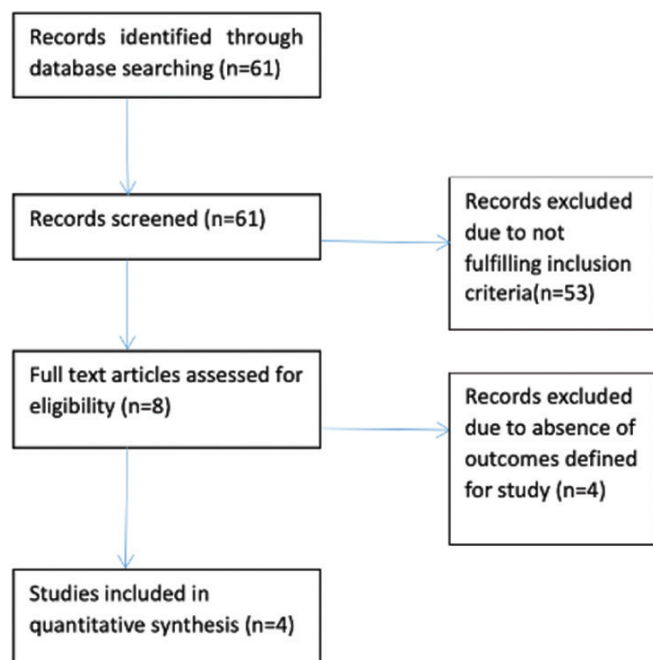


Figure 1: Study flow diagram

The literature search flowchart, characteristics of the included studies, and baseline characteristics of the included populations are demonstrated in Figure 1 and Tables 1, 2 respectively.

Methodological quality and risk of bias

The assessment of methodological quality was performed by two independent reviewers, with a third opinion sought in the event of disagreement. The Cochrane tool for methodological quality assessment of RCTs was utilized, with resultant sub-categorization into low, unclear, and high risk of bias. The domains assessed included selection bias, detection bias, performance bias, reporting bias, attrition bias, and other sources of bias. The results of the methodological quality assessment are displayed in Figure 2.

OUTCOME SYNTHESIS

All reported outcomes are displayed as a Forest Plot in Figure 3.

Primary outcome ureteral stent symptom questionnaire Urinary index score

Urinary Index Score was reported in three studies,^[11-13] enrolling 346 patients. There was a statistically significant association between the use of wider (6Fr) diameter stents and the incidence of urinary symptoms as measured by

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Cubuk 2018	+	+	+	+	+	?	+
Erturk 2003	+	?	?	?	+	?	+
KIm 2019	+	+	?	?	?	+	+
Nestler 2019	+	+	+	?	?	+	+

Figure 2: Methodological quality assement

Table 1: Characteristics of included studies

Author	Year	Country	Journal	Type of study	Study population	Comparison
Cubuk11	2018	Turkey	Kaohsiung Jour of Med Sci	RCT	URS for ureteric stone	4.8Fr vs 6Fr
Erturk5	2003	USA	Journal of Endourology	RCT	URS for ureteric stone	4.7Fr vs 6Fr
Kim12	2020	South Korea	Journal of Endourology	RCT	URS for ureteric stone	5Fr vs 6Fr
Nestler13	2020	Germany	World Journal of Urology	RCT	URS for ureteric stone	4.7Fr vs 6Fr

RCT=Randomised control trial

Table 2: Baseline demographics of included studies

Study	Sample size	6Fr	4.7-5Fr	Age	Gender (M/F)	Stone size	Stent indwelling time
Cubuk11	126	63	63	41.9±14.4 vs 40.7±12.7 ($P=0.629$)	46/17 vs 38/25 ($P=0.133$)	11.6±5.8 vs 13.0±6.8 ($P=0.211$)	4 weeks
Erturk5	45	24	21	51 vs 53 ($P=0.64$)	13/11 vs 6/15	10 vs 14 ($P=0.04$)	NR
Kim12	106	55	51	60.0±12.5 vs 58.9±12.5 ($P=0.640$)	31/24 vs 29/22 ($P=0.557$)	10.7±5.6 vs 9.5±4.4 ($P=0.247$)	2-3 weeks
Nestler13	114	48	66	52 vs 49	NR	NR	4 weeks

NR=not recorded

the Urinary Index Score (MD - 5.65, 95% confidence interval [CI] -6.83-4.46, $P < 0.00001$). A low level of heterogeneity among the studies existed ($I^2 = 32\%$, $P = 0.23$).

Work performance score

Work Performance Score was reported in 3 studies,^[11-13] enrolling 346 patients. There was no statistically significant difference in the score between the two compared stent diameters (MD - 0.38, 95% CI - 3.00-2.23, $P = 0.77$). A high level of heterogeneity among the studies existed ($I^2 = 86\%$, $P = 0.0008$).

Pain index score

Pain Index Score was reported in three studies,^[11-13] enrolling 346 patients. Larger stent diameters were associated with a statistically significant increase in patient-reported pain (MD - 3.33, 95% CI - 4.77-1.96, $P < 0.00001$). A moderate level of heterogeneity among the studies existed ($I^2 = 51\%$, $P = 0.13$).

General health index score

General Health Index Score was reported in 3 studies,^[11-13] enrolling 346 patients. There was no statistically significant difference in the score between the two compared groups (MD - 1.80, 95% CI - 3.80-0.19, $P = 0.08$). A high level of heterogeneity among the studies existed ($I^2 = 85\%$, $P = 0.001$).

Sexual matters index score

Sexual Matters Index was reported in two studies,^[11,12] which was an insufficient number to perform a meta-analysis of this domain.

Additional problems index score

Additional Problems Index scores were reported in three studies,^[11-13] enrolling 346 patients. There was no statistically significant difference in the score between the two compared groups (MD 0.20, 95% CI - 0.36-0.76,

$P = 0.48$). A low level of heterogeneity among the studies existed ($I^2 = 18\%$, $P = 0.30$).

Secondary outcome

Stent migration

Incidence of stent migration was reported in three studies,^[5,11,13] enrolling 285 patients. There was no statistically significant difference in the stent migration rate between the two groups (OR 3.23, 95% CI 0.87-12.02, $P = 0.08$). A low level of heterogeneity among the studies existed ($I^2 = 0\%$, $P = 0.61$).

SENSITIVITY ANALYSIS

The use of the fixed-effects model, instead of random-effects, altered the reported outcome for Work Performance Score, to result in statistical significance favoring smaller diameter stents (MD - 1.86, 95% CI - 2.19 - -1.52, $P < 0.00001$). The reporting of Pain Index Score in Std. MD (SMD), rather than MD, resulted in our results no longer displaying a significant difference between each evaluated group (SMD - 1.27, 95% CI - 2.84-0.30, $P = 0.11$). Leave-one-out sensitivity analysis could not be performed due to the inclusion of 3 studies in each of our reported outcomes.

DISCUSSION

We performed a systematic review of the literature and meta-analysis of reported outcomes to compare the effect of ureteric stent diameter on stent symptoms and rate of stent migration following ureteric stent insertion for ureteric stones. We included 4 RCTs^[5,11-13] enrolling a total of 391 patients. Our analyses suggest that the use of ureteric stents of a smaller diameter (4.7-5Fr) is associated with the reduced incidence of urinary symptoms and postoperative pain when compared to stents of a larger diameter (6Fr). The between-study heterogeneity was

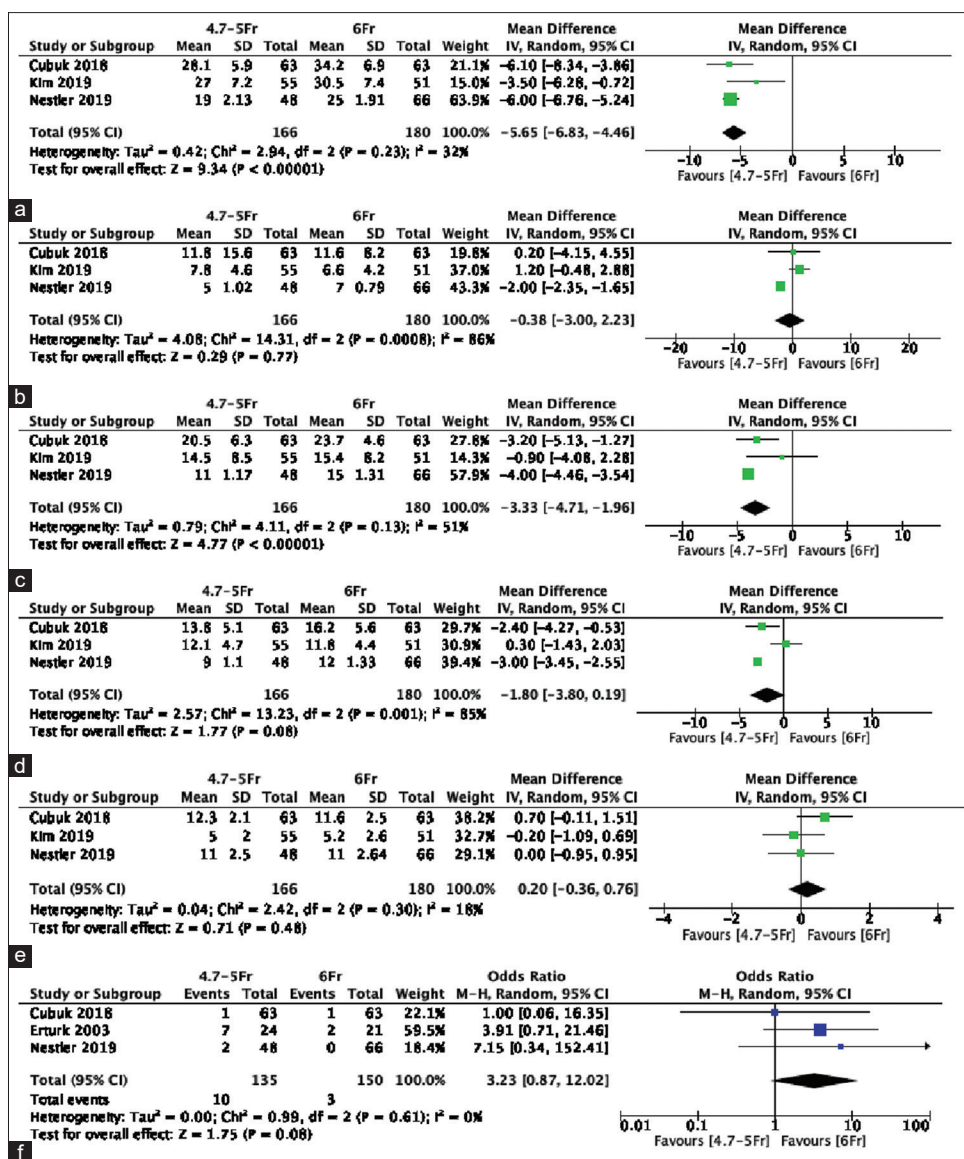


Figure 3: (a) Forest plot of urinary index score. (b) Forest plot of work performance index score. (c) Forest plot of pain index score. (d) Forest plot of general health index score. (e) Forest plot of additional problems index score. (f) Forest plot of stent migration. CI = Confidence interval; IV = Inverse variance; SD = Standard deviation

low-moderate for most reported outcomes, while the quality of available evidence was moderate.

Though ureteric stent insertion after ureterorenoscopy is no longer routine practice due to the likelihood of adverse effects and the resultant impact on patient's quality of life, a survey of urologists found that approximately 80% placed a stent after a ureteroscopy for stone disease.^[14] The rationale for this may surround the belief that the insertion of the stent will assist the passage of stone fragments, as well as diminish the risk of postprocedural ureteric obstruction as a result of spasm in the inflamed oedematous ureter.^[15] Vogt *et al.*^[16] and Nestler *et al.*^[13] both highlight that stent diameter has little effect on the overall ureteric dilatation postplacement, with similar

ureteric dilatation to be expected with differing ureteric stent sizes.

Furthermore, the landmark paper by Kinn *et al.*,^[17] which assessed the flow dynamics of a stented ureter, found that urine passage around the stent is 3–4 times more than the urine flowing through the stent. We hypothesize that the smaller stent allows more space between the stent and the ureteric wall as a functional ureteric lumen, hence reducing the symptoms.

It is plausible that using the ureteric stents with the smallest possible available diameter will not only improve patient quality of life postoperatively, but also might reduce any unnecessary presentations to the emergency departments,

hospital admissions for pain control, and need to seek medical advice. The reduction in postoperative pain may translate to an earlier return to normal daily activities and reduced social dependence. Social life enjoyment and earlier return to physical activities not only benefit patients physically but also has undeniable psychological benefits that will help the patient to recuperate holistically.

Reduced postoperative pain along with reduced urinary symptoms will also instill confidence in the patient's medical service provider, especially if further urological procedures are indicated such as: Staged stone procedures, stone procedures on the contralateral renal unit, or stone procedures for recurrent stone formers.

There were no differences in the USSQ domains of Work Performance, General Health Index and Additional Problems Index scores between the two groups. Using the fixed effects model showed that narrower stent is favored in the Work Performance score, denoting a possible advantage. Similarly, no statistically significant association was found between the stent diameter and the incidence of stent migration, though it appears narrower stents may be more prone to postoperative migration.

The lack of reported outcomes from the Sexual Matters Index resulted in a meta-analysis on this particular domain to be unable to be performed. However, data provided by Cubuk *et al.*,^[11] as well as published data by Kim *et al.*,^[12] showed no statistically significant difference in this domain when comparing the two stent sizes.

There have been a number of studies investigating the multitude of factors that might contribute to stent migration. Kawahara *et al.*^[18] describe a strong correlation of short ureteric stents to postoperative migration of ureteric stents. Burns *et al.*^[19] describe other factors that might result in stent migration, such as stent shape, size, material, patient factors, and surgeon factors including poor stent deployment and poor positioning.

Our study contains limitations, firstly owed to the small sample size of the limited number of studies we were able to include. Our results found a beneficial role of smaller diameter stents, we hope it will provide incentive for larger randomized studies to be performed in the future. Stent material was not provided in the included studies and could therefore not be commented upon. Various other confounding factors could be included in future studies, including the rates of stone impaction, evidence of infection, preoperative acute kidney injury rates, and ureteric wall injury. Data including the baseline patient

height or Body mass index, stent length, stent material, and bladder loop location, may also allow for further homogeneity between each compared group. The included studies also contained variability with regards to the timing of questionnaire completion. Cubuk *et al.*^[11] provided the questionnaire to patients 1 week following stent insertion, Kim *et al.*^[12] 2–3 weeks postinsertion, while Nestler *et al.*^[13] provided the USSQ to patients after 4 weeks.

CONCLUSION

The association of ureteric stent insertion with postoperative pain is well-established, with a clear subsequent impact on patient quality of life. Our study has shown that the use of smaller diameter stents has a statistically significant relationship to the reduced incidence of urinary symptoms and patient-reported pain, when compared to larger diameter stents, with equivalence in work-related symptoms, general symptoms, additional problems, and stent migration.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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Appendix 1: Search Strategy

Search number	Search strategy*
#1	MeSH descriptor: [ureteric stent] explode all trees
#2	Ureteric stent: TI, AB, KW
#3	MeSH descriptor: [ureteral stent] explode all trees
#4	Ureteral stent: TI, AB, KW
#5	MeSH descriptor: [diameter] explode all trees
#6	Diameter: TI, AB, KW
#7	#1 OR #2 OR #3 OR #4 OR #5 OR #6
#8	MeSH descriptor: [ureteric stone] explode all trees
#9	Ureteric stone: TI, AB, KW
#10	MeSH descriptor: [urolithiasis] explode all trees
#11	Urolithiasis: TI, AB, KW
#12	#8 OR #9 OR #10 OR #11
#13	#7 AND #12

*This search strategy was adopted for following databases: MEDLINE, EMBASE, CINAHL and the Cochrane Central Register of Controlled Trials (CENTRAL)