Magnetic versus conventional stent in ureteral stenting: meta-analysis

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Introduction

In 1978, Finney introduced the double-J (DJ) ureteral catheter stent, which is now widely used. DJ stents can cause many symptoms, such as low backache, flank pain, frequency, urgency, haematuria and incomplete emptying. In addition, stent removal can cause anxiety and discomfort for patients and impose additional financial burdens. Significant emphasis has been placed on decreasing the stent dwell time, impregnating stents with drugs and different mechanisms of stent removal, with possible solutions involving magnetic stents or stents tipped with string. The magnetic ureteral stent was first described by Macaluso et al. in 1989. Despite the potential benefits of the magnetic ureteral stent, including easier and faster removal, they are not yet widely adopted due to concerns over unfamiliarity, unclear safety and efficacy, such as difficult insertion, unintentional dislodgment and retrieval failure, etc. Accordingly, this meta-analysis compares the strengths and weaknesses of magnetic ureteral and conventional ureteral stents.

Methods

Search strategy

The systematic review was registered with the International Prospective Register of systematic reviews (PROSPERO) (CRD42023413418). Studies published in English were systematically retrieved from PubMed, Embase and Cochrane databases, using the search words ‘magnetic’ and ‘ureteral stents or double-J stents’.

Data extraction

Two researchers reviewed studies included in this study and extracted data independently using a self-defined data sheet. Stent-related symptoms were measured using the Ureteral Stent Symptoms Questionnaire (USSQ), and pain on stent removal was measured using the Visual Analogue Scale (VAS).

Data analysis

Review Manager version 5.4 (the Cochrane Collaboration 2014, Nordic Cochrane Center Copenhagen, Denmark) was employed to analyse the data. The authors used weighted mean difference (WMD) with the corresponding 95% c.i. to explain continuous data. All statistical tests were two-sided, with \( P < 0.05 \) regarded as significant. To assess the level of inconsistency or heterogeneity in the data analysis, the authors utilized the I^2 statistic, which represents the percentage of the variance that can be attributed to between-study heterogeneity.

Results

Characteristics and quality of the individual studies

Six randomized clinical trials (RCTs) were included (Fig. S1). Characteristics of these RCTs are presented in Table S1. Fig. S2 presents the evaluation of the risk of bias in the included studies.

Stent-related symptoms

Stent-related symptoms measured using USSQ included urinary symptoms, pain, general health, work performance and sexual matters.

The frequency of urinary symptoms between magnetic and conventional stent groups was statistically significant (MD 2.37; 95% c.i. 0.33 to 4.41; \( P = 0.02 \)) (Fig. S3a).

No significant difference in pain between the two groups (WMD 0.14; 95% c.i. −1.75 to 5.59; \( P = 0.50 \)) was found, and the general health score also demonstrated no significant difference (MD 0.55; 95% c.i. −1.49 to 2.60; \( P = 0.60 \)) (Fig. S3b, c).

The pooled estimates revealed no significant difference in work performance and sexual matters between the two groups (MD 0.5; 95% c.i. −0.85 to 12.07; \( P = 0.09 \) and MD 0.04; 95% c.i. −1.03 to 1.11; \( P = 0.94 \)) (Fig. S3d, e).

Pain on stent removal

Pain on stent removal was measured using VAS. The results revealed no significant difference in pain on stent removal between the two groups (MD −1.75; 95% c.i. −4.09 to 0.59; \( P = 0.14 \)) (Fig. S3f).

Removal time

The forest plot demonstrates that the magnetic stent group was associated with a significantly reduced removal time compared with the conventional stent group (MD −6.18; 95% c.i. −10.33 to −2.03; \( P = 0.004 \)) (Fig. S3g).

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The results of sensitivity analysis and publication bias

The results of Farouk et al.’s study were reported as medians rather than means. So in the case of the USSQ score and VAS, a relative outlier study was excluded. For urinary symptoms, no statistically significant difference between two groups was found. And this led to a decrease in heterogeneity, with I² values changing from 75 to 53 (Fig. S4a). For pain, this led to a decrease in heterogeneity, with I² values changing from 95 to 30 (Fig. S4b). This suggests that the heterogeneity was primarily influenced by Farouk et al.’s study. For general health, work performance and sexual matters, there were no significant changes (Fig. S4c–e). For pain on the stent removal, we revealed a lower pain during stent removal in the magnetic stent. The presence of a magnet may cause discomfort in the bladder and abdomen, leading to the reported pain in those areas.

As the types of magnetic stents differed, a different study was identified as a relative outlier and excluded. For urinary symptoms, no statistically significant difference between two groups was found (Fig. S5a). For pain, there was no significant change (Fig. S5b). For general health, this resulted in a reduction in heterogeneity, with I² changing from 84 to 41 (Fig. S5c). The type of magnetic stent may affect urinary symptoms. In addition, there were no significant changes for work performance, sexual matters and VAS (Fig. S5d–f).

Information regarding publication bias is described in the Supplementary Results.
cystoscopes used, the formulation of questionnaire questions or the use of local anaesthesia during the procedure. Further research and the utilization of more scientifically rigorous evaluation methods are necessary to better understand and address these discrepancies.

In this meta-analysis, the stent removal time was significantly less in the magnetic stent group compared with the conventional stent group. This time-saving aspect benefits both the patient and the hospital, allowing for improved efficiency in the healthcare setting. Five RCTs reported a decrease in cost associated with magnetic stents compared with conventional stents\textsuperscript{10–14}, due to the reduced need for cystoscopy during removal.

Overall, this meta-analysis included six RCTs that focused on comparing the strengths and weaknesses of magnetic ureteral stents and conventional ureteral stents in patients with indications for stenting. However, there are a few limitations that should be acknowledged. First, the number of RCTs included in the analysis and the sample size of the studies were relatively small. The six RCTs only involved 565 participants, with individual trial sizes ranging from 40 to 50 participants. This limited sample size may impact the generalizability of the findings. Second, the methodological rigour of the RCTs included in this analysis was low. To ensure the accuracy and reliability of the results, it is important to conduct more high-quality trials with robust methodologies. Third, there was significant heterogeneity observed in the assessed outcomes. This heterogeneity can be attributed to various factors, including differences in statistical methods, variations in the diseases studied and discrepancies in the types of magnetic stents employed. These differences contribute to the overall heterogeneity and may influence the evaluation of the results. Therefore, conducting more comprehensive and well-designed trials to further compare the efficacy and safety of magnetic ureteral stents versus conventional ureteral stents is crucial.

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Disclosure
The authors declare no conflict of interest.

Supplementary material
Supplementary material is available at BJU Open online.

Data availability
The data sets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Author contributions
Zhunan Xu (Writing—original draft), Hang Zhou (Writing—original draft), Qihua Wang (Formal analysis), Congzhe Ren (Formal analysis), Yang Pan (Data curation), Shangren Wang (Data curation), Li Liu (Conceptualization, Writing—review & editing) and Xiaogiang Liu (Conceptualization, Writing—review & editing).

References
9. Dehui L, Xiang W, Jiejun L, Tiejun T. How to estimate the sample mean and standard deviation from the sample size, median, extremes or quartiles? Chin J Evid-Based Med 2017;17:1350–1356

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