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Review

Prevention strategies for ureteral stricture following ureteroscopic lithotripsy

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Abstract Ureteral stricture formation after ureteroscopic lithotripsy is a late complication that can lead to hydronephrosis and a subsequent risk of renal deterioration. The specific incidence is unknown, and the mechanism of stricture formation has not been completely explained. In this review, we summarize the current evidence regarding the incidence of this condition and discuss its pathogenesis. We then list preventive strategies to reduce the morbidity of ureteral strictures.

1. Introduction

Due to technological developments in the past 2 decades, ureteroscopy has played an increasingly important role in the diagnosis and treatment of upper urinary diseases. According to a recent report, ureteroscopic lithotripsy (URL) has replaced shockwave lithotripsy (SWL) as the primary treatment modality for upper tract calculi in the United States [1].

However, with such wide application, the complications of URL should not be ignored [2,3]. As one of the late complications of URL, ureteral stricture can lead to ureteral obstruction and progressive deterioration of renal function. In patients with "silent ureteral obstruction", irreversible renal failure may occur if routine postoperative follow-ups are not conducted.

Our aim is to summarize the incidence, risk factors, etiology, and prevention strategies of ureteral stricture following URL.

2. Evidence acquisition

A literature search was performed using the PubMed from January 1970 to March 2017. The following terms and combinations of terms were searched: "ureteral stricture or ureteral stenosis" combined with the terms

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"ureteroscopy or ureteroscopic lithotripsy", and "complications" combined with "ureteroscopy or ureteroscopic lithotripsy". The review identified 1428 articles in total with the use of the above mentioned keywords in English. We excluded those articles if they did not corresponding with the aim of our review by reading title, abstracts and full-text screening. Finally, 48 studies were considered valuable for this review (Fig. 1). These articles include four reviews, five randomized controlled trials, five prospective studies, and 34 retrospective studies. The primary aim of the review is to report the incidence, pathogenesis and risk factors of ureteral strictures following ureteroscopy. The second aim is to introduce preventive measures for ureteral strictures.

3. Incidence

There is significant variability in the reported incidence of ureteral stricture formation following URL. According to recent studies, the incidence of ureteral stricture following URL is 0.71% (0.30%—23.81%) (Table 1). In addition to the risk factors of stricture formation, the incidence of ureteral stricture is also influenced by the strategy of postoperative imaging follow-up. In some studies, the incidence of ureteral stenosis may be underestimated due to insufficient follow-up [4,5].

With the development of equipment and accumulation of experience, the risk of ureteral injury and ureteral stricture has decreased dramatically. In a retrospective study, Elashry et al. [6] compared the outcomes of patients who underwent URL from 1991 to 1995 (Group 1) with patients who underwent this procedure from 1996 to 2005 (Group 2) in a single center. In the latter group, intraoperative perforation and avulsion decreased from 3.3% to 0.5% and from 1.3% to 0.1%, respectively. In addition, the incidences of ureteric stricture were 0.7% and 0.1% in Group 1 and Group 2, respectively ($p = 0.007$). Another study summarizing the 15-year experience of a urologist and showed a similar result [7].

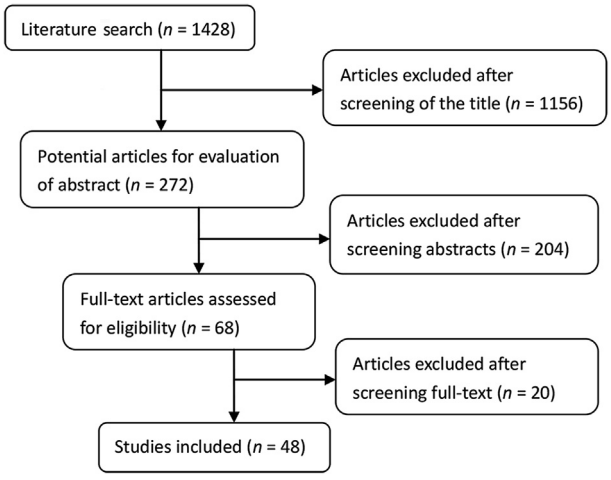

Figure 1 Flowchart for article selection of the review.

4. Risk factors

According to previous reports, the incidence of ureteral stricture is high in patients with impacted stones. A retrospective study conducted in 1998 reported that the incidence of stricture formation following endoscopic treatment was nearly 24% [8]. Brito et al. [10] evaluated the outcomes of URL for impacted ureteral stones with a pneumatic lithotripter. Ureteral stricture was observed in 14.29% of patients (6/42) during the follow-up period. A more recent prospective study was conducted to evaluate the risk of ureteral stricture in patients with impacted stones after ureteroscopic treatment [14]. The incidence of ureteral stricture in this previous report was 7.8% of a total 64 patients. Xi et al. [15] compared the outcomes of URL and ureteroureterostomy for patients with impacted ureteral stones. Compared with the ureteroureterostomy group, a higher incidence of ureteral stricture was observed in the URL group (26.2% *vs.* 4.0%; $p = 0.019$). This result showed that the removal of the pathologic ureter with a polyp or stricture lesion might reduce the long-term risk of ureteral stricture for patients with impacted stones [15].

There is limited literature evaluating the risk of stricture formation in different parts of the ureter. In a global study of 9681 cases of URL, the incidence of ureteral stricture was 0.9% for proximal ureter locations, 1.1% for midureteral locations and 0.7% for distal ureter locations [16]. The difference between the three groups was not statistically significant. However, according to the study by Brito et al. [10], URL for proximal ureter stones was associated with a higher risk of perforation and ureteral stricture compared to distal or midureteral stones. In addition, the study by Schuster et al. [17] showed similar result. The intraoperative perforation rate after URL was 6.3% and 4.2% for proximal and distal stones, respectively. Another retrospective study also concluded that proximal ureteral stone was one of the significant factors for unfavorable results of semi-rigid ureteroscopy [18].

The ureteral access sheath (UAS) has been used worldwide for flexible-URL to enable multiple access points to the collecting system, to maintain low intrarenal pressure and to protect the scope [19—21]. Use of UAS has the advantages of minimizing the damage to ureter and improving the effectiveness of operation [22]. However, there is no consensus on whether the application of a UAS in flexible ureteroscopy increases the risk of ischemic injury and subsequent stricture. Lallas et al. [23] studied the potential risk of ischemia in porcine ureters, and the results showed that the ischemia is transient and is not enough to induce ischemic injuries. A study assessed the long-term incidence of ureteral stricture formation in patients receiving ureteroscopy with a UAS [24]. The incidence of ureteral stricture was 1.4% (1/71) which is similar to previously reported published stricture rates without the use of UAS and no evidence showed that the UAS is a contributing factor for stricture formation in the patient who developed this complication [24,25]. Wang et al. [26] evaluated the influence of the use of a UAS on the outcomes of ureteroscopy in children. The intraoperative complication rate was higher in patients undergoing ureteroscopy with a UAS (15% *vs.* 2%, $p = 0.02$). Ureteral stricture was not observed with a