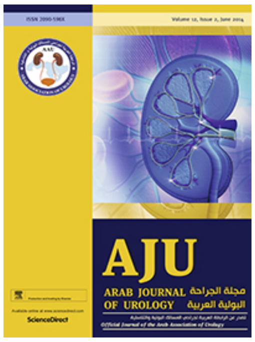

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ORIGINAL ARTICLE

The development of ureteric strictures after ureteroscopic treatment for ureteric calculi: A long-term study at two academic centres

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ABBREVIATION

RUS, renal ultrasonography

Abstract ***Objective:*** To determine the incidence of symptomatic and 'silent' obstruction after ureteroscopic procedures.

Patients and methods: In all, 1980 patients underwent ureteroscopy for ureteric calculi in two large centres. The methods of disintegration, auxiliary procedures used and type of stenting were considered. Intraoperative complications, in addition to the size and site of the stone, were assessed in relation to postoperative obstruction. The mean (range) follow-up was 42 (12–68) months, with patients assessed after 3–6 months and yearly thereafter. The postoperative evaluation included an assessment of pain, renal ultrasonography, a plain abdominal film, intravenous urography, and a diuretic renal scan in some cases to confirm obstruction.

Results: The success rate of stone removal was 98.5%. The failures were related to the size of the stone (>2 cm; $P < 0.001$). In eight patients there was a ureteric perforation, and six of these developed a ureteric stricture. A stricture also occurred in 12 patients (0.6%) during the follow-up; these included nine of 204 with stones of >2 cm (4.4%), compared to three (0.17%) of 1746 patients with stones of <2 cm

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(P < 0.001). Fourteen patients presented with pain (0.7%), and five had no obstruction, while in nine (0.46%) the pain was associated with obstruction. There was silent obstruction in three cases (0.15%). The negative and positive predictive values for pain were 99.8% and 64.3%, respectively.

Conclusions: Radiographic surveillance for stricture formation and obstruction is mandatory in patients who are symptomatic after ureteroscopy, and for up to 18 months in patients with intraoperative complications or with a stone of >2 cm in the proximal ureter.

Introduction

The improvements in endoscopes and stone-disintegration devices have expanded the indications and success of ureteroscopic procedures for stone disease, while decreasing associated complication rates [1]. Historically, the incidence of ureteric stricture after routine ureteroscopy was reported to be relatively high (up to 4%), with a subsequent risk of renal deterioration. Therefore, follow-up radiographic studies after ureteroscopy have been the standard of care adopted by many urologists [2].

However, recent series of ureteroscopy have reported the rate of postoperative ureteric stricture to be 0–0.2%. Consequently, the need for routine imaging after the procedure has been questioned, because of concerns about the cost and radiation exposure [3]. Thus there are controversial studies of the follow-up not only after intraoperatively complicated and uncomplicated ureteroscopy, but also for both symptomatic and asymptomatic cases [4]. In the present study we tried to determine the appropriate follow-up after ureteroscopy in these different scenarios.

Patients and methods

This retrospective study was carried out at the Tanta University Hospital, Egypt, and the Washington University School of Medicine, St. Louis, MO, USA, from January 2004 to July 2011. We evaluated 1980 patients who underwent ureteroscopy for ureteric calculi in these two large centres. None of the patients had been stented before ureteroscopy. The imaging studies used to detect ureteric stones included plain abdominal films, renal ultrasonography (RUS), IVU, and/or spiral CT and renal scintigraphy, when indicated. Patients with small stones (<0.5 cm), ureteric strictures, previous ureteric operations, an invisible ureteric orifice, hepatic or cardiac disease with bleeding disorders, acute infection, and those with previous stents, were excluded from the study.

Information obtained before ureteroscopy included any history of pain, stone size and location, and any obstruction. Both rigid and flexible ureteroscopy were used to treat the ureteric calculi, with or without lithotripsy (using a holmium laser or pneumatic lithoclast). Operative reports were reviewed for ureteroscope size, adjuncts used to facilitate the procedure, intracorporeal lithotripsy devices and the placement of a ureteric stent. Extraction of the whole stone or its fragmentation to <2 mm was considered as a successful outcome.

A plain film was taken immediately after ureteroscopy to confirm the absence of residual stone fragments. The subsequent evaluation included an assessment of pain, using a pain analogue scale, and radiographic studies by RUS, plain film and IVU at 3 months, and then annually thereafter. In patients with persistent hydronephrosis a diuretic renal scan was taken to confirm obstruction. A ureteric stricture was defined as a radiographic finding of ureteric narrowing and/or hydronephrosis, with no recurrent or persistent calculi. Patients were considered to have 'silent' obstruction when there was evidence of obstruction on imaging but with no concurrent pain. The mean (range) follow-up was 42 (12–68) months. The results were analysed statistically using the chi-square and Fisher's exact tests, with $P < 0.05$ considered to indicate statistical significance.

Results

In all, 1980 patients underwent rigid and flexible ureteroscopy for ureteric calculi, of whom 1219 had calculi below the pelvic brim (61.6%) and 761 had stones in the proximal ureter (38.4%), including 406 with stones in the upper third of the ureter (20.5%) and 355 with stones in the middle third (17.9%) overlying the pelvic bone.

In all, 830 patients had a stone of <1 cm, of whom 827 (99.6%) had successful stone extraction and/or fragmentation. Another 930 patients had stones of 1–2 cm, and 919 (98.8%) in this group were treated successfully. Stones of >2 cm were found in 220 patients, and 204 (92.7%) had a successful and complete stone disintegration. Overall, 1950 of the 1980 patients (98.5%) had a successful outcome, with a complete follow-up, while 30 had incomplete data or were lost to follow-up.

For the procedures, a semi-rigid ureteroscope of 8.5 F was used in 1085 patients (54.8%), in 105 for proximal stones (13%) and in 980 (83.8%) for distal stones. A flexible 7.4 F ureteroscope was used in 895 patients (45.2%); the stones were in the proximal ureter in 705 (87%) and in the distal ureter in 190 (16.2%) of these patients. Ureteric dilatation was not used routinely, and balloon dilatation was only used in 365 patients (18.7%).

Ureteric stents were placed routinely on completing the procedure. In patients with no intraoperative complications and an intact mucosa by direct vision, a short-term (1–2 day) open-tip 6-F ureteric catheter was left in situ. In other patients with a ureteric injury (with or without perforation), residual gravel or migrating fragments, a ureteric stent was left in situ for 4–6 weeks.

Assessing the procedures deemed to be successful and the patients stone-free at the first radiological follow-up (1950 patients), a Dormia basket was used alone to extract small stones, with no need for lithotripsy, in 829 (42.5%), while 1121 (57.5%) required lithotripsy using the holmium: YAG laser or a pneumatic lithoclast. A second ureteroscopy was done 2 weeks later for residual stones in 12 patients. An intraoperative mucosal injury was identified in 28 patients.

There were eight cases (0.4%) that were complicated by ureteric perforation (four proximal and four distal). All of these patients were treated with an immediate internal stent, and a second procedure at 4–6 weeks later was successful and safe in all for removing the stone. There were no perforations in any patient with a stone of < 1 cm. In five of the eight patients the stone was > 2 cm, and in three of these the stone was in the proximal ureter. Six of eight patients who had a ureteric perforation developed ureteric strictures.

Ureteric strictures were detected in 12 patients (0.6%) during the follow-up. Eight developed in those with a proximal stone and in four with a distal stone. There was a history of intraoperative perforation in six of these patients and four of them were in the proximal ureter. The relation between perforation at the site of the stone and the site of subsequent stricture was statistically significant ($P = 0.005$). This relation was not statistically significant in the total cohort ($P = 0.06$). In five of the 12 cases there was perforation during disintegration of a large stone of > 2 cm. The stone was in the distal ureter in two of these patients. In nine patients the stone was large but with no associated perforation in four, constituting 0.46% of the successful cases (Table 1).

In eight patients the stricture was detected at 3–6 months after surgery, while in three the stricture was detected at 13 months. One stricture was found at 18 months after treatment. In these cases the stricture was suspected by the clinical presentation, with a dull aching pain reported by nine patients. The stricture and resulting obstruction were confirmed radiographically. A ureteric stricture occurred in nine of 204 patients with stones of > 2 cm (4.4%), compared to three strictures (0.17%) in 1746 patients with stones of < 2 cm. Therefore, stone size correlated statistically with postoperative stricture ($P < 0.001$; Table 2).

Table 1 The relationship between stone size, site, ureteric perforation and late stricture.

Variable, *n* (%)	Site		Total, *n* (%)
	Proximal	Distal	
Total	789	1161	1950
Perforation	4 (0.5)	4 (0.3)	8 (0.4)
Stone size (cm)			
< 2	1	2	3
> 2	7 (0.88)	2 (0.17)	9 (0.46)
Late stricture	8 (1)	4 (0.3)	12 (0.6)
Treatment (dilatation)			
Antegrade	–	1	
Retrograde	8	3	11

Stone site vs late stricture, $P = 0.003$; stent size > 2 cm vs late stricture, $P = 0.001$; perforation vs late stricture, $P = 0.005$.

All patients with strictures were managed successfully, 11 by retrograde endoscopic dilation and/or incision and one with antegrade dilatation.

Fourteen patients (0.7%) had pain on the ipsilateral side after removing the stent, and five of these were not obstructed when assessed by radiography. The remaining nine patients in this group were both symptomatic and obstructed. This constitutes only 0.46% of the total after ureteroscopy. In three patients an asymptomatic obstruction was diagnosed during the routine radiographic follow-up protocol. The difference between the painless, obstructed group (0.15%) and the obstructed group with pain (0.46%) was statistically significant ($P = 0.02$).

The negative and positive predictive values for pain were calculated as 99.8% and 64.3%, respectively, i.e. 99.8% of patients with no pain had no postoperative obstruction, and 64.3% of patients who complained of pain had postoperative obstruction.

Discussion

The improvements in ureteroscopes, with advances in intracorporeal lithotripsy devices, specifically the holmium: YAG laser, small graspers and baskets, have allowed the ureteroscopic treatment of ureteric stones to be safe and with high success rates [5]. Major

Table 2 The relationship between stone size and late stricture after ureteroscopy.

Stone size (cm)	Successful, *n*	Late stricture, *n*/*N* (%)
< 1	827	0
1–2	919	3/1746 (0.17)
> 2	204	9/204 (4.4)
Total	1950	12 (0.6)

complications have decreased to <2% and ureteric stricture rates to <0.5%. With these data some have questioned the need for a routine radiological follow-up after ureteroscopy [1].

We previously reported that major intraoperative complications like perforation and avulsion have decreased with the increasing experience of surgeons and with advanced devices, from 3.3% to 0.5%, and from 1.3% to 0.1%, respectively [6]. In the present series there were no ureteric avulsions, which is the most catastrophic complication of ureteroscopy. This compares to 0.1% in our previous report, because from our long-term experience we adopted the view that two safe endoscopic procedures are much better than one complicated operation.

Stoller and Wolf [7] reported a 6.1% incidence of perforation in a review on 5117 procedures, with complete ureteric avulsion in 0.3%. In a recent study of 908 procedures comparing cases with unfavourable and favourable results, El-Nahas et al. [8] found that the most important factors influencing the results favourably and significantly were the stone site, size and impaction, in addition to the experience of the surgeon. In that excellent study, the overall stone-free rate after 3 months, and the intraoperative complication and perforation rates, were 98%, 6.7%, and 1.3%, respectively.

In the present series a ureteric perforation was detected in 0.4% of the patients, which was very similar to the 0.65% incidence reported by Geavelate et al. [2] in 2006. We detected a perforation in 0.5% of proximal ureters, compared to 0.3% in lower ureters in patients with large (>2 cm) stones. Many authors believe that ureteric perforation is associated with a higher rate of stricture formation, of up to 75%, in patients with impacted calculi, and that the mechanism is multifactorial [9].

The predisposing factors for late stricture are direct ureteric injury due to mucosal ischaemia from prolonged manipulation, leading to fibrinous exudates on the traumatised wall, and peri-ureteric fibrosis due to extravasation after perforation, especially in the presence of infection. Therefore, the use of small ureteroscopes with less traumatic disintegration tools, not only to treat the stone but also to reduce ureteric injury, is consistent with the decreased incidence of ureteric stricture in the recent years. Studies have shown lower perforation rates after holmium: YAG laser ablation of the stone [10]. Small fragments can remain adherent to the ureteric wall when using the pneumatic lithoclast. Oedema and interstitial fibrosis are also local predisposing factors for late ureteric stricture [8,9].

The relationship between perforation and stricture has been reported frequently. In the present series there was an association between perforation and stricture formation in half of the patients in whom strictures developed. This is comparable with ureteric strictures in 37% of patients with a perforation reported by Kramolowsky [11], and 80% reported by Robert et al. [12]. Brito et al. [13] reported an overall incidence of stricture of 14.2% after pneumatic lithotripsy of impacted calculi. Strictures occurred in 2.9% of patients with no perforation, compared to three-quarters of patients with a perforated ureter.

In the present study, seven of eight patients with a proximal stricture and two of four with a distal stricture had a stone of >2 cm. Overall, in patients with large stones (>2 cm), there was a stricture in the proximal ureter in 0.88%, compared to 0.17% in the distal ureter (statistically significant, $P < 0.05$). It is possible that the ureteric stenting protocol adopted at the end of the procedure, the in situ fragmentation to <2–3 mm, and the extraction of large particles with forceps, might have decreased the risk of early postoperative morbidity, improved the stone-free rate and decreased the rate of late stricture. Therefore, we consider, as do many other authors, that ureteroscopy in a well-equipped unit can be safe as an outpatient procedure [14,15].

By contrast, Stackl and Marberger [16] found no correlation between intraoperative perforation and late complications, including stricture formation. Therefore, some authors recommended postoperative routine functional radiographic studies to exclude silent obstruction, and differentiate it from a ureteric stricture that might result in a loss of renal function [17]. Imaging to monitor renal function is associated with a greater cost, but the risk of renal functional deterioration should be considered. It is difficult to place a monetary value on the loss of kidney function.

In the present series the presence or absence of flank pain was assessed as a predictor of postoperative ureteric obstruction. Pain in this area can come from the colon, lumber muscle spasm or costovertebral joint disorders, and can be clinically misdiagnosed as renal pain. As such, pain is not a definite sign of underlying ureteric obstruction. Associated fever is a more reliable indicator during a clinical examination. Silent obstruction is primarily a radiological and not a clinical diagnosis. We found a significant relationship between ureteric stricture and postoperative pain, as nine of the 12 patients with postoperative obstruction complained of flank pain, compared to a quarter of the obstructed patients who were clinically asymptomatic, constituting 0.46% and 0.15% of the total cohort ($P < 0.05$).

Of the 14 patients who had pain after ureteroscopy, nine had obstruction and five had ipsilateral symptoms with no radiographic signs of obstruction. All the obstructed patients were managed endoscopically, according to our previously published protocol [18], either by a retrograde route (eight) or by antegrade dilatation (one), with a successful ultimate outcome, preserving renal function and unobstructed drainage of the kidney during the follow-up.

Karod et al. [19] found that patients with radiologically confirmed obstruction and flank pain constituted 10% of their patients after ureteroscopy, but none of the asymptomatic patients were obstructed on a radiological follow-up at a median of 60 days. They concluded that routine postoperative imaging to exclude obstruction is not necessary in asymptomatic patients, as all obstructed patients will present with flank pain. Moreover, Beiko et al. [4] suggested that routine postoperative imaging should be considered in cases of chronic stone impaction, significant ureteric trauma, pre-existing renal functional impairment, endoscopic evidence of stricture, and postoperative flank pain or fever. In another study, Kishore et al. [20] concluded that a routine radiological examination after ureteroscopy is not necessary unless there is postoperative ipsilateral obstruction and flank pain. They assert that routine follow-up imaging is not essential after an uncomplicated ureteroscopy.

In another retrospective study by Weizer et al. [3], 12.3% of the patients developed postoperative obstruction at a mean follow-up of 5.4 months, and 67.7% of the obstructed patients had pain and 23.3% were clinically asymptomatic. Therefore, there was silent obstruction in 2.9% of the total patients compared to only 0.15% in the present series that had a longer follow-up. We advocate, as these authors also concluded, that silent obstruction remains a potentially significant risk after the endoscopic treatment of stones, and relying only on pain to determine the need for imaging places the patients at risk of progressive renal functional deterioration due to the silent obstruction. We also suggest that postoperative pain is a predictor of obstruction, because almost a third of the patients with pain had no obstruction and a quarter of the obstructed patients had silent obstruction. Furthermore, the costs of treating the potential morbidity, that could extend to nephrectomy, is difficult to calculate and can be easily avoided in the suspected cases.

Therefore, we advocate a routine postoperative follow-up with imaging for all patients after a complicated ureteroscopy, and in those with impacted stones of > 2 cm. The follow-up should extend to 18 months after the ureteroscopic stone-extraction procedure. In the present series, four of 12 of these patients were diagnosed after a normal initial radiological follow-up study.

In conclusion, a radiographic surveillance for stricture formation and obstruction is mandatory in patients who are symptomatic after ureteroscopic stone removal. Surveillance up to 18 months is recommended in patients with a history of intraoperative ureteric complications (perforation or false passage) and in those with stones of $\geqslant 2$ cm in the proximal ureter.

Conflict of interest

None.

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None.

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