Original Article

Factors affecting the durability of flexible ureteroscopes: An academic center review

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Abstract

Objective: To analyze the factors which affect the durability of the flexible ureteroscope and the causes of scope damage in a single academic center.

Material and Method: Between March 2014 and August 2017, 479 flexible ureteroscopic procedures, using 6 flexible ureteroscopes (Olympus model URF-V), were systematically reviewed. Data including indication for procedures, auxiliary device usage, the characteristics of scope damage, and the number of times a scope was used before requiring major repair were gathered. Fisher exact test and Chi-square test were used to evaluate the factors which caused the damage.

Results: The major flexible ureteroscopic procedure performed was treatment of renal calculi (81%). The most common auxiliary device used was the Holmium laser (70%). The most common cause of damage requiring repair was working channel leakage (93%). The factor that affected the durability of flexible ureteroscopes was the size of laser fiber. Utilizing laser fiber 200 nm decreased scope damage significantly compared to various other sizes (p-value=0.002 and p-value<0.001). However, the usage of nitinol basket and ureteral access sheath did not affect the durability of flexible ureteroscopes.

Conclusion: Large laser fibers are a risk factor for flexible ureteroscope damage. Utilizing small laser fibers during flexible ureteroscopy can decrease scope damage significantly.

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Introduction

Ureteroscopy is widely used to inspect the ureter, renal pelvis, and upper collecting system. The first ureteroscopy was performed in 1956. After fiber-optic technology was developed, the first flexible ureteroscopy was performed in 1964 by Marshall[1]. The development of specification in the working channel, the deflection capability, and the decrease in the diameter of the flexible ureteroscopy have all increased the capabilities of diagnostic and therapeutic management in the upper collection system.

Flexible ureteroscopy plays a number of roles in diagnostic management, such as determining the cause of gross hematuria, pathology in the ureter caused by hydronephrosis, biopsy, and selective ureteral sampling for cytology. The other is the therapeutic management, such as tumor ablation and stone management[2,3].

However, the high cost of the administration and maintenance of flexible ureteroscopy should be a concern and thus the durability of the flexible ureteroscope is an important factor for its utility. Durability varies depending on the model and manufacturer, operative procedure, the use of auxiliary equipment, and operator experience[4,5].

In this study we analyzed the factors which affected the durability of the flexible ureteroscope and the causes of scope damage in Siriraj Hospital.

Material and Method

We retrospectively reviewed 479 procedures performed by 13 experienced urologists with 6 flexible ureteroscope URF-V models from Olympus between March 2014 and August 2017 in Siriraj Hospital. Intraoperative details included the indication for procedure, therapeutic and diagnostic details, auxiliary device usage, the characteristics of flexible ureteroscope damages, and the number of times a ureteroscope was used before major repairs were recorded. After repair, the flexible ureteroscope was checked and analysed for the cause of damage by the manufacturer before usage. We excluded 30 flexible ureteroscope records which were prepared but not used in any procedures. A total of 449 procedures were analyzed. The auxiliary devices used in the procedures were the nitinol basket (1.9 Fr, Zero tip) from Boston, the ureteral access sheath (Navigator HD 11/13Fr, 12/14 Fr) from Boston, and laser fiber size 200, 365 and 550 micron from Luminis. All the equipment was used with standard instructions and specifications. The procedures performed before January 2016 used the various sizes of laser fiber (200, 365, 550 micron). However, after January 2016, we changed the protocol by using the laser fiber 200 nm. These 2 periods were compared. The Fisher exact test and Chi-square test were used to assess for the factors which affected the number of times a flexible ureteroscope was used before being damaged. The cause of ureteroscopic damage was recorded.

Results

In this study we performed flexible ureteroscopic procedures 449 times with 6 flexible ureteroscopes which required 15 major repairs. The average number of procedures before a major repair was 31.9 times.

The major indication for flexible ureteroscopic procedure was renal and ureteral calculi in 81.06% of cases, with laser lithotripsy performed 82.69% of the time and diagnostic procedures in 14.28% of cases.

Flexible ureteroscopic procedure for an upper tract tumor was performed in 18.9% of cases, with diagnostic procedures 72.94%, tumor ablation 11.76% and tumor biopsy in 14.11% of cases (Table 1).

It was during the study that we found the protocol for laser fiber usage was altered after January 2016. Before January 2016, we had used various sizes of laser fiber (200, 365, 550 micron) in procedures, and after January 2016 we used only laser fiber 200 micron. Comparison between these 2 periods: Scope

Number 3, in 5 there was an increase in usage before major repairs with statistical significance (p=0.002 and p<0.001) (Table 2). In contrast, the ureteral access sheath was used in most procedures (88%) and the nitinol basket was only used in a few cases (14%). Thus, there was no difference in damage concerning the usage of the nitinol basket and ureteral access sheath (Table 3).

The major cause of scope damage as determined from manufacturing reports was working channel leakage; the other cause was deflection components. One scope had damage caused by a fracture to the laser fiber tip (Table 4). None of the scope damage occurred during the cleansing and sterilization process.

Table 1. Indication and flexible ureteroscopic procedure.

Scope Number	Number of times	Indication for flexible ureteroscopy		Procedure				
		Stone	Tumor	Diagnostic	Ablation	Laser	Biopsy	Basketing
I	127	106 (83.46%)	21 (16.54%)	33	1	92	1	0
II	27	21 (77.78%)	6 (22.22%)	8	0	18	1	0
III	64	37 (57.81%)	27 (43.19%)	26	8	27	0	3
IV	100	83 (83%)	17 (17%)	23	1	69	5	2
V	84	69 (62.14%)	15 (17.86%)	16	1	61	4	2
VI	47	42 (89.36%)	5 (10.64%)	8	0	34	1	4

Table 1. Comparison of the number of times a scope was used before repair between the various laser fiber group and the 200 micron laser fiber group.

Scope Number	Total laser usage	Various size laser fiber usage	200 micron laser fiber usage	P-value
I	94	26	68	0.116
II	19	19	0	N/A
III	34	14	20	0.002
IV	73	3	70	0.502
V	62	3	59	0.000
VI	34	18	16	0.312

Table 3. Auxiliary device usage.

Scope Number	Number of times used	Ureteral access sheath	Basket	Laser
I	127	118 (92.91%)	12 (9.45%)	94 (74.02 %)
II	27	27 (100%)	2 (7.4%)	19 (70.37%)
III	64	50 (78.13%)	11 (17.19%)	34 (53.13%)
IV	100	87 (87%)	19 (19%)	73 (73%)
V	84	70 (83.33%)	6 (7.14%)	62 (73.81%)
VI	47	45 (95.74%)	12 (25.53%)	34 (72.34%)

Table 4. Cause of flexible ureteroscope damage before major repair.

Scope Number	Repair Number	Number of times used	Cause of damage
I	1	25	instrument channel has leak
	2	14	instrument channel has leak
	3	58	instrument channel has leak, angulation wire has cut
	4	30	distal-end burnt, imaging problem
II	1	27	instrument channel has leak, bending unit has leaked
III	1	33	instrument channel has leak, bending unit has misshapen
	2	5	instrument channel has leak
	3	26	instrument channel has leak LASER fiber tip was broken
IV	1	4	instrument channel has leak
	2	17	instrument channel has leak
	3	79	instrument channel has leak
V	1	12	instrument channel has leak
	2	72	instrument channel has leak, bending unit has leaked, angulation wire has cut
VI	1	27	instrument channel has leak, bending unit has misshapen
	2	20	bending unit has leaked, insert tube has misshapen, imaging problem

Discussion

Nowadays, the flexible ureteroscope plays an important role in retrograde intrarenal surgery. It is used as both diagnostic and therapeutic equipment for upper urinary tract pathology. Due to advances in technology, the new model has a smaller diameter, more deflection angle, and greater durability.

The durability of flexible ureteroscopes depends on multiple factors, such as surgeon experience, type of usage, the auxiliary device, and model specification[6,7]. There were guidelines for flexible ureteroscopic usage in previous studies in order to prevent the damage proposed by Koraolides and colleagues, which increased scope usage before repair from 11 to 22 times[8]. Routine use of the ureteral access sheath was proposed in many studies for the benefits of decreasing intrarenal pressure, decreasing the operative time, more simple ureteral re-entry, and decreasing ureteral injury. In our center, the ureteral access sheath was used in most cases.

In our study, we found 2 flexible ureteroscopes that statistically increased the number of times a scope could be used before requiring repair when used with a small laser fiber in the procedure. We think that this result is related to the laser fiber specification (Table 5). The small size laser fiber 200 micron has a radius that bends less which causes more deflection than the larger fiber (Figure 1). However, with the small laser fiber there is a risk of fiber fracture which leads to ureteroscopic damage. We should be concerned about the specification of each piece of equipment before usage in order to avoid damage.

Table 5. Laser fiber specification.

Fiber specification	200 micron	365 micron	550 micron
Core diameter (nm)	272	365	550
Maximum outer diameter (nm)	450	580	780
Minimum working channel diameter (Fr)	1.65	2.05	2.65
Fiber bending radius (mm)	12	14	20
Recommended number of uses	10	10	10
Maximum input energy (J)	1.5 J	6.0 J	6.0 J
Maximum input power (W)	45 W	120 W	120 W

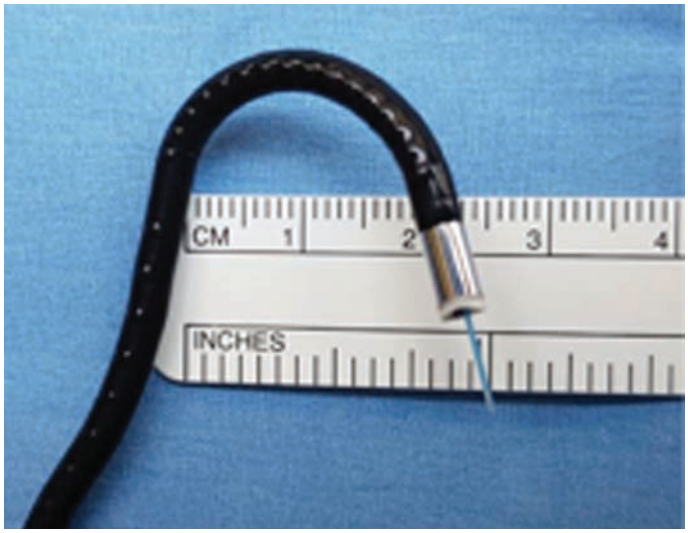

Figure 1.
Flexible ureteroscope with laser fiber have less deflection degree.

The analysis determined that the main cause of scope damage in this study was working channel leakage. This finding is in accordance with a previous study by Sung9, which found that the most damaged part of the flexible ureteroscope was the distal working channel. The mechanism of damage is initiated with over-angulated deflection while using the laser fiber. Then the working channel is burned and leaks at the maximum deflection point causing damage to the deflection wire. The irrigant leak causes internal scope damage (Figure 2).

From the study by Carey, it was suggested that previous scope damage leads to more damage occurring frequently10. In our study, we didn't compare the number of damaged scopes. A prospective study should be conducted to investigate this point.

The cleansing and sterilization process are factors that affected the durability of the equipment. In a previous study in our center we had a well-trained team that completed the sterilization process and preparation of all equipment before an operation. Nevertheless, the previous study proposed that most damage occurs during the operation.

Limitations

There are several limitations in this study owing to its retrospective nature. Some data could not be collected accurately, such as ureteroscopic time, number of scope passages in each procedure, and the deflection angles which indicate a difficult case. Thus, a prospective study should focus more on intraoperative details.

Conclusion

In this study we concluded that large laser fibers are a risk factor for flexible ureteroscope damage. Utilizing small laser fibers during flexible ureteroscopy can decrease scope damage significantly. The most common cause of damage is the unsuitable usage of equipment. Urologists should recognize and follow the instructions for flexible ureteroscope usage and the auxiliary devices in order to avoid the damage responsible for the high cost of maintenance.

Conflict of interest

The authors declare no conflict of interest.

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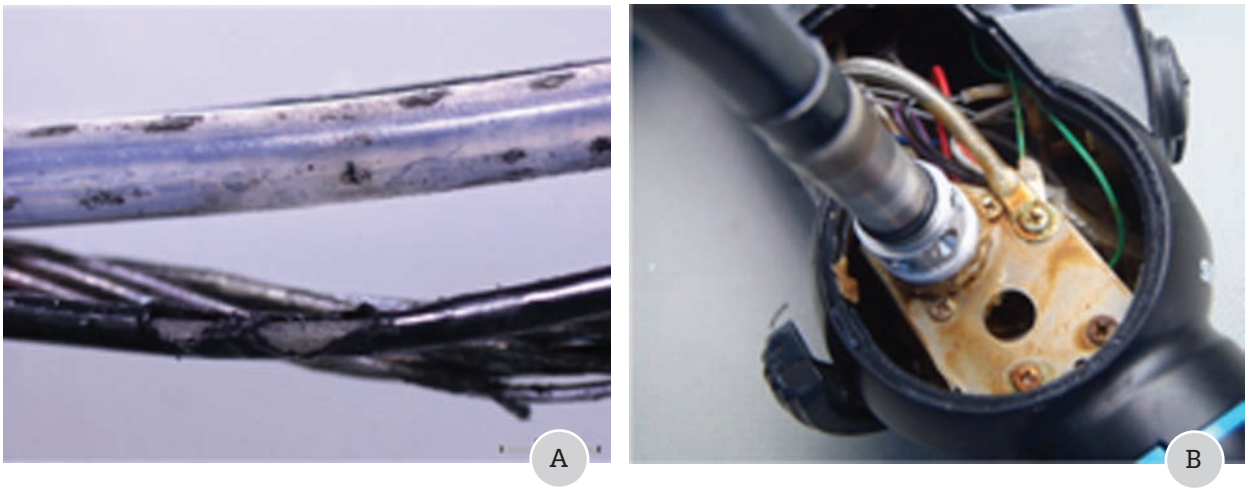

Figure 2. The deflection wire was damaged from a working channel leakage and internal scope damage.

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