Review Article

Reusable flexible ureterorenoscopes are more cost-effective than single-use scopes: results of a systematic review from PETRA Uro-group

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Abstract: Clinical data suggest an equipoise between single-use (disposable) and reusable flexible ureterorenoscope (fURS) in terms of scope characteristics, manipulation, view and clinical outcomes. The procedural cost of reusable fURS is dependent on the initial and repair cost, maintenance and scope sterilization and on the number of procedures performed/repair. We conducted a systematic review on the procedural cost ($) of fURS based on the individual authors reported data on the number of procedures performed before repair and to see if it is a feasible option compared to single use fURS. A systematic review carried out in a Cochrane style and in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) checklist using Medline, Scopus, CINAHL, EMBASE and Cochrane library for all English language articles. All papers on fURS cost analysis were searched from 2000–2018 (19 years), which mentioned the cost of fURS based on the number of procedures performed and the repairs needed (procedure/repair) as reported by the individual authors. Six studies reported on both the number of procedures performed with number of repairs needed and the cost calculated/procedure in the given time period. The number of uses/repair in various studies varied between 8–29 procedures and the cost per procedure varied between $120–1,212/procedure. A significant trend was observed between the decreasing cost of repair with the number of usages. With studies reporting on a minimum of 20 cases/repair the mean cost was around $200/procedure. This is contrast to the disposable scopes such as Lithovue ($1,500–2,000/usage) and Pusen ($700/usage). The cost of reusable fURS is low in centres performing a high volume of procedures. Similarly, when a reasonable volume of procedures is performed before scope repair, the cost is lower than the disposable scopes. Although, the disposable and reusable scopes seem to be comparable in terms of their performance, this review proves that reusable fURS are still more cost effective than disposable scopes.

Keywords: Flexible ureterorenoscopy; disposable; ureterorenoscope; retrograde intrarenal surgery (RIRS); reusable; cost; cost analysis

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Introduction

Ureteroscopy for stone disease has risen over the last two decades reflecting an increase in the lifetime prevalence of stone disease of up to 14% (1,2). Warm weather, metabolic syndrome, diet and lifestyle are all blamed for this rise (3-5). There has also been broadening indication for its use and it is now preferably been used for stone treatment in paediatrics, pregnancy and obese patients (6-8).

Flexible ureterorenoscopy is now one of the first-choice treatment option for renal stones up to 2 cm (9). As the technology advances, the scope has improved in vision, manoeuvrability, deflection and weight (10-12). With advances in digital technology, single use flexible ureterorenoscope (fURS) are now being marketed and used, with tests showing comparable results in terms of scope characteristics and vision (13-16). While the traditional reusable scopes have a fixed purchase cost, there is additional cost related to scope processing and repairs (17).

The cost of single-use fURS is defined with the initial purchase price, whereas the procedural cost of reusable fURS is dependent on the initial and repair cost, maintenance and scope sterilization/disinfection and on the number of procedures performed before it needs to be repaired. There is also the cost of repair and the number of procedures with a refurbished scope until it has to be replaced. We conducted a systematic review on the cost ($) of fURS based on author reported data on the number of procedures performed before repair, and to compare the cost with disposable flexible ureteroscopes.

Materials and methods

A systematic review was carried out in a Cochrane style and in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) (18) checklist using MEDLINE, Scopus, CINAHL, EMBASE and Cochrane (19) library for all English language articles. All papers on cost analysis, which mentioned the cost of fURS based on the number of procedures performed and the repairs needed (procedure/repair) as reported by the individual authors, from 2000 to 2018, were included. The latest literature search was performed on June 2018. The search terms researched were “flexible ureterorenoscope”, “cost”, “single use ureterorenoscope”, “single use”, “disposable”, “reusable”, “ureteroscope”, “URS”, “retrograde intra renal surgery” and “RIRS”.

Data was extracted independently by two authors (BK Somani, M Talso) and all discrepancy was resolved by mutual consensus. Costs were initially expressed in USD ($) and Euro (€). Costs in Euros were converted in USD using an online currency converter, with the exchange rate of €1= $1.17. The following information regarding each eligible study was recorded: author’s name, journal of publication, year of publication, country of origin of the first author, study type and total number of cases performed during the study period. Data on brand and model of flexible reusable and single-use scope were also recorded.

Results

Study selection and characteristics

The initial search strategy identified 995 potentially eligible studies of which 19 articles (15,17,20-36) met the inclusion criteria and were considered for this systematic review (*Table 1*). The studies were published between 2006 and June 2018. Nine studies were performed in the Unites States (21,22,25-30,36), five in Europe (Germany, The Netherlands, France) (15,20,31,33,34), three in the United Kingdom (17,23,24), one in Brazil (35) and one in Australia (32). Thirteen were prospective studies (15,17,20-22,24,27-30,34-36), 4 were retrospective (23,25,26,33), one was a review article (33) and one was a basic-science benchmark study (31).

The brand of the reusable scope was noted in 14 studies: in eight studies Olympus scopes were used (P5, P6, URF-V and URF-V2); in eight studies Karl Storz flexible scopes were used (11278 AU1 Flex X, Flex XC and Flex X2); in one study Wolf Viper, Gyrus ACMI DUR8-E and Stryker Flex-Vision U-500 were used (*Table 1*). In relation to the disposable scope, six studies remarked which scope was used. All these studies analysed the Boston Scientific Lithovue™ scope. Davis *et al.* (32) in the systematic review, included the Poliscope™ and the SemiFlex™. Four studies received industry funding for their study whereas 14 studies did not receive any funding. In one study funding support was not specified (*Table 1*).

Meta-analysis of studies

Only 5 studies compared disposable and reusable instruments (15,27,28,36) of which 2 studies were multicentric (22,29), 1 was a review (32) and one was a basic science study (31). The rest of them were single-centre studies. Given the substantial heterogeneity across

Table 1 Studies reporting on disposable and reusable fURS

Author, year	Country	Study design	Fundings	Study period	Disposable (brand)	Reusable (brand)	N fURS		Procedures/ repair (yes/no)	Cost/disposable analysis ($)
							Reusable	Disposable		
Mager, 2018 (15)	EU	P	No	2015–2016	Lithovue	Storz	68	–	7.5	1,300 to 3,180
Traxer, 2006 (20)	EU	P	–	–	–	Storz		–	50	
Semins, 2009 (21)	USA	P	No	2007–2008	–	Storz	478	–	28.1	
Knudsen, 2010 (22)	USA	P	No	–	–	ACMI, Olympus, Stryker, Wolf	175	–	18.00	
Somani, 2011 (17)	UK	P	No	2009–2010	–	Storz	260	–	24.00	
Chapman, 2014 (23)	UK	R	No	2009–2010 and 2011–2012	–	Storz	–	–	–	
Karaolides, 2013 (24)	UK	P	No	2011	–	Olympus	141	–	10.6–21.6	
Tosoian, 2015 (25)	USA	R	No	2013	–	-		–	–	
Kramolowsky, 2016 (26)	USA	R	No	2011–2014	–-	Olympus	643	–	20.74	
Martin, 2017 (27)	USA	P	No	2014–2015	Lithovue	Storz	150	–	12.5	
Usawachintachit, 2017 (28)	USA	P	No	2014 – 2015	Lithovue	Olympus	65	–	–	
Taguchi, 2018 (29)	USA	P	Yes	2014–2015	–	Olympus, Storz	424	–	18.00	
Isaacson, 2017 (30)	USA	P	No	2016–2017	–	–	–	–	–	
Schlager, 2017 (31)	EU	Basic science	Yes	–	–	–	–	–	–	
Davis, 2018 (32)	AUS	Review	No	–	Lithovue/ Poliscope/ Semiflex	–	–	–	–	
Ozimek, 2017 (33)	EU	R	No	2013–2016	Lithovue	Olympus, Storz	423	–	14.4	
Legemate, 2018 (34)	EU	P	Yes	2015–2017	–	Olympus, Storz	198	–	–	
Marchini, 2018 (35)	Brazil	P	No	–	–	–		–	–	
Taguchi, 2018 (36)	USA	P	Yes	2016	Lithovue	Olympus	14	–	–	2,852.00

Cost/disposable analysis" column indicates the cost per disposable reported by papers analyzing this data. fURS, flexible ureterorenoscope; P, prospective; R, retrospective.

Table 2 The number of procedures/repair in studies

Author, year	Cases	N of repair	Instruments	Procedures/repair	
				Data	Units of measures
Traxer, 2006	50	1	Storz	50	Total cases/breakages
Semins, 2009	478	–	Storz	28.1	Total cases/breakages
Knudsen, 2010	175	–	ACMI, Olympus, Stryker, Wolf	5.3 (1–10; 4.50)/18.0 (14–22; 4.0)/ 17.6 (5–32; 13.57)/17.3 (8–25; 8.62)	Mean (standard deviation)
Somani, 2011	260	11	Storz	24	Total cases/breakages
Karaolides, 2013	141	8	Olympus	10.6–21.6	Total cases/breakages
Kramolowsky, 2016	643	31	Olympus	20.74	Total cases/breakages
Martin, 2017	150	11	Storz	12.5	Total cases/breakages
Taguchi, 2018	424	28	Olympus, Storz	4.8±4.2; 7.3±4.1	Mean (standard deviation)
Ozimek, 2017	423	32	Olympus, Storz	14.4	Total cases/breakages
Legemate, 2018	198	–	Olympus, Storz	27.00 (16–48)	Median
Mager, 2018	68	9	Storz	7.5	Total cases/breakages

studies we did not attempt a meta-analysis because it would not have yielded clinically meaningful results; data were descriptively summarized.

Repair and procedures performed for re-usable scopes

Out of 19 studies, 11 performed an analysis on number of procedures performed with number of repairs needed (15,17,20-22,24,26,27,29,33,34) (*Table 2*). The number of uses/repair in various studies varied between 7.5 to 50 procedures with reusable fURS. Eight studies reported an average time to failure, measured as the number of breakages on the total of the fURS performed in a given period of time (15,17,20,21,24,26,27,33). Two authors reported the mean +/– standard deviation and one author reported the median +/– the interquartile range (22,29) (*Table 2*). Taguchi *et al*. in a prospective multi centric study, reported the average number of procedures performed by each non-repaired scope, compared to the number of procedures performed by each repaired scope (29).

Cost per procedure using re-usable or single use scope

Eight studies calculated the total costs of reusable fURS repair in a given period of time and they divided it by the number of cases performed (15,17,21,25-27,33,36), obtaining the average repair cost per case (*Table 3*) that ranged from $120.73 to $957.61. Six authors performed a cost-per-procedure analysis regarding the reusable fURS (15,17,25,27,33,36). In this case, the lowest cost per case was reported as $197 by Somani and colleagues (17). The cost per repair was $7521 in Tosoian *et al*.'s study (25) giving an average cost of $355 per fURS performed. Single use scopes prices varied from $700 to $1,500 per disposable scope (32).

Discussion

Ureteroscopy is a safe effective procedure to access the upper urinary tract (37,38). Reusable flexible ureteroscopes are now well established for diagnosis and treatment of stones and upper tract tumours. There are proven benefits of new digital fURSs compared to the traditional optical ones, especially in terms of their image quality (15). Disposable digital flexible ureteroscopes are new entrants in the market with similar clinical outcomes to the existing scopes (15,39).

There seems to be a surge of clinical papers on the use of disposable scopes. The cost seems to vary between different manufacturers and the special discounts they give for the amount of usage, however, these costs seem to vary between $700 to $1,500 (32). While there is more interest and wider use of these disposable scopes in USA, the use would be dictated by the healthcare system, the reimbursement for the

Table 3 Cost per repair (based on the number of repairs)

Author, year	Number of cases (reusable)	Number of repairs	Procedures/repair	Cost/procedure ($)	Cost repair/case ($)
Mager, 2018 (15)	68	9	7.5	1,212–1,743	436–708
Semins, 2009 (21)	478	–	28.1	–	120.73
Somani, 2011 (17)	260	11	–	196.6–222/338–444/644*	181
Tosoian, 2015 (25)	–	–	–	4,852.00	605
Kramolowsky, 2016 (26)	643	31	20.74	–	355.00
Martin, 2017 (27)	150	11	12.5	848.10	848.10
Ozimek, 2017 (33)	423	32	14.4	582.794	279.597
Taguchi, 2018 (36)	14	–	–	2,799.00	957.61

*, diagnostic ureterorenoscope, UTUC, stone treatment. UTUC, upper tract urothelial carcinoma.

procedure and ultimately who would be responsible to bear the cost of these procedures or scopes. Although costs need to be justified, in some countries like France, Italy and UK where public health system provides a full reimbursement for surgical interventions the use of disposable scopes would be higher compared to a predominantly private healthcare system in some Asian countries such as India. Similarly, when private insurance covers the cost of all consumables, it is perhaps easier to use them. With global URS cases set to rise, there will be an increased demand of both reusable and disposable scopes in the future (40).

Our review shows that there is no one standardized method to analyse costs among reported studies. The data is heterogeneous that makes it difficult to analyse the overall cost. For example, Somani *et al*. (17) analysed the average cost of each flexible ureterorenoscopy by dividing the total cost based on the number of repairs and the ancillary costs for the procedure. In their study the cost of diagnostic flexible ureteroscopy ranged from $196.6 to $222, and the cost of stone treatment ranged between $444 and $644 although they excluded the cost of the initial purchase of the ureterorenoscopes and the holmium laser. In another study, Mager *et al*. calculated the costs with and without the instrument purchase price, with a cost variation that ranged from $436 to $1,743 per case respectively (15). On the contrary, Tosoian and colleagues presented their data with direct variable costs, indirect variable costs, direct fixed costs, and indirect fixed costs and they calculated that the average institutional cost of each URS was $4,852 (25).

Due to differences in cost comparison and reporting, it is difficult to compare costs across studies. As Mager and colleagues showed, the longer a reusable fURS's endurance the more cost-saving is a reusable ureterorenoscope program. The authors hypothesized that centres performing only a small number of flexible ureterorenoscopies per year might realize cost savings using single-use ureterorenoscopes, particularly if the purchase of an expensive new plasma sterilization system was necessary. They fixed the threshold of 61 cases per year/institution for preferring reusable ureterorenoscopes instead of single-use ureterorenoscopes if calculated with the lower limit recurring and reprocessing costs for the reusables (15). There was a wide variation in the literature on the cost of repair and the number of cases/repair (*Figure 1*). Although when we consider all studies that looked at cost of repair and number of repairs both, it was clear that as the number of repairs reduced, so did the cost of doing the procedure (*Figure 2*). When we take these 6 studies into account, the mean cost per repair per procedure was $370, which needs to be added to the initial cost of equipment purchase and the reprocessing costs which might vary across different countries.

The cost repair/case rate, indicates the cost of a repair divided by the number of usages of the instrument before the breakage. To better understand this ratio, imagine to use a scope 10 times before the breakage and the total cost to repair the scope is 10,000 USD: the ratio will be 10,000/10. This means that the cost of repair will be 1,000 USD per case. The more cases performed with a multiple use instrument, the less this ratio will be.

We can hypothesise that in high volume centres, reusable fURSs is likely to be cost effective. Based on literature, the carbon footprint of single use and reusable ureteroscopes seems to be comparable and is also likely that the cost of disposable scopes will reduce in future (39). Some studies

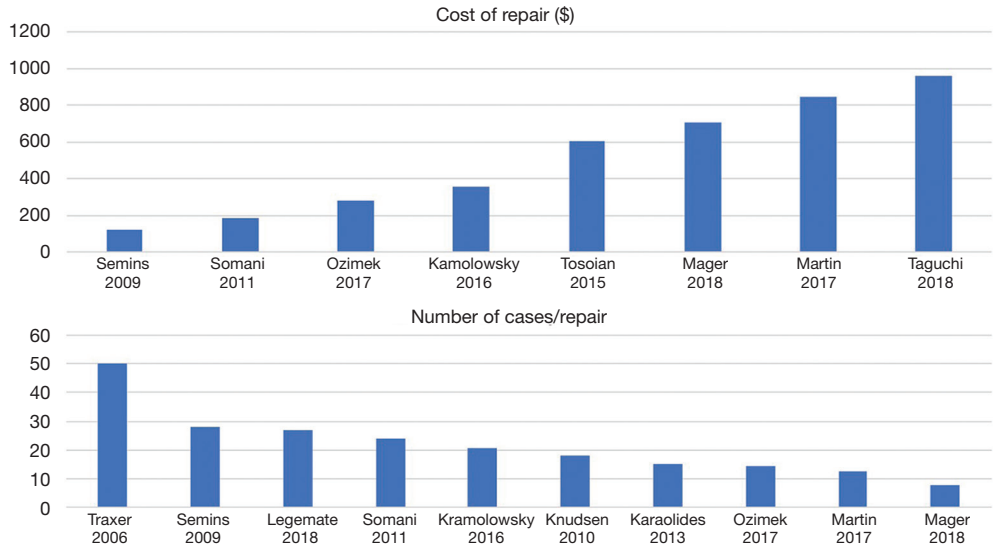

Figure 1 The graphic above shows the papers that reported the cost per repair of a reusable fURS expressed in USD. The grafic below shows the papers that analysed the number of cases of flexible ureterorenoscopy performed with a fURS in their center before the need of the fURS repair. fURS, flexible ureterorenoscope.

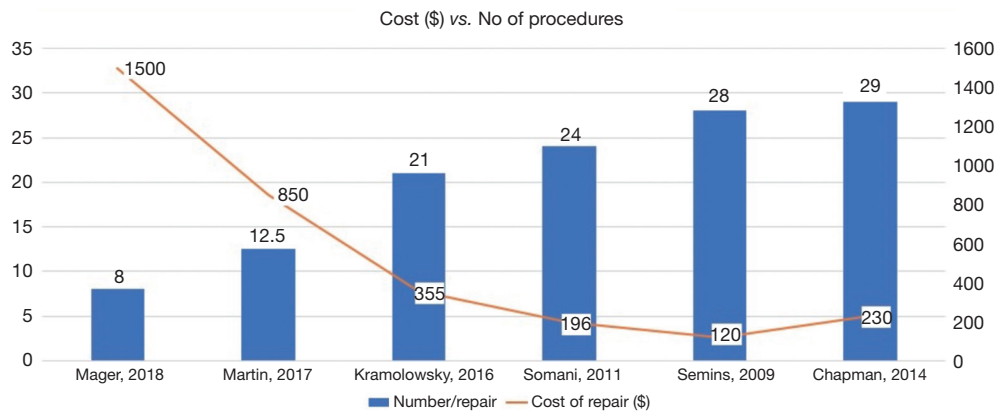

Figure 2 The graphic shows the studies that looked at cost of repair (USD) and number of repairs. With the increase of number of procedures performed before the fURS breakage, the cost per single repair decreases. fURS, flexible ureterorenoscope.

have compared new reusable ureteroscopes to disposable scopes, and with the former degrading with time and usage, it might give an edge to the single use scopes. Given the substantial heterogeneity across studies in our review it was not possible to perform a meta-analysis.

Conclusions

Although, the disposable and reusable scopes seem to be comparable in terms of their performance, reusable scopes seem to be more cost effective in high volume centres. The overall procedural costs for reusable scopes depend on the initial capital outlay, reprocessing and importantly the number of repairs needed.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest

to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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