TURKISH JOURNAL OF UROLOGY
Turk J Urol 2020; 46(Supp. 1): S40-S45 • DOI: 10.5152/tud.2020.20223
ENDOUROLOGY
Invited Review

Cost comparison of single-use versus reusable flexible ureteroscope: A systematic review

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Cite this article as: Ventimiglia E, Godínez AJ, Traxer O, Somani BK. Cost comparison of single-use versus reusable flexible ureteroscope: A systematic review. Turk J Urol 2020; 46(Supp. 1): S40-S45.

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Submitted:
01.06.2020

Accepted:
21.06.2020

Available Online Date:
25.08.2020

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Available online at
www.turkishjournalofurology.com

ABSTRACT

Single-use flexible ureteroscopes (su-fURS) aim at overcoming the main limitations of conventional reusable flexible ureteroscopes (re-fURS) in terms of acquisition and maintenance costs, breakages, and reprocessing. We aimed to perform a literature review on available re-fURS and su-fURS performances with a focus on costs. A search of Medline, EMBASE, CINAHL, and Scopus databases was performed to identify articles published in English within the last 10 years addressing refURS and su-fURS characteristics, clinical, and cost data. Relevant studies were then screened, and the data were extracted, analyzed, and summarized. The Preferred Reporting Items for Systematic Reviews and Meta-analysis criteria were applied. A narrative synthesis was performed. To date, few studies have properly investigated the issue of costs in ureteroscopy. An important local and international variation in costs exists for both re-fURS and su-fURS in terms of acquisition, maintenance, and repair costs. Reusable scopes have high acquisition and ancillary (e.g. repair, involved personnel) costs, which are not considered in a pure su-fURS activity. However, only recently su-fURS were shown to have a similar efficacy as compared with reusable devices. In high-volume centers, with proper training for reusable ureteroscopes management, the cost per case of reusable and single-use scopes are overlapping ($1,212–$1,743 versus $1,300–$3,180 per procedure). There is a partial overlap in the ranges of costs for single-use and reusable scopes, which makes it important to precisely know the caseload, repair bills, and added expenses when negotiating purchase prices, repair prices, and warranty conditions for scopes.

Keywords: Cost; disposable; flexible ureteroscopy; single-use.

Introduction

Single-use flexible ureteroscopes (su-fURS) are rapidly changing the daily practice in endourology. Su-fURS were initially developed to overcome the main limitations of reusable flexible ureteroscopes (re-fURS), that is, acquisition and maintenance costs, breakages, ready availability, and reprocessing between procedures.[1] Besides, su-fURS proved to be comparable with re-fURS in terms of maneuverability, quality of vision, and efficacy.[2-4] However, we still lack official recommendations for the use of su-fURS, as well as solid clinical data that indicates a substantial benefit of single-use over reusable scopes. Moreover, as with many new technologies, the cost of su-fURS are still considered to be relatively high, mainly because of the lack of competitors and their low market share as compared with re-fURS.[5] However, it is likely that newer products will hit the market and different brands will propose newer scopes, determining a variation in selling prices. To date, the cost issue still remains one of the main barriers in the adoption of these novel technologies, and a head-to-head detailed cost comparison with re-fURS is not available. Against this background, the aim of this review was to summarize the costs of available su-fURS and re-fURS and to analyze the available clinical evidence regarding their use.

Methods

An initial search was carried out using the Medline, EMBASE, CINAHL, and Scopus databases. We largely selected publications from the past 10 years (2010–2020) but did not exclude commonly referenced and highly

regarded older publications. The keywords included single-use or disposable and ureteroscope or ureteroscopy or ureterorenoscopy and cost (title/abstract). Abstracts were reviewed by the panel for relevance to the defined review question. If it was not clear from the abstract whether the paper might contain relevant data, full paper was assessed. The references cited in all full-text articles were also assessed for additional relevant or associated articles. Non-English articles were excluded from the analysis. With the consensus of the co-authors, the relevant studies were then selected and screened, and the data were extracted, analyzed, and summarized after an interactive peer review process of the panel. The Preferred Reporting Items for Systematic Reviews and Meta-analysis flowchart was used to report the numbers of papers identified and included or excluded at each stage (Figure 1). We then performed a narrative review of relevant findings.

Evidence synthesis

Flexible ureteroscopy and costs: General principles

The acquisition cost of re-fURS is usually considered one of the main barriers for the adoption of these devices. However, in the analysis of global costs of a reusable ureteroscope, one must also consider the cost of personnel involved in the care and the sterilization/reprocessing of the scopes, as well as the repair cost in case of breakages.[6] In addition, due to the inherent frailty of the re-fURS, any institution that aims at providing a continuative stone activity should be equipped with at least two different scopes because the repairing of re-fURS is usually a time consuming process.[1] It is evident that all these ancillary costs are not contemplated in a pure su-fURS–based activity. Conversely, when dealing with single-use devices, one might question the effectiveness compared with the established clinical use of the reusable ureteroscopes in everyday practice. More than 10 su-fURS are available to date, although, for most of them, data regarding their clinical performance are substantially lacking.[1] The first available su-fURS models were inferior to re-fURS, and an initial study comparing Polyscope, that is, the first single-use ureteroscope, with Olympus URF-P5, found that the Polyscope was inferior in terms of stone-free rate (SFR) for inferior calyceal stones (69.2% versus 82.0%) and operation time (11% longer). No further differences were found in terms of complication rate and hospital stay. The introduction of LithoVue and Pusen scopes led to additional improvements.[7,8] Mager et al.[9] compared 68 consecutive procedures using reusable flexible ureterorenoscopes (Flex-X2 and Flex-Xc, Karl Storz) with 68 consecutive procedures utilizing single-use digital flexible ureterorenoscopes (LithoVue, Boston Scientific), with similar results in terms of SFR (82% and 85% for reusable and single-use scopes, respectively) and complication rates (7% versus 17%).[9] In terms of *in vitro* technical features, the LithoVue ureteroscope proved to have equivalent deflection and irrigation flow as compared with some of the re-fURS bestsellers, Olympus URF-V and Karl Storz Flex- Xc, showing a better performance in terms of deflection.[5] Similar results were reported for the Uscope PU3022 (PUSEN Medical, Zhuhai Pusheng Medical Technology Co., Ltd. China).[10,11] Once the su-fURS are able to perform at least as good as re-fURS, the issue becomes mainly related to the cost and the sustainability of the chosen technology. In this review paper, we arbitrarily decided to focus on the following costs: acquisition costs, sterilization/maintenance costs, and repair costs. The currency of choice for cost comparison will be United States dollars (USD, $).

Main Points:

- The aim of this review paper was to perform a literature review on available reusable and single-use flexible ureteroscopes with a focus on costs.
- Few studies have properly investigated the issue of costs in ureteroscopy.
- There is an important local and international variation in costs for both reusable and single-use scopes in terms of acquisition, maintenance, and repair costs.
- There is a partial overlap in the ranges of costs for single-use and reusable scopes after accounting for ancillary costs.
- It is important to precisely know the caseload, repair bills, and added expenses when negotiating purchase prices, repair prices, and warranty conditions for scopes.

Acquisition costs

Acquisition costs show both local and international variations. Moreover, high-volume centers and major international experts are able to negotiate separate, and usually more convenient, deals. Temporary variations exist as well, determined by the freshness of the product itself. Because it is not possible to keep track of all these composite factors, in this review paper we will refer to referenced official retail prices in each country as detailed in available publications. Table 1 shows the reusable ureteroscopes included in this review, detailing the manufacturer, technical features, and associated costs. As a whole, there is a substantial variation not only among different scopes but also for the same model. Purchase costs for re-fURS ranged between $13,611 and $85,000. More precisely, in 2014, Flex X2 (Karl Storz) was priced at $13,611, whereas URF-V (Olympus) was priced at $20,200. Table 2 shows similar findings for single-use scopes. Recent purchase prices reported for available su-fURS are $1,300 to $3,180 for LithoVue (Boston Scientific), $800 for Pusen, $700 for Polyscope (Lumenis), and $800 for SemiFlex (Maxiflex).

In terms of available evidence, Al-Balushi[12] performed a comprehensive medico-economic study evaluating purchase and ancillary costs during 2011–2017 at a French institution; in terms of acquisition, Flex X2 (Karl Storz) ureteroscope was priced at

Turk J Urol 2020; 46(Supp. 1): S40-S45
DOI: 10.5152/tud.2020.20223

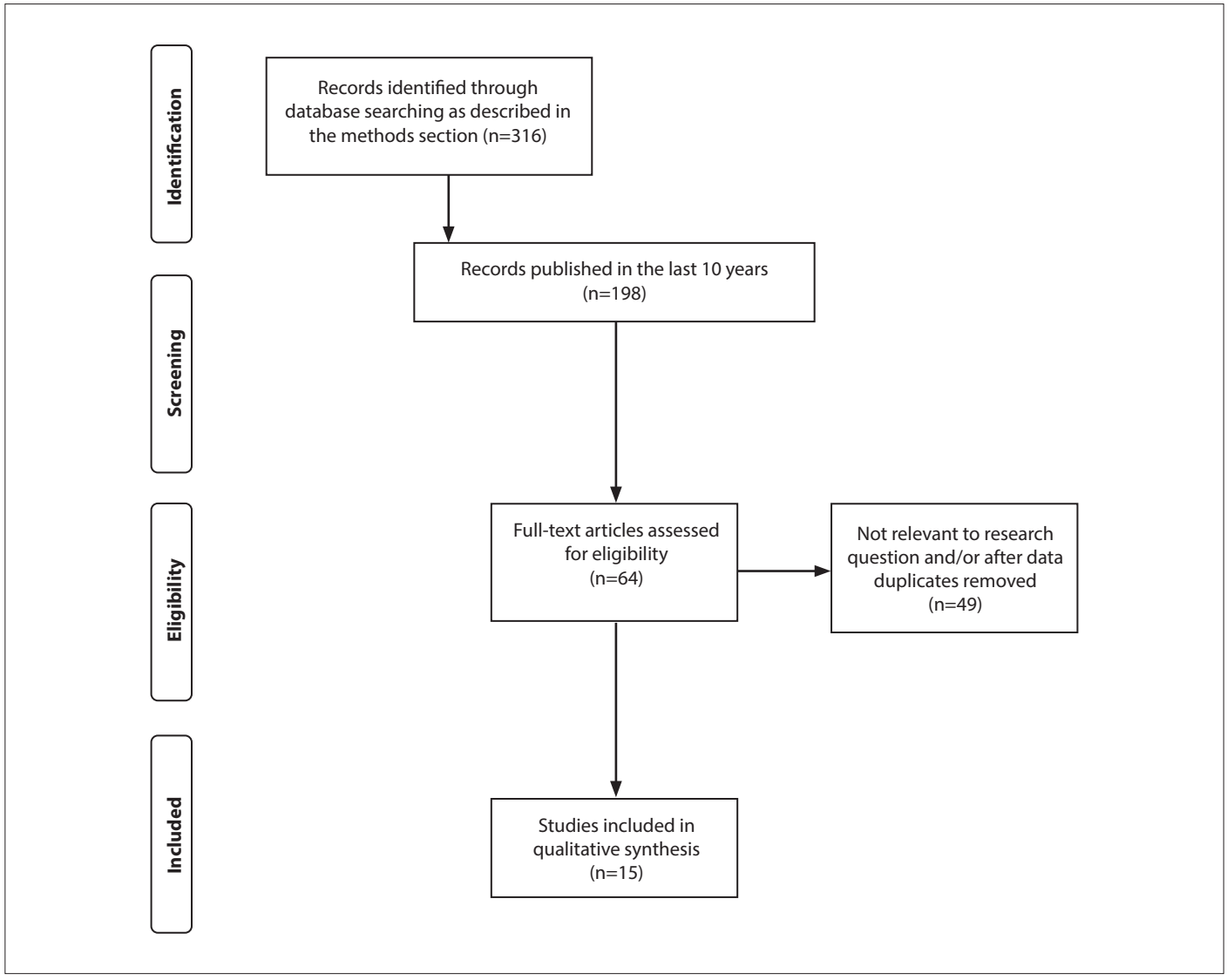

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-analysis flow diagram showing the outcome of the initial and additional searches resulting in the full studies included in the review

$14,300 in 2012, whereas Flex-Xc (Karl Storz) ureteroscope was priced at $17,452 in 2015. Temiz et al.[13] in his paper from Turkey in 2014 evaluated a purchase cost of Flex X2 ureteroscope at $29,500 with a per case cost average of $549 and Cobra (Richard Wolf) as $58,000 with a per case cost of $1,137.

Gurbuz et al.[14] from Germany in 2013 priced Flex X2 (Karl Storz) at $13,611. This latest report is rather interesting because according to the local contract that the authors had at that time, the old flexible ureteroscope was replaced with a new scope at a cost of $8,477[14] in case a major repair was needed. Somani et al.[15] reported data from the United Kingdom-in 2010, the cost of a brand-new Flex X2 (Karl Storz) was $21,000-remarkably, in this case the warranty covered all major repair costs at $4,500 and minor repair costs at $1,950.

Ordinary cleaning and sterilization

Al-Balushi[12] evaluated the operating expenses involving the costs of decontamination, transport, and storage.The authors broke down the postoperative path of the ureteroscope into several steps after each use: 1) the wiping, aspiration, and tightness test of the scope (performed in the operating theater); 2) sterilization and repacking carried out in the sterilization room, which involves brush cleaning, rinsing, disinfection by soaking in peracetic acid, drying, and reconditioning; 3) transport from the decontamination room to the operating room. The average cost of all the previous processes for reusable ureteroscopes was $71.67 per procedure.[12] However, because each center may have a reprocessing protocol of its own, it is likely that this cost does not represent a solid benchmark. More recent cost analysis studies reported a reprocessing cost varying from $19.9 to $108.00 per

Table 1. Reusable flexible ureteroscopes and costs

Name	Brand	Country	Length	Width	Working channel	Imaging	Purchase cost	Sterilization cost[a]	Repair cost
URF-V3	Olympus	Tokyo, Japan	98 cm	8.4 Fr	3.6 Fr	Digital	$20,200-85,000	~$100	NA
URF-P7	Olympus	Tokyo, Japan	67 cm	7.9 Fr	3.6 Fr	Fiberoptic	NA	~$100	$7,521
Flex-X2	Storz	Tuttlingen, Germany	67 cm	7.5 Fr	3.6 Fr	Fiberoptic	$13,611–$14,300	~$100	$1,950—$4,500
Flex-Xc	Storz	Tuttlingen, Germany	70 cm	8.5 Fr	3.6 Fr	Digital	$17,452–$70,390	~$100	$2,480–4,535
Cobra	Wolf	Knittlingen, Germany	68 cm	9.9 Fr	3.6 Fr and 2.4 Fr	Digital	$58,000	~$100	NA
Boa	Wolf	Knittlingen, Germany	68 cm	9.5 Fr	3.6 Fr	Digital	NA	~$100	NA
Viper	Wolf	Knittlingen, Germany	68 cm	8.8 Fr	3.6 Fr	Fiberoptic	NA	~$100	NA

[a]Extrapolated from reference 16. NA: not applicable

Table 2. Single-use flexible ureteroscopes and costs

Name	Brand	Country	Length	Width	Working channel	Imaging	Purchase cost
Lithovue	Boston Scientific	Marlborough, USA	65 cm	7.7 Fr (tip)	3.6 Fr	Digital	$1,300–$3,180
Uscope PU3022	Pusen	Guangdong, China	65 cm	9 Fr	3.6 Fr	Digital	$800
AXIS	Dornier Med-Tech	Munich, Germany		9 Fr	3.6 Fr	Digital	NA

NA: not applicable

case.[16] It is key to stress the importance of scope reprocessing because a careful reprocessing reduces the risk of breakages and therefore reduces the repair costs.[6,17] Generally speaking, it is recommended that every strategy aimed at maximizing re-fURS longevity should be implemented.[18]

Flexible ureteroscopy and repair costs

Longer lasting scope inevitably results in lower maintenance costs. In this setting, ureteroscope longevity involves a considerable number of intervening factors. A recent case series of flexible ureteroscopies performed using Flex-Xc (Karl Storz) by a single experienced endourologist (>1,000 procedures) has shown longevity with a single scope lasting 159 cases.[19] Considering real-life numbers, a digital ureteroscope is used at an average of 21 times before requiring repair, whereas the median fiberoptic ureteroscope is only used 6–15 times before going back to the manufacturer.[20] Factors influencing the occurrence of breakage include the number of surgeons who have access to the scope, endourological versus non-endourological centers, university versus private hospital, and the degree of training of the personnel involved in the use or reprocessing of the scopes.[21] Of importance, it was demonstrated that the ureteroscopes last more if they are repaired by the original manufacturer rather than by outsourced vendors (mean: 11 versus 7 cases).[22] Moreover, the routine use of ureteral access sheaths, miniaturized nitinol baskets, and smaller laser fibers was shown to minimize the risk of breakage, ultimately increasing the flexible ureteroscope longevity.[18] Proper training of the personnel involved in processing the scopes is key in terms of reducing the risk of breakages. Semins et al.[23] found that after nursing training and education to proper endoscope cleaning, processing, and sterilizing protocols, the average number of uses per ureteroscope before repair increased from 10.8 to 28.1, with a repair cost saving of $300.00 per case.

As far as the data regarding specific flexible ureteroscopes is concerned, there is again a wide variation according to the model, country, and the type of breakage. For the URF-P6 (Olympus), the total cost of each repair was between $233 and $7,521, whereas the average repair cost per case was $355. The repair cost, diluted by case and scope longevity, also showed a wide range in the literature ($48 to $605 per case). For the URF-V series (Olympus) total repair costs at a single institution were $119,632, with a mean cost per case of $511.[24] Taguchi et al.[25] performed a US-based micro-cost analysis of the overall cost (purchase cost, repair cost, reprocessing cost, operative time) per case, resulting in $2,790 for URF-P6 (Olympus) and $2,852 for LithoVue.

Ancillary factors

There is a debate on whether the consequences of ureteroscopy should be regarded as part of the costs of the procedure itself. As far as complications are concerned, urinary tract infections deserve a special mention in this setting.[26] Scope contamination is an issue in this setting because it has been shown to be present even in cases of high-level disinfection. Legemate et al.[27] collected pre-procedure microbial samples of the scope during 389 cases: of them, 47 were found to be positive (12%). The

Turk J Urol 2020; 46(Supp. 1): S40–S45
DOI: 10.5152/tud.2020.20223

rate of urinary tract infections could be theoretically higher with the use of reusable ureteroscopes, thus increasing the total costs; however, this has never been confirmed in the clinical practice.[27] Operative time needs to be considered as well. Taguchi et al.[25] prospectively compared flexible ureteroscopy with the URF-P6 (Olympus) and LithoVue (Boston Scientific) in a cost analysis. They found non-significant ~20% shorter total operative time with the single-use scope (73.6 versus 93.4 minutes, p=0.09), corresponding to a mean reduction from $1,618.72 to $1,348.64 per procedure.[25] A prospective cohort study provided a comprehensive evaluation accounting for these extra costs[9]; repair and purchase costs resulted in a total of $1,212–$1,743 per procedure for re-fURS cases, whereas the price of single-use ureteroscopy was $1,300–$3,180 per procedure. There is a partial overlap in the ranges of costs for single-use and reusable scopes, which raises the importance to precisely know the caseload, repair bills, and added expenses when negotiating purchase prices, repair prices, and warranty conditions for scopes.

Conclusion

Since their introduction, su-fURS have gained widespread popularity with their efficacy becoming closer to reusable scopes. There is a partial overlap in the ranges of costs for single-use and reusable scopes, which raises the importance to precisely know the caseload, repair bills, and added expenses when negotiating purchase prices, repair prices, and warranty conditions for scopes.

Peer-review: This manuscript was prepared by the invitation of the Editorial Board and its scientific evaluation was carried out by the Editorial Board.

Author Contributions: Concept – E.V., O.T., B.K.S.; Design – E.V., O.T., B.K.S.; Supervision – B.K.S., O.T.; Data Collection and/or Processing – E.V., A.J.G.; Analysis and/or Interpretation – E.V., O.T., B.K.S.; Literature Search – E.V., A.J.G.; Writing Manuscript – E.V.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

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