Uro-Technology Journal 2025; 9(2): 47-59 *47*
DOI: 10.31491/UTJ.2025.06.041

Flexible and navigable ureteral access sheath (FANS-UAS): a narrative literature review

Luis Enrique Ortega Polledo[a, b, *], Álvaro Serrano Pascual[a], Eduardo J. García Rico[a, b], Miguel Ángel Ruiz León[a], Geo F.J. Bianchini Hernández[b], Alejandro Sánchez Pellejero[b], Ángeles Sanchís Bonet[a], Laura Ibañez Vázquez[a], Paula Mata Deniz[a], Isabel Galante Romo[a], Juan Gómez Rivas[a, c], Sergio Alonso y Gregorio[b], Jesús Moreno Sierra[a, c]

[a] *Hospital Clínico San Carlos, Urology Department, Madrid, Spain.*
[b] *Instituto de Urología de la Peña-Hidalgo-Alonso, Madrid, Spain.*
[c] *Health Research Institute, Hospital Clínico San Carlos Madrid, Spain.*

Abstract

Since the first description in 1974 of the ureteral access sheaths (UAS), its use during retrograde intrarenal surgery (RIRS) has showed multiple benefits. In addition, due to minimizing intra renal pressure (IRP), it could decrease the incidence of infectious complications after ureteroscopy, that have an overall incidence of 10% after RIRS. Nonetheless, there is still discordant data about the role of UAS in decreasing the risk of UTI and sepsis, and the use of UAS may cause lesions to the ureter by direct trauma during sheath insertion or affecting blood flow during its usage. During the last 10 years, suction access sheaths for mini-PCNL and RIRS have sparked interest among endourologists as they may achieve higher stone-free rates (SFR) and lower complication rates. In this paper, we perform a narrative review, covering the current evidence regarding flexible and navigable ureteral access sheath for RIRS.

Keywords: Ureteroscopy, suction, UAS, RIRS, stone

Introduction

Since the first description in 1974 of the ureteral access sheaths (UAS) [1], its use during retrograde intrarenal surgery (RIRS) has showed multiple benefits, such as facilitating multiple entries into the kidney during the procedure and achieving better vision due to improved irrigation and outflow, washing out small stone particles created during lithotripsy, a feature that may improve stone clearance [2]. In addition, due to minimizing intra renal pressure (IRP), it could decrease the incidence of infectious complications after ureteroscopy [3]. Urinary tract infections (UTI) and sepsis still represent a major issue, with an overall incidence of 10% after RIRS [4]. Nonetheless, there is still discordant data about the role of UAS in decreasing the risk of UTI and sepsis [5], and the use of UAS may cause lesions to the ureter by direct trauma during sheath insertion or affecting blood flow during its usage [6, 7].

The study of IRP has been more frequently debated, since a prolonged increase in IRP can lead to complications, especially related to pyelorenal backflow, leading to potential severe complications [8]. During the last 10 years, suction access sheaths for mini-PCNL and RIRS have sparked interest among endourologists as they may achieve higher stone-free rates (SFR) and lower complication rates [9-12]. In this paper, we perform a narrative review, covering the current evidence regarding flexible and navigable ureteral access sheath for RIRS.

Evidence acquisition

We performed a comprehensive English literature research for original and review articles through December 2024 and January 2025, using Pubmed and Embase databases, as well as a comprehensive review of The American Urological Association (AUA) guidelines and European Association of Urology (EAU) Guidelines. We searched

* Corresponding author: Luis Enrique Ortega Polledo
Mailing address: Hospital Clínico San Carlos. Urology Department. C/ Profesor Martín Lagos, s/n, 28040, Madrid, Spain.
Email: leortegapolledo@gmail.com
Received: 12 March 2025 / Revised: 19 March 2025
Accepted: 07 May 2025 / Published: 25 June 2025

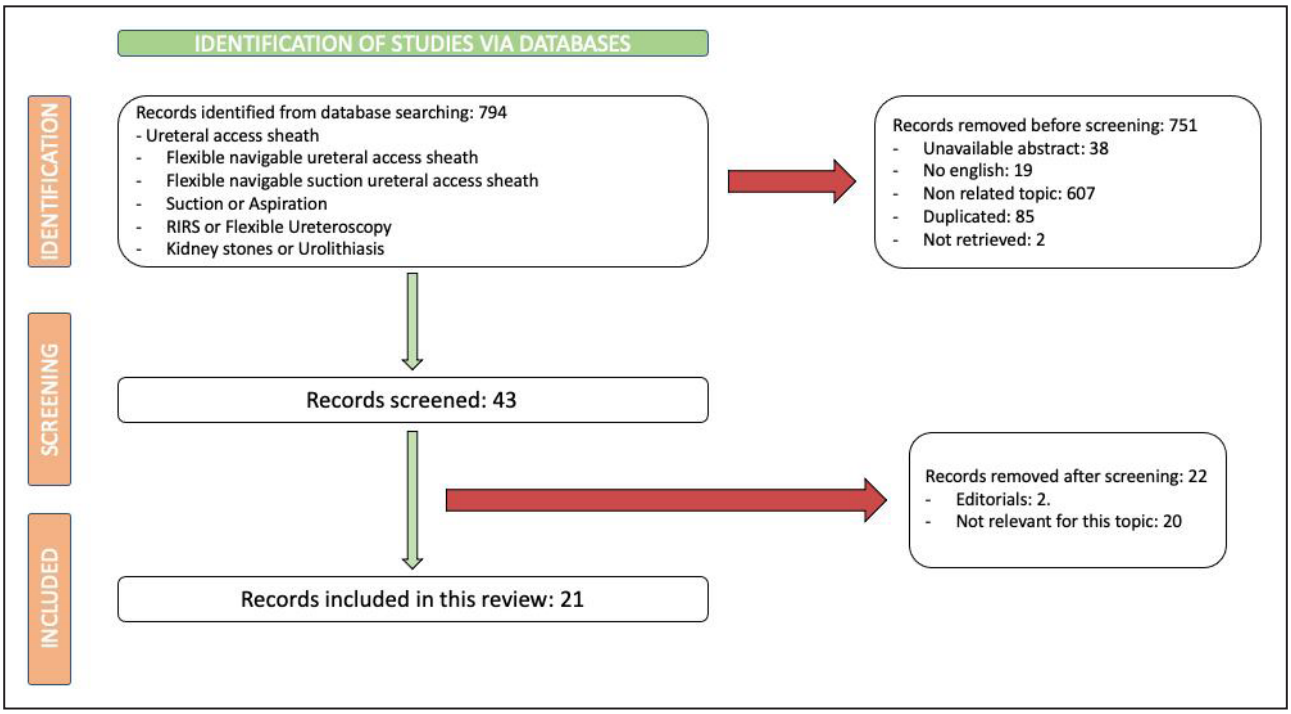

Figure 1. Overview of the study selection process.

for the following terms: "ureteral access sheath", "flexible navigable ureteral access sheath", "flexible navigable suction ureteral access sheath". and "((("Ureteral Access Sheath" OR "ureteral access sheath" OR "UAS") AND ("Aspiration" OR "Suction") AND ("Retrograde Intrarenal Surgery" OR "RIRS" OR "Flexible Ureteroscopy") AND ("Kidney Calculi"[Mesh] OR "renal stones" OR "nephrolithiasis" OR "urolithiasis")).

The combination of terms found 794 related articles; articles that were not in English, case reports, editorials, duplicated papers and papers without available abstract were not considered for this review. After the initial screening, 43 full-text studies were left for evaluating eligibility. Finally, 21 papers were considered eligible and included in this review (Figure 1).

Evidence synthesis and discussion

Current guidelines recommendations

The European Association of Urology (EAU) accepts the use of UAS as part of routine practice in RIRS, being safe and useful for large and multiple renal stones, or if a long procedural time is expected [13, 14]. The American Urological Association (AUA) guidelines also discusses their positive role, but there is no specific recommendation for patient selection for UAS selection [14, 15]. Currently, there is insufficient evidence to create consensus on suction access sheaths. The European Association of Urology (EAU) guidelines do not mention ureteral FANS, but they remark that there is some evidence regarding suction access sheaths for mini-PCNL in order to reduce IRP and increase SFR [13, 16]. The American Urological Association (AUA) does not mention any recommendations regarding these devices [15].

FANS-UAS stone-free rate

Of the 21 studies analyzed, 20 reported stone-free rate (SFR) in their results (Table 1), defining it as the sum of SFR-A (no residual fragments) and SFR-B (one residual fragment smaller than 2 mm) within the first 30 days. Additionally, SFR-A is also referred to as the Zero-Fragment Rate (ZFR). Two studies in the pediatric population reported a high SFR with FANS-UAS [17, 18]. Seven studies [17, 19-24] compared the performance of FANS-UAS with conventional UAS (CUAS), finding that the initial and final SFR was statistically higher for FANS-UAS. However, the final SFR showed no statistically significant differences in pediatric population [17]. In the adult population, the overall SFR with FANS-UAS was greater than 90%. Two studies [25, 26] stratified their results based on the caliber of the ureteral access sheath. Kwok *et al*. [25] reported a significantly higher ZFR in the smaller-diameter group (67.5% *v.s*. 52.9%, $P = 0.02$), but they were not able to find statistically significant differences between smaller and larger diameters for SFR (SFR smaller group: 95.9%; SFR larger group: 95.3%; $P > 0.99$). In contrast, Gauhar *et al*. [26] reported better outcomes with larger sheath diameters (SFR 10 Ch: 68.8%; SFR 12 Ch: 94.7%; $P < 0.01$). However, although Castellani *et al*. [27] subdivided their cohort into 2 groups according to the source of energy source used for lithotripsy (Thulium-fiber laser (TFL) and Pulsed-Thulium:YAG Laser), the group with the higher stone-free rate (Pulsed-Thulium:YAG laser) also had a greater proportion of cases treated with smaller caliber sheaths (10-12 Ch) than the other group (TFL 12.5%; Pulsed-Thulium:YAG laser 98.4%, $P < 0.001$).

Nine papers described the use of baskets specifically to

Table 1. Comparison between rodent and non-rodent models for AD research.

Author	Study design	Population	Number of patients (*n*)	UAS/FURS size	Basketing only for stone removal	SFR	Reintervention rate / ESWL for residual fragments	Year of publication
Turedi *et al*. [17]	Double-arm, retrospective	Pediatrics	46 (23 patients/arm)	CUAS 9,5/11,5 Ch 10/12 Ch 11/13 Ch FANS/UAS 10/12 Ch-26 cm ClearPetra Wellead 7,5 Ch Scope	CUAS: 73.9% FANS/UAS: 30.4% ***P* = 0.003**	Initial: CUAS: 65.2% FANS/UAS: 91.3% ***P* = 0.03** Final: CUAS: 87% FANS/UAS: 95.7% *P* = 0.29	CUAS: 26.1% - RIRS 17.4% - miniPCNL 4.35% - ESWL: 4.35% FANS/UAS: 8.7% - RIRS 8.7% *P* = NR	2025
Gauhar *et al*. [18]	Multicentric, prospective	Pediatrics	50	10/12 Ch 11/13 Ch 40-46 cm ClearPetra Wellead	0%	100 %	0%	2024
Gonçalves *et al*.[19]	Systematic review and meta-analysis	Adults	2255	T-UAS 12/14 Ch 11/13 Ch S-UAS 10/12 Ch 11/13 Ch 12/14 Ch	NR	Day 1 T-UAS: 7.2-75.68% S-UAS: 76.3-88.73% Day 30: T-UAS: 70-93.4% S-UAS: 86.7-95.2%	NR	2025
Rico *et al*. [20]	Double-arm, retrospective	Adults	96	FANS/UAS 10/12 Ch CUAS 10/12 Ch Uscope 7.5 Ch PUSEN	Only in CUAS, percentage NR	4th-week CT-scan: FANS/UAS: 93.7% CUAS: 75% ***P* < 0.001**	NR	2025
Cacciatore *et al*. [21]	Randomized Controlled Trial	Adults	132	FANS/UAS 10–12 Ch/46 cm or 10-12Ch/50 cm ClearPetra® Wellead, or NP-UAS® Innovex CUAS 10/12 Fr Dual Lumen UAS (Rocamed Bi-Flex®) 35-45 cm	NR	FANS-UAS: 95% CUAS: 67% ***P* = 0.005**	FANS-UAS: 5% CUAS: 23% ***P* = 0.02**	2025
Uslu *et al*. [22]	Multicentric, prospective	Adults	88	NTBS ClearPetra Wellead Diameter NR SAS 9.5/11.5 Scope NR	NR	NTBS: 81.4% SAS: 73.3% *P* = 0.259	NR	2024

Table 1 continued.

Author	Study design	Population	Number of patients (n)	UAS/FURS size	Basketing only for stone removal	SFR	Reintervention rate / ESWL for residual fragments	Year of publication
Geavlete *et al.* [23]	3 arms, single center, prospective	Adults	105	CUAS 10/12 Ch FANS 10/12 Ch DISS + FANS 10/12 Ch ClearPetra or YigaoMed PUSEN 7.5 Ch	NR	CUAS: 17.14% FANS: 11.42% DISS + FANS: 2.85% *P* = NR	NR	2024
Chen *et al.* [24]	Double-arm, retrospective	Adults	238	TFS-UAS 12-14 Ch 38-45 cm T-UAS 12-14 Ch 38-45 cm	NR	Day 1: TFS-UAS: 87.2% T-UAS: 73.45% Day 30: TFS-UAS: 95.2% T-UAS: 85.84% ***P* < 0.05**	NR	2024
Giulioni *et al.* [34]	Systematic review	Adults and exvivo models (porcine)	2028	FANS-UAS Intelligent pressure-control system Negative pressure induced by a ureteral catheter DISS Irrigation and suctioning platform	NR	64.3% (At 3-weeks) to 100% (at 1 month)	NR	2024
Gauhar *et al.* [35]	Multicentric, prospective	Adults	394	10/12 Ch 11/13 Ch 12/14 Ch ClearPetra Wellead Innovex Elephant Other Scope NR	NR	97.2%	RIRS 2.79%	2024
Gauhar *et al.* [28]	Multicentric, prospective	Adults	142	ClearPetra Wellead Innovex Elephant ZSR Biomedical Technology < 8 Ch Scope (48.1%) < 8 Ch Scope (51.9%)	0%	96.5%	RIRS 2.8%	2024

Table 1 continued.

Author	Study design	Population	Number of patients (n)	UAS/FURS size	Basketing only for stone removal	SFR	Reintervention rate / ESWL for residual fragments	Year of publication
Kwok *et al*. [25]	Multicentric, prospective	Adults	295	ClearPetra Innovex Elephant Seplou Group A: 10/12 Ch Group B: 11/13 or 12/14 Ch Scope 7,5 Ch or > 8 Ch	Group A: 0% Group B: 0%	Group A: 95.9% Group B 95.3% *P* > 0.99	Group A: 10.6% Group B 2.3% *P* = 0.08 ESWL or RIRS not specified	2024
Gauhar *et al*. [26]	Multicentric, retrospective	Adults	31	TFS-UAS 12-14 Ch 38-45 cm T-UAS 12-14 Ch 38-45 cm	NR	Day 1: TFS-UAS: 87.2% T-UAS: 73.45% Day 30: TFS-UAS: 95.2% T-UAS: 85.84% P < 0.05	NR	2024
GiShrestha *et al*.[29]	Multicentric, prospective	Adults	394	ClearPetra Innovex Elephant Others 10/12 Ch 11/13 Ch 12/14 Ch Scope: < 8 Ch or >8 Ch	Group 1. Non-lower pole: 13.1% Group 2. Lower pole: 13.5% *P* > 0.99	Group 1. Non-lower pole: 96.6% Group 2. Lower pole: 98.4% *P* = 0.6	Group 1. Non-lower pole: 3.36% - RIRS: 3.36% - ESWL: 0% Group 2. Lower pole: 1.59% - RIRS: 1.59 - ESWL: 0% *P* = NR	2024
Bai *et al*.[30]	Multicentric, retrospective	Adults	231	Elephant 12/14 Ch Uscope 9.2 Ch PUSEN	0%	Immediate SFR 90.48% Long-term SFR 95.67%	3.46% RIRS: 3.46% ESWL: 0%	2024
Geavlete *et al*. [36]	Review	Adults	NR	ClearPetra Elephant 10/12 Ch 11/13 Ch 12/14 Ch Scope: Flex-X2 Storz Uscope 9.2 Ch PUSEN Scivita Medical 8.4 Ch.	NR	SFR Day-1 Range: 57.1-100% SFR Day-30 Range: 66.7-100% SFR Day-90 Range: 68.8-100%	NR	2024

Table 1 continued.

Author	Study design	Population	Number of patients (n)	UAS/FURS size	Basketing only for stone removal	SFR	Reintervention rate / ESWL for residual fragments	Year of publication
Castellani *et al*. [27]	Multicentric, prospective	Adults	179	ClearPetra Innovex Elephant 10/12 Ch 11/13 Ch 12/14 Ch Scope NR	Group 1. Thulium-fiber laser (TFL): 4.7% Group 2. Pulsed-Thulium:YAG Laser: 10.9% *P* = 0.32	Group 1. Thulium-fiber laser (TFL): 93.7% Group 2. Pulsed-Thulium:YAG Laser: 85.9% ***P* = 0.04**	Group 1. Thulium-fiber laser (TFL): 3.1% RIRS: 3.46% ESWL: 0% Group 2. Pulsed-Thulium:YAG Laser: 17.2% ***P* = 0.02**	2025
Fong *et al*. [31]	Multicentric, prospective	Adults	310	ClearPetra Innovex Yigaomed Seplou 10/12 Ch 11/13 Ch 12/14 Ch Scope NR	4.5%	95.1%	4.2% RIRS: 3.88% ESWL: 0.32%	2025
Gauhar *et al*. [37]	Multicentric, prospective	Adults	192	ClearPetra Innovex Elephant Seplou 10/12 Ch 11/13 Ch 12/14 Ch Scope NR	NR	Group 1. HPHL: 99% Group 2. TFL: 95.9% *P* > 0.99	Group 1. HPHL: 1% Technique NR Group 2. TFL: 1% Technique NR *P* > 0.99	2025
Lim *et al*. [38]	Multicentric, prospective	Adults	562	10/12 Ch 11/13 Ch 12/14 Ch Scope NR	NR	Group 1: 91.3% Group 2: 98.3% ***P* = 0.001**	Group 1: 6.8% - RIRS: 5.3% - ESWL: 1.5% Group 2: 1.2% - RIRS: 0.8% - ESWL: 0.4% ***P* = 0.003**	2025

Note: UAS: ureteral access sheath. FURS: flexible ureteroscope. SFR: stone-free rate. CUAS: conventional ureteral access sheath. T-UAS: traditional UAS. S-UAS: suction UAS. FANS-UAS: flexible and navigable suction ureteral access sheath. NTBS: nobel tip-bendable suction-assisted ureteral access sheath. SAS: standard ureteral access sheath. DISS: direct in-scope suction. TFS-UAS: tip-flexible suctioning ureteral access sheath. RIRS: retrograde intrarenal surgery. ESWL: extracorporeal shock wave lithotripsy. PCNL: percutaneous nephrolithotomy. NR: not reported. TFL: thulium fiber laser. HPHL: high-power holmium laser. Significant *P* values are in bold font.

extract stones [17, 18, 20, 25, 27-31]. Except for Turedi *et al*. [17] who used basketing in approximately 30% of cases, the remaining studies [18, 20, 25, 27-31]. described utilization rates ranging from 0% to 13.5%. Overall re-intervention rates are low: all but two papers [25, 27] reported rates below 9%, most favoring a second-look RIRS when necessary. Additionally, the overall SFR described by these papers was slightly higher than what has been previously described in the literature for RIRS with CUAS [32, 33].

Intraoperative IRP and perioperative complications

There were only two papers that described intraoperative IRP measurements during surgery among their results. Chen *et al*. [8] described and stratified IRP during RIRS with FANS-RIRS according to different variables. IRP was measured using LithoVue Elite™ ureteroscope (Boston Scientific Corp., Marlborough, MA, USA) with pressure sensing capability. The IRP remained below 40 mmHg in 76.2% of the total time in all procedures, but the overall amount of procedure time spent at pressures between 60-80 mmHg and > 80 mmHg was 3.6% and 1.8% respectively. Median IRP was 29.0 mmHg for the 11/13 Ch diameter and 14.0 mmHg for the 12/14 Ch diameter ($P = 0.008$). Pre-stenting also significantly decreased IRPs (pre-stented 14.5 mmHg; non-prestented patients 29.0 mmHg ($P < 0.001$)). Other variables significantly associated with lower IRP were the use of preoperative alpha-blocker and having a prior endourological intervention (any ipsilateral URS or ureteral stenting within the last 5 years). Bai *et al*. [30] measured IRP in 30 patients with a computed numerical control system based on sheath-side fiber optic pressure sensor monitoring, where the fiber optic pressure sensor enters the renal pelvis through a side channel to monitor renal pelvis pressure. During lithotripsy, pressure variated across calyxes and upper ureter, with statistically significant differences (Upper calyx 19.82 ± 0.57; Middle calyx 18.07 ± 0.85; Lower calyx 20.32 ± 0.72; Upper ureter 21.59 ± 1.14; $P < 0.001$). All values are below the cut-off value of 35–40 mmHg when the pyelotubular back-flow usually occurs [39-41], hence increasing the risk of infectious complications and postoperative pain.

All papers describe an overall complication rate lesser than 20% with the use of FANS (Table 2), including intra and postoperative ones. Most of the complications are Clavien-Dindo grades 1 or 2. The infectious complication rate was rather low. Regarding urosepsis, defined as sepsis (life-threatening organ dysfunction caused by a dysregulated host response to infection) caused by a urogenital tract infection, has an incidence between 0.1 and 4.3% after ureteroscopy [4]. All but one of the papers cited in this article had 0% rate of urosepsis. Giulioni *et al*. [34] analyzed different suction modalities (via Access Sheath, via Scope and via catheter), with an overall low complication rate for all of them.

Postoperative pain was measured at day 1 after surgery using a 10-point visual analogue score (1-4: mild pain; 5-8: moderate pain; 9-10: severe pain). Eleven papers describe postoperative pain [18, 21, 25, 27-31, 35, 37, 38], reporting low rates of discomfort after surgery.

Surgical times (ST)

We only considered for this section those papers that compared ST according to different features, such as UAS diameter, stone location, suction. energy used for lithotripsy and anesthesiology ventilation modality during surgery (Table 3), including thirteen articles. ST were measured in minutes and divided into three categories: Operative time, ureteroscopy time and laser time.

Turedi *et al*. [17] , Rico *et al*. [20] and Kwok *et al*. [25] found a statistically significant difference in operative time (OT) in favor of the suction UAS and the larger UAS. Regarding ureteroscopy time, only Kwok *et al*. [25] were able to describe a statistically significant difference for larger UAS. Finally, Castellani *et al*. [27] and Lim *et al*. [38] described statistically significant shorter laser times for Pulsed Thulium:YAG laser and Gated ventilation. The rest of the papers did not find differences in ST. In addition, Giulioni *et al*. [34] described shorter operative times in the different analyzed suction modalities.

Intraoperative ergonomy

Nine papers evaluated subjectively different ergonomics [18, 23, 25, 26, 28, 29, 31, 37, 38] (Table 4). Except for Gauhar *et al*. [22] that did not use a numeric-scale, and Geavlete *et al*. [23] that used an ascending scale from 0 to 10, from worst to best, the rest of the articles used a Likert-scale between 1 (excellent) and 5 (difficult) to assess either subjective maneuverability, visibility, manipulation of the sheath and ease of suction. Overall results were between excellent or very good in all sections. Kwok *et al*. [25] found statistically significant differences in visibility and ease of suction depending on the diameter (better visibility with larger sheaths and easier suction with smaller sheaths). In addition, Gauhar *et al*. [37] described significant differences in visibility and manipulation depending on the source of energy (results were better in the TFL group compared to the HPHL group).

Study limitations

Our study has some limitations. The nature of its design (narrative review) is not exempt from bias. The included studies differ significantly in terms of study design and methodologies, patient demographics, and outcome measures. For instance, many of the studies did not compare FANS-UAS against CUAS. Many of these studies were performed by high-volume experienced centers/surgeons, being difficult to extrapolate these results to less experienced centers.

Conclusions

Current evidence on the safety profile and stone-free rates (SFR) of suction ureteral access sheaths (UAS) demonstrates superior outcomes compared to standard UAS, supporting their recommendation and adoption in routine

Table 2. Overall complication rates and postoperative pain.

Author	Clavien-Dindo (C-D) grade complications	Postoperative pain
Chen *et al*. [8]	Grade 1-2: 0% Grade 3-4: 4% UTI: 4% (all grade 3)	NR
Turedi *et al*. [17]	CUAS - Grade 1-2: 17.4% - Grade 3-4: 8.7% - UTI: 8.7% (all grade 2) FANS-UAS - Grade 1-2: 13% - Grade 3-4: 0% - UTI: 4.35% (all grade 2) *P* = 0.30	NR
Gauhar *et al*. [18]	Grade 1-2: 16% UTI: 8% (all grade 2)	2.18 1.34 SD
Gonçalves *et al*.[19]	T-UAS - Fever: 5.3-18.92% S-UAS - Fever: 0.8-9.5%	NR
Rico *et al*. [20]	FANS-UAS - Grade < 2: 4.2% CUAS - Grade < 2: 6.3% *P* = 0.64	NR
Cacciatore *et al*. [21]	FANS-UAS: 10% CUAS: 25% *P* = 0.02	FANS-UAS: 16% CUAS: 33% *P* = 0.02
Uslu *et al*. [22]	NTBS: 9.3% SAS: 26.6% *P* = 0.032	NR
Geavlete *et al*. [23]	CUAS: 14.29% FANS: 14.29% DISS + FANS: 5.71% *P* = NR	NR
Chen *et al*. [24]	TFS-UAS - Grade 1-2: 1.6% T-UAS - Grade 1-2: 14.16% *P* < 0.001	NR
Gauhar *et al*. [35]	Grade 1-2: 13.8% UTI: 3.3% (all grade 2)	1 1-2 IR
Gauhar *et al*. [28]	Grade 1-2: 26.6% UTI: 7% (all grade 1)	2 1-2 IR
Kwok *et al*. [25]	Group A - Grade 1-2: 4% - Grade 3-4: 0% - UTI: 0.8% Group B - Grade 1-2: 12.46% - Grade 3-4: 0% - UTI: 4.9% *P* > 0.05	Group A 1 1-2 IR Group B 2 1-2 IR *P* = 0.58
Gauhar *et al*. [26]	Group 1 - Grade 1: 6.3% - UTI: 0% Group 2 - Grade 1: 5.3% - Grade 2: 5.3% - UTI: 0% *P* > 0.05	NR

Table 2 continued.

Author	Clavien-Dindo (C-D) grade complications	Postoperative pain
Shrestha *et al*. [29]	Group 1 - Grade 1-2: 4.2% - Grade 3-4: 0% - UTI: 2% Group 2 - Grade 1-2: 11.3% - Grade 3-4: 0% - UTI: 5,7% *P* > 0.1	Group 1: 1 1-2 IR Group 2: 2 1-2 IR *P* = 0.04
Bai *et al*.[30]	Grade 1-2: 0.86% Grade 3-4: 0% UTI: 0.86%	1: 12.99% 2: 37.23% 3: 44.59% 4: 0.43% 5: 4.76%
Castellani *et al*. [27]	Group 1 - Grade 1-2: 4.7% - Grade 3-4: 0% - UTI: 4.7% (all grade 2). Group 2: 0% *P* = 0.24	Group 1: 1 1-2 IR Group 2: 2 1-1.25 IR *P* = 0.06
Fong *et al*.[31]	Grade 1-2: 6.7% Grade 3-4: 0%	1 1-2
Gauhar *et al*.[37]	Group 1 - Grade 1-2: 5.4 % - Grade 3-4: 0% - UTI: 3.4% (all grade 1). Group 2: 0% - Grade 1-2: 10% - Grade 3-4: 0% - UTI: 3.8% (all grade 1). *P* > 0.99	Group 1: 2 1-3 IR Group 2: 2 1-2 IR *P* = 0.61
Lim *et al*. [38]	Group 1 - Grade 1-2: 5.9% - Grade 3-4: 0% Group 2 - Grade 1-2: 7.3% - Grade 3-4: 0% *P* > 0.5	Group 1: 1 1-2 IR Group 2: 2 1-2 IR *P* = 0.06

Note: UAS: ureteral access sheath. CUAS: conventional ureteral access sheath. FANS-UAS: flexible and navigable suction ureteral access sheath. T-UAS: traditional UAS. S-UAS: suction UAS. NTBS: nobel tip-bendable suction-assisted ureteral access sheath. SAS: standard ureteral access sheath. DISS: direct in-scope suction. UTI: urinary tract infection. NR: not reported. Significant *P* values are in bold font.

Table 3. Comparative surgical time.

Author	Comparison	Operative time (minutes)	Ureteroscopy time (minutes)	Laser time (minutes)
Turedi *et al*. [17]	Suction *v.s*. non-suction UAS	CUAS: 67.9 ± 21.0 FANS-UAS: 50.4 ± 21.1 *P* < 0.01	NR	NR
Gonçalves *et al*. [19]	Suction *v.s*. non-suction UAS	T-UAS (range): 39.03-101.2 S-UAS: 40.9-80 *P* = NR	NR	NR
Rico *et al*. [20]	Suction *v.s*. non-suction UAS	FANS-UAS: 33.5 26.3-44.5 IR CUAS: 57.5 40-65 IR *P* < 0.001	NR	FANS-UAS: 17.5 12.5-23 IR CUAS: 21.5 18-24.6 IR *P* = 0.04
Cacciatore *et al*. [21]	Suction *v.s*. non-suction UAS	CUAS: 61.36 46.63-125.35 IR FANS-UAS: 55.25 43.63-118.35 IR *P* = 0.028	NR	CUAS: 11.96 5.64-23.7 IR FANS-UAS: 11.85 5.14-23.88 IR *P* = 0.56

Table 3 continued.

Author	Comparison	Operative time (minutes)	Ureteroscopy time (minutes)	Laser time (minutes)
Uslu *et al*. [22]	Suction *v.s*. non-suction UAS	NTBS: 55 48-65 IR SAS: 62 59-72 IR *P* = 0.016	NR	NR
Geavlete *et al*. [23]	Non-suction *v.s*. suction UAS *v.s*. suction UAS + DISS	CUAS: 50.28 30-90 IR FANS: 53 35-80 IR DISS + FANS: 52.5 30-75 IR *P* = NR	NR	NR
Chen *et al*. [24]	Suction *v.s*. non-suction UAS	TFS-UAS: 101.17 ± 25.64 T-UAS: 86.23 ± 20.35 *P* < 0.001	NR	NR
Kwok *et al*. [25]	Sheath diameter A: Smaller Sheath (10/12 Ch) *v.s*. B: Larger Sheath (11/13 or 12/14 Ch)	Group A: 50 37.5-73.5 IR Group B: 45 32-55 IR *P* < 0.01	Group A: 35 25-58 IR Group B: 31.5 23-41 IR *P* = 0.02	Group A: 17 12-28 IR Group B: 17 11-25 IR *P* = 0.34
Gauhar *et al*. [26]	Sheath diameter Group 1: 10 Ch *v.s*. Group 2: 12 Ch	Group 1: 63 52-74.5 p25-75 Group 2: 76 63-85.25 p25-75 *P* = 0.09	NR	NR
Shrestha *et al*. [29]	Stone location Group 1: Non-lower pole Group 2: Lower pole	Group 1: 49 38-67 IR Group 2: 50 36-71 IR *P* = 0.8	Group 1: 35 26-55 IR Group 2: 35 24-54 IR *P* = 0.6	Group 1: 19 12-28 IR Group 2: 17 11-28 IR *P* = 0.3
Castellani *et al*.[27]	Energy: Group 1. Thulium-fiber laser (TFL) Group 2. Pulsed-Thulium:YAG	Group 1: 45 29.9-55 IR Group 2: 40 35-45 IR *P* = 0.09	Group 1: 30 22-39 IR Group 2: 28 25-33 IR *P* = 0.14	Group 1: 15.5 10-23 IR Group 2: 13 10-15 IR *P* = 0.02
Gauhar *et al*. [37]	Energy: Group 1. High-Power Holmium Laser (HPHL) Group 2. Thulium-fiber laser (TFL)	Group 1: 45 38-59 IR Group 2: 47 33-65 IR *P* = 0.70	Group 1: 33 26-40 IR Group 2: 35 23-49 IR *P* = 0.78	Group 1: 18 11-26 IR Group 2: 16 11-24 IR *P* = 0.96
Lim *et al*. [38]	Anesthesiology ventilation modality Mechanical *v.s.* Gated ventilation	Mechanical: 45 36-60 IR Gated: 49 39-60 IR *P* = 0.24	Mechanical: 31 24-45 IR Gated: 35 25-45 IR *P* = 0.33	Mechanical: 16 11-25 IR Gated: 15 10-22 IR *P* = 0.02

Note: UAS: ureteral access sheath. CUAS: conventional ureteral access sheath. FANS-UAS: flexible and navigable suction ureteral access sheath. T-UAS: traditional UAS. S-UAS: suction UAS. NTBS: nobel tip-bendable suction-assisted ureteral access sheath. SAS: standard ureteral access sheath. DISS: direct in-scope suction. TFL: thulium fiber laser. HPHL: high-power holmium laser. Significant *P* values are in bold font.

Table 4. Subjective data regarding ergonomics.

Author	Subjective maneuverability	Visibility	Manipulation	Ease of suction
Gauhar *et al*. [18]	NR	Likert-scale 1.02 0.32 SD	Likert-scale 1.24 0.52 SD	Likert-scale 1.16 0.47 SD
Geavlete *et al*. [23]	NR	CUAS: 6/10 FANS: 8/10 FANS + DISS: 9/10	NR	NR
Gauhar *et al*. [28]	NR	Likert-scale 2 1-3 IR	Likert-scale 2 2-3 IR	Likert-scale 2 1-3 IR

Table 4 continued.

Author	Subjective maneuverability	Visibility	Manipulation	Ease of suction
Kwok *et al*. [25]	NR	Likert-scale Group A 1.41 0.76 IR Group B 2.68 1.53 IR *P* < 0.01	Likert-scale Group A 1.99 0.75 IR Group B 2.15 0.82 IR *P* = 0.09	Likert-scale Group A 1.64 0.82 IR Group B 1.85 0.71 IR *P* = 0.02
Gauhar *et al*. [26]	Group A Excellent 37.5% Very good 56.3% Good 6.3% Group B Excellent 52.6% Very good 36.8% Good 10.6% *P* = 0.57	Group A Excellent 68.8% Very good 31.3% Group B Excellent 84.2% Very good 15.8% *P* = 0.15	Group A Excellent 31.3% Very good 56.3% Good 12.5% Group B Excellent 44.4% Very good 44.4% Good 11.2% *P* = 0.73	NR
Shrestha *et al*. [29]	NR	Likert-scale Group 1: 1 1-3 IR Group 2: 1 1-3 IR *P* = 0.7	Likert-scale Group 1: 2 2-2 IR Group 2: 2 1-3 IR *P* = 0.2	Likert-scale Group 1: 2 1-2 IR Group 2: 2 1-2 IR *P* = 0.3
Fong *et al*. [31]	NR	Likert-scale 1 1-1 IR	Likert-scale 2 2-2 IR	Likert-scale 2 1-2 IR
Gauhar *et al*. [37]	NR	Likert-scale Group 1: 3 1-4 IR Group 2: 1 1-2 IR *P* < 0.01	Likert-scale Group 1: 2 2-3 IR Group 2: 1 1-2 IR *P* < 0.01	Likert-scale Group 1: 2 1-2 IR Group 2: 2 1-2 IR *P* = 0.11
Lim *et al*. [38]	Likert-scale Group 1: 2 1-2 IR Group 2: 2 2 IR *P* = 0.24	Likert-scale Group 1: 1 1-3 IR Group 2: 1 1-2 IR *P* < 0.01	NR	Likert-scale Group 1: 2 1-2 IR Group 2: 2 1-2 IR *P* = 0.48

Note: NR: not reported. SD: standard deviation. IR: interquartile range. FANS-UAS: flexible and navigable suction ureteral access sheath. DISS: direct in-scope suction. Significant *P* values are in bold font.

clinical practice.

Declarations

Authors' Contributions: "Conceptualization", L.E.O.P.; methodology, L.E.O.P.; J.G.R.; validation, L.E.O.P.; J.G.R.; formal analysis, L.E.O.P., E.J.G.R.; investigation, L.E.O.P., E.J.G.R., A.S.P., G.F.J.B.H.; data curation, L.E.O.P.,; writing—original draft preparation, L.E.O.P., E.J.G.R., A.S.P., G.F.J.B.H.; writing—review and editing, L.E.O.P., E.J.G.R., A.S.P., G.F.J.B.H.; supervision, L.E.O.P., A.S.P., E.J.G.R., M.A.R.L., A.S.P., G.F.J.B.H., A.S.B., L.I.V., P.M.D., I.G.R., J.G.R., S.A.G., J.M.S.; All authors have read and agreed to the published version of the manuscript.

Availability of Data and Materials: Not applicable.

Financial Support and Sponsorship: None.

Conflict of Interest: All authors declared that there are no conflicts of interest.

Ethical Approval and Informed consent: Not applicable.

Consent for Publication: Not applicable.

References

1. Takayasu H, & Aso Y. Recent development for pyeloureteroscopy: guide tube method for its introduction into the ureter. *J Urol*, 1974, 112(2): 176-178. [Crossref]
2. Santa Cruz J, Danilovic A, Vicentini F, Brito A, Batagello C, Marchini G, *et al*. Ureteral access sheath. Does it improve the results of flexible ureteroscopy? A narrative review. *Int Braz J Urol*, 2024, 50(3): 346-358. [Crossref]
3. Yuen S, Zhong W, Chan Y, Castellani D, Bhojani N, Agarwal M, *et al*. Current utility, instruments, and future directions for intra-renal pressure management during ureteroscopy: scoping review by global research in intrarenal pressure collaborative group initiative. *Ther Adv Urol*, 2025, 17: 17562872251314809. [Crossref]
4. De Coninck V, Keller E, Somani B, Giusti G, Proietti S, Rodriguez-Socarras M, *et al*. Complications of ureteroscopy: a complete overview. *World J Urol*, 2020, 38(9): 2147-2166. [Crossref]
5. Villa L, Dioni P, Candela L, Ventimiglia E, De Angelis M, Corsini C, *et al*. Understanding the role of ureteral access sheath in preventing post-operative infectious complications in stone patients treated with ureteroscopy and Ho:Yag laser lithotripsy: results from a tertiary care referral center. *J Clin Med*, 2023, 12(4): 1457-1467. [Cross-

ref]
6. Wright A, Williams K, Somani B, & Rukin N. Intrarenal pressure and irrigation flow with commonly used ureteric access sheaths and instruments. *Cent European J Urol*, 2015, 68(4): 434-438. [Crossref]
7. Alhefnawy M, Abdelrahman M, Abo-Elnasr H, & Eldib H. Ureteral access sheath or percutaneous nephrostomy during flexible ureteroscopy: which is better? *Urolithiasis*, 2025, 53(1): 18-28. [Crossref]
8. Chen K, Koo K, Zhong T, Ren R, Wong V, Almousa S, *et al*. Real time monitoring of intrarenal pressures while using the flexible and navigable suction ureteral access sheath. *World J Urol*, 2025, 43(1): 76-86. [Crossref]
9. Zeng G, Wan S, Zhao Z, Zhu J, Tuerxun A, Song C, *et al*. Super-mini percutaneous nephrolithotomy (SMP): a new concept in technique and instrumentation. *BJU Int*, 2016, 117(4): 655-661. [Crossref]
10. Kankaria S, Gali K, Chawla A, Bhaskara S, Hegde P, Somani B, *et al*. Super-mini PCNL (SMP) with suction versus standard PCNL for the management of renal calculi of 1.5 cm-3 cm: a randomized controlled study from a university teaching hospital. *World J Urol*, 2024, 42(1): 257-267. [Crossref]
11. Quhal F, Zeng G, & Seitz C. Current evidence for suction in endourological procedures: comprehensive review of literature. *Curr Opin Urol*, 2023, 33(2): 77-83. [Crossref]
12. Liang H, Liang L, Lin Y, Yu Y, Xu X, Liang Z, *et al*. Application of tip-bendable ureteral access sheath in flexible ureteroscopic lithotripsy: an initial experience of 224 cases. *BMC Urol*, 2023, 23(1): 175-185. [Crossref]
13. EAU Guidelines. Edn. presented at the EAU Annual Congress Paris 2024. ISBN 978-94-92671-23-3.
14. Yuen S, Traxer O, Wroclawski M, Gadzhiev N, Chai C, Lim E, *et al*. Scoping review of experimental and clinical evidence and its influence on development of the suction ureteral access sheath. *Diagnostics*, 2024, 14(10): 1034-1044. [Crossref]
15. Assimos D, Krambeck A, Miller N, Monga M, Murad M, Nelson C, *et al*. Surgical management of stones: American urological association/endourological society guideline, part i. *J Urol*, 2016, 196(4): 1153-1160. [Crossref]
16. Tzelves L, & Skolarikos A. Suction use during endourological procedures. *Curr Urol Rep*, 2020, 21(11): 46-56. [Crossref]
17. Turedi B, & Sezer A. Comparison of flexible and navigable suction ureteral access sheath with conventional ureteral access sheath for pediatric retrograde intrarenal surgery: a single-center propensity-matched analysis. *Urolithiasis*, 2024, 53(1): 17-27. [Crossref]
18. Gauhar V, Madarriaga Y, Somani B, Joshi R, Tanidir Y, Castellani D, *et al*. Is flexible and navigable suction ureteral access sheath (FANS-UAS) the next best development for retrograde intrarenal surgery in children? Results of a prospective multicentre study. *World J Urol*, 2024, 42(1): 627-637. [Crossref]
19. Gonçalves F, Porto B, Terada B, Spilborghs J, Passerotti C, Sardenberg R, *et al*. Enhanced stone-free rates with suctioning ureteral access sheath *vs.* traditional sheath in retrograde intrarenal surgery: a systematic review and meta-analysis. *BMC Urol*, 2025, 25(1): 86-99. [Crossref]
20. Rico L, Diaz-Zorita V, Blas L, Ramos L, Sabeh P, & Contreras P. Is the ablation stone efficacy and efficiency better with a flexible and navigable suction ureteric access sheath? *World J Urol*, 2025, 43(1): 219-225. [Crossref]
21. Cacciatore L, Minore A, Bonanno L, Contessa P, Esperto F, Iannello A, *et al*. Is flexible navigable suction ureteral access sheath (FANS) safer and more efficient than conventional sheaths? Italian multicentric experience. *World J Urol*, 2025, 43(1): 153-163. [Crossref]
22. Uslu M, Yildirim Ü, Ezer M, Arslan Ö, Yaşar H, & Sarica K. Comparison of tip-bendable aspiration-assisted and standard access sheaths in the treatment of lower calyceal stones. *Rev Assoc Med Bras (1992)*, 2024, 70(12): e20241033. [Crossref]
23. Geavlete P, Mareş C, Mulţescu R, Georgescu D, Ene C, Iordache V, *et al*. Small diameter (7.5 Fr) single-use flexible ureteroscopy with direct in-scope suction (DISSTM) in conjunction with aspiration-assisted flexible access sheath: a new hype for real stone-free? *J Clin Med*, 2024, 13(23): 7191-7204. [Crossref]
24. Chen H, Xiao J, Ge J, & Liu T. Clinical efficacy analysis of tip-flexible suctioning ureteral access sheath combined with disposable flexible ureteroscope to treat 2-4 cm renal stones. *Int Urol Nephrol*, 2024, 56(10): 3193-3199. [Crossref]
25. Kwok J, Somani B, Sarica K, Yuen S, Zawadzki M, Castellani D, *et al*. Multicenter outcome analysis of different sheath sizes for flexible and navigable suction ureteral access sheath (FANS) ureteroscopy: an EAU endourology collaboration with the global FANS study group. *Urolithiasis*, 2024, 52(1): 162-172. [Crossref]
26. Gauhar V, Traxer O, Castellani D, Ragoori D, Heng C, Chew B, *et al*. A feasibility study on clinical utility, efficacy and limitations of 2 types of flexible and navigable suction ureteral access sheaths in retrograde intrarenal surgery for renal stones. *Urology*, 2023, 178: 173-179. [Crossref]
27. Castellani D, Fong K, Traxer O, Malkhasyan V, Gadzhiev N, Ragoori D, *et al*. Propensity score matched analysis of thulium fiber *vs.* pulsed thulium : yttrium aluminum garnet laser lithotripsy in flexible ureteroscopy for kidney stone disease using a flexible and navigable suction ureteral access sheath: results from a prospective, multicenter study of the eau section of endourology. *Urology*, 2025, 199: 47-53. [Crossref]
28. Gauhar V, Traxer O, Castellani D, Fong K, Bin Hamri S, Gökce M, *et al*. Operative outcomes 24 hours after retrograde intrarenal surgery for solitary renal calculi using a flexible and navigable suction ureteral access sheath. A prospective global multicenter study by the European Association of Urology Section on Urolithiasis. *Minerva urology and nephrology*, 2024, 76(5): 625-634. [Crossref]
29. Shrestha A, Traxer O, Seitz C, Corrales M, Castellani D, Chew B, *et al*. Assessing flexible ureteroscopy outcomes for lower Pole versus non lower Pole stones using the flexible and navigable suction ureteric access sheath: a prospective multicenter study by EAU Endourology and PEARLS group. *World J Urol*, 2024, 43(1): 41-51. [Cross-

ref]
30. Bai J, Shangguan T, Zou G, Liu L, Xue X, Lin J, *et al*. Efficacy and intrarenal pressure analysis of flexible and navigable suction ureteral access sheaths with flexible ureteroscopy in modified surgical positions for 2-6 cm upper urinary tract stones: a multicenter retrospective study. *Front Med*, 2024, 11: 1501464. [Crossref]
31. Fong K, Yuen S, Somani B, Malkhasyan V, Tanidir Y, Persaud S, *et al*. Assessment of outcomes and anatomical changes in the upper urinary tract following flexible ureteroscopy with a flexible and navigable suction ureteral access sheath: 3-month results from a multicenter study. *Urology*, 2025, 199: 35-41. [Crossref]
32. Aboumarzouk O, Monga M, Kata S, Traxer O, & Somani B. Flexible ureteroscopy and laser lithotripsy for stones >2 cm: a systematic review and meta-analysis. *J Endourol*, 2012, 26(10): 1257-1263. [Crossref]
33. Geraghty R, Abourmarzouk O, Rai B, Biyani C, Rukin N, & Somani B. Evidence for ureterorenoscopy and laser fragmentation (URSL) for large renal stones in the modern era. *Curr Urol Rep*, 2015, 16(8): 54-64. [Crossref]
34. Giulioni C, Castellani D, Traxer O, Gadzhiev N, Pirola G, Tanidir Y, *et al*. Experimental and clinical applications and outcomes of using different forms of suction in retrograde intrarenal surgery. Results from a systematic review. *Actas Urol Esp* (*Engl Ed*), 2024, 48(1): 57-70. [Crossref]
35. Gauhar V, Traxer O, Castellani D, Sietz C, Chew B, Fong K, *et al*. Could use of a flexible and navigable suction ureteral access sheath be a potential game-changer in retrograde intrarenal surgery? Outcomes at 30 days from a large, prospective, multicenter, real-world study by the european association of urology urolithiasis section. *Eur Urol Focus*, 2024, 10(6): 975-982. [Crossref]
36. Geavlete P, Multescu R, Mares C, Buzescu B, Iordache V, & Geavlete B. Retrograde intrarenal surgery for lithiasis using suctioning devices: a shift in paradigm? *J Clin Med*, 2024, 13(9): 2493-2506. [Crossref]
37. Gauhar V, Traxer O, Fong K, Sietz C, Chew B, Bin Hamri S, *et al*. Comparing thulium fiber versus high-power holmium laser lithotripsy combined with the flexible and navigable suction access sheath in flexible ureteroscopy for kidney stone disease: a propensity score matched analysis by the global FANS collaborative group. *J Endourol*, 2025, 39(1): 42-49. [Crossref]
38. Lim E, Somani B, Gokce M, Heng C, Satapathy A, Robles J, *et al*. General anaesthesia with gated or controlled mechanical ventilation and its influence on peri and post operative outcomes of retrograde intra renal surgery when using flexible and navigable suction access sheath, an EAU-endourology and global FANS collaborative study group: a prospective study. *World J Urol*, 2025, 43(1): 110-120. [Crossref]
39. Tokas T, Herrmann T, Skolarikos A, & Nagele U. Pressure matters: intrarenal pressures during normal and pathological conditions, and impact of increased values to renal physiology. *World J Urol*, 2019, 37(1): 125-131. [Crossref]
40. Han Z, Wang B, Liu X, Jing T, Yue W, Wang Y, *et al*. Intrarenal pressure study using 7.5 French flexible ureteroscope with or without ureteral access sheath in an ex-vivo porcine kidney model. *World J Urol*, 2023, 41(11): 3129-3134. [Crossref]
41. Tang Q, Liang P, Ding Y, Zhou X, & Tao R. Comparative efficacy between retrograde intrarenal surgery with vacuum-assisted ureteral access sheath and minimally invasive percutaneous nephrolithotomy for 1-2 cm infectious upper ureteral stones: a prospective, randomized controlled study. *Front Surg*, 2023, 10: 1200717. [Crossref]

Cite this article as: Ortega Polledo LE, Pascual Serrano A, García Rico EJ, Ruiz León MA, Bianchini Hernández GFJ, Sánchez Pellejero A, *et al*. Flexible and navigable ureteral access sheath (FANS-UAS): a narrative literature review. *Uro-Technology Journal*, 2025, 9(2): 47-59. doi: 10.31491/UTJ.2025.06.041