APPENDIX

Supplementary Table 1. The Medline search strategy is provided, from inception until September 12, 2024

#	Searches	Results
1	(Thulium OR thulium:YAG OR Thu:YAG OR Tm:YAG OR thulium fiber laser OR TFL).mp,af,tw,kf.	3179
2	(thulium adj2 laser*).mp,af,tw,kf.	1063
3	Exp Thulium/	977
4	1 OR 2 OR 3	3179
5	Exp lithotripsy/ OR cystolithotripsy/ OR laser lithotripsy/ OR nephrolithotripsy/	12341
6	(ureterorenoscopic OR URS OR lithotripsy OR litholapaxy or lithotripsy OR flexible ureteroscopic lithotripsy OR FURSL OR retrograde intrarenal surgery OR RIRS OR percutaneous nephrolithotripsy OR PCNL).mp,af,tw,kf.	29709
7	(endoscopic adj2 litho*).mp,af,tw,kf	491
8	5 OR 6 OR 7	29745
9	4 AND 8	283

Supplementary Table 2. The EMBASE search strategy is provided, from inception until September 12, 2024

#	Searches	Results
1	(Thulium OR thulium:YAG OR Thu:YAG OR Tm:YAG OR thulium fiber laser OR TFL).mp,af,tw,kf.	5088
2	(thulium adj2 laser*).mp,af,tw,kf.	2253
3	Exp Thulium/	2348
4	1 OR 2 OR 3	5088
5	Exp lithotripsy/ OR cystolithotripsy/ OR laser lithotripsy/ OR nephrolithotripsy/	20355
6	(ureterorenoscopic OR URS OR lithotripsy OR litholapaxy or lithotripsy OR flexible ureteroscopic lithotripsy OR FURSL OR retrograde intrarenal surgery OR RIRS OR percutaneous nephrolithotripsy OR PCNL).mp,af,tw,kf.	52493
7	(endoscopic adj2 litho*).mp,af,tw,kf	777
8	5 OR 6 OR 7	52676
9	4 AND 8	623

Supplementary Table 3. The Scopus search strategy is provided, from inception until September 12, 2024

(Thulium OR thulium:YAG OR Thu:YAG OR Tm:YAG OR thulium fiber laser OR TFL) AND (urolithiasis OR stones OR *lithiasis) AND (lithotripsy OR cystolithotripsy OR laser lithotripsy OR nephrolithotripsy)

= 695 results

Supplementary Table 4. The Web of Science search strategy is provided, from inception until September 12, 2024

ALL = (Thulium OR thulium:YAG OR Thu:YAG OR Tm:YAG OR thulium fiber laser OR TFL)
AND
TS = (urolithiasis OR stones OR *lithiasis)
AND
ALL = (lithotripsy OR cystolithotripsy OR laser lithotripsy OR nephrolithotripsy)

= 415 results

Supplementary Table 5. Bibliometric data from a systematic review of pre-clinical and clinical studies on the Thulium fibre laser for lithotripsy from 2005–2024

Study	**Journal**	**Country of lead**	**Citations**	**FWCI**	**Citations per year**
Clinical studies= 38					
Bergmann 2023 (1)	Journal of clinical medicine	Germany	8	4.24	4.0
Cano-García 2024 (2)	Actas Urol. Esp.	Spain	0	0	0.0
Carrera 2021 (3)	Urology	USA & Canada	16	2.57	4.0
Chandramohan 2023 (4)	Urology annals	India	1	0.51	0.5
Corrales 2021 (5)	World journal of urology	France	17	4.27	4.3
Delbarre 2023 (6)	European urology open science	France	9	4.6	4.5
Enikeev 2020a (7)	World journal of urology	Russia	72	4.43	14.4
Enikeev 2020b (8)	Journal of endourology	Russia	43	2.63	8.6

Enikeev 2021 (9)	International journal of urology	Russia	41	6.55	8.2
Fonseka 2023 (10)	Journal of endourology	UK	0	0	0.0
Geavlete 2021 (11)	Journal of medicine and life	Romania	7	0.66	1.8
Geavlete 2022 (12)	Journal of medicine and life	Romania	4	0.63	1.3
Gupta 2024a (13)	Asian journal of urology	India	2	2.94	2.0
Gupta 2024b (14)	Urologia	India	0	0	0.0
Haas 2023 (15)	Journal of urology	USA	35	14.85	17.5
Jaeger 2022 (16)	Journal of urology	USA	15	3.42	5.0
Korolev 2021 (17)	Urolithiasis	Russia	21	3.14	5.3
Mahajan 2022 (18)	Indian journal of urology	India	25	5.68	8.3
Martov 2021 (19)	Journal of endourology	Russia	57	8.54	14.3
Michiels 2024 (20)	Tijdschrift voor urologie	The Netherlands	0	0	0.0
Nikoufar 2023 (21)	Journal of endourology	Canada	2	0.44	1.0
Panthier 2023 (22)	World journal of urology	France	17	2.99	8.5
Para 2023 (23)	Urology research & practice	India	4	2.08	2.0
Pathak 2024 (24)	Journal of endourology	India	0	0	0.0
Patil 2022a (25)	Journal of endourology	India	14	2.73	4.7
Patil 2022b (26)	World journal of urology	India	17	3.12	5.7
Perri 2022 (27)	World journal of urology	Italy	14	2.15	4.7
Ryan 2022 (28)	World journal of urology	USA	24	4.69	8.0
Shah 2021 (29)	World journal of urology	India	29	4.12	7.3
Sierra 2022a (30)	World journal of urology	France	19	3.51	6.3
Singh 2023 (31)	World journal of urology	India	5	1.35	2.5
Solano 2023 (32)	World journal of urology	France	1	0.27	0.5

Taratkin 2021a (33)	Central European journal of urology	Russia	17	2.36	4.3
Taratkin 2022 (34)	Urologia internationalis	Russia	23	3.97	7.7
Taratkin 2023 (35)	World journal of urology	Russia	7	1.89	3.5
Ulvik 2022 (36)	European urology	Norway	137	23.65	45.7
Vaddi 2022 (37)	Indian journal of urology	India	8	1.21	2.7
Vergamini 2024 (38)	British journal of urology international	USA	2	1.09	2.0
Pre-clinical studies= 69					
AEsoy 2022 (39)	Scandinavian journal of urology	Norway	18	2.75	6.0
Amasyali 2024 (40)	Journal of endourology	USA	0	0	0.0
Andreeva 2020 (41)	World journal of urology	Russia	144	14.59	28.8
Basulto-Martinez 2023 (42)	Urolithiasis	Italy	15	3.78	7.5
Belle 2022 (43)	Journal of endourology	USA	46	7.94	15.3
Blackmon 2010a (44)	Lasers in surgery and medicine	USA	69	3.37	4.6
Blackmon 2010b (45)	Lasers in surgery and medicine	USA	92	3.19	6.1
Blackmon 2011 (46)	Journal of biomedical optics	USA	142	1.78	10.1
Blackmon 2012 (47)	Journal of biomedical optics	USA	39	1.91	3.0
Blackmon 2013 (48)	Journal of biomedical optics	USA	35	1.78	2.9
Blackmon 2014 (49)	Optical engineering	USA	53	4.63	4.8
Buell 2022 (50)	The Canadian journal of urology	USA	6	1.04	2.0
Chen 2023 (51)	Urolithiasis	USA	11	2.7	5.5
Chew 2023 (52)	Investigative and clinical urology	Canada	12	3.17	6.0
Chicaud 2024 (53)	Journal of endourology	France	5	2.17	5.0
Ding 2024 (54)	World journal of urology	China	3	1.63	3.0
Fried 2005 (55)	Lasers in surgery and medicine	USA	187	2.5	9.4

Hajiha 2023 (56)	Journal of endourology	USA	1	0.27	0.5
Hall 2019 (57)	Journal of biomedical optics	USA	21	0.93	3.5
Hardy 2014 (58)	Journal of biomedical optics	USA	105	1.97	9.5
Hutchens 2013a (59)	Journal of biomedical optics	USA	27	1.36	2.3
Hutchens 2013b (60)	Journal of biomedical optics	USA	22	1.26	1.8
Hutchens 2017 (61)	Journal of biomedical optics	USA	28	1.23	3.5
Huusmann 2021 (62)	World journal of urology	Germany	27	3.1	6.8
Jiang 2022 (63)	Journal of endourology	USA	20	3.28	6.7
Jiang 2023 (64)	Journal of endourology	USA	13	3.51	6.5
Johnson 2024 (65)	Journal of urology	USA	8	4.34	8.0
Kamal 2016 (66)	Journal of endourology	Greece	24	1.83	2.7
Keller 2021 (67)	World journal of urology	France	73	7.23	18.3
Kilinc 2024 (68)	Urolithiasis	Turkey	1	0.54	1.0
Kraft 2022a (69)	Lasers in medical science	Germany	24	4.52	8.0
Kraft 2022b (70)	Journal of endourology	Germany	23	3.8	7.7
Kutchukian 2023 (71)	Progres en urologie	France	1	0.27	0.5
Kwok 2023a (72)	World journal of urology	Switzerland	19	5.13	9.5
Kwok 2023b (73)	World journal of urology	Switzerland	14	3.78	7.0
Liu 2021 (74)	Journal of endourology	China	11	1.33	2.8
Li 2024 (75)	Urolithiasis	China	5	2.17	5.0
Martov 2024 (76)	Journal of endourology	Russia	3	1.63	3.0
Miller 2023 (77)	Journal of endourology	USA	4	1.08	2.0
Mishra 2024 (78)	British journal of urology international	USA	16	8.15	16.0

Molina 2021 (79)	World journal of urology	USA	54	6.05	13.5
Nakao 2024 (80)	International journal of urology	Japan	0	0	0.0
Okhunov 2021 (81)	Journal of endourology	USA	32	3.69	8.0
Pal 2019 (82)	Applied optics	India	4	0.19	0.7
Panthier 2021 (83)	World journal of urology	France	57	5.32	14.3
Panthier 2022 (84)	Journal of clinical medicine	France	16	2.49	5.3
Panthier 2024 (85)	World journal of urology	France	4	2.17	4.0
Peng 2020 (86)	Journal of endourology	China	44	4.09	8.8
Peteinaris 2023 (87)	Central European journal of urology	Greece	7	1.62	3.5
Petzold 2021a (88)	World journal of urology	Germany	25	3.25	6.3
Petzold 2021b (89)	Journal of endourology	Germany	33	4.28	8.3
Petzold 2021c (90)	Journal of endourology	Germany	12	1.62	3.0
Scott 2009 (91)	IEEE Journal of selected topics in quantum electronics	USA	130	1.66	8.1
Shen 2024 (92)	World journal of urology	China	2	1.09	2.0
Sierra 2022b (93)	Journal of endourology	France	38	6.39	12.7
Sierra 2023 (94)	Journal of clinical medicine	France	26	6.11	13.0
Sierra 2024a (95)	Journal of endourology	France	4	2.17	4.0
Sierra 2024b (96)	World journal of urology	France	3	1.63	3.0
Soto-Palou 2023 (97)	Journal of endourology	USA	14	3.78	7.0
Taratkin 2020 (98)	World journal of urology	Russia	64	5.87	12.8
Taratkin 2021b (99)	World journal of urology	Russia	15	2.21	3.8
Taratkin 2021c (100)	Journal of endourology	Russia	53	6.35	13.3
Tianfu 2023 (101)	Urology journal	China	3	0.81	1.5

Wanderling 2024 (102)	Urolithiasis	USA	7	3.8	7.0
Wilson 2015a (103)	Lasers in surgery and medicine	USA	34	2.35	3.4
Wilson 2015b (104)	Journal of endourology	USA	25	1.16	2.5
Wilson 2016 (105)	Journal of biomedical optics	USA	21	0.98	2.3
Yang 2023 (106)	Urolithiasis	UK	10	2.7	5.0
Zhang 2015 (107)	Journal of biomedical optics	USA	10	0.3	1.0

FWCI: field-weighted citation impact, Citations are included until September 2024

Supplementary Table 6. Comparing median citation variables between clinical and pre-clinical studies from systematic review on Thulium fiber laser for lithotripsy

	Total	**Clinical**	**Pre-clinical**	**p**
Citations (IQR)	16 (5, 30.5)	14 (2.5, 22.5)	19 (7, 35)	0.045*
FWCI (IQR)	2.5 (1.2, 4.0)	2.7 (0.8, 4.2)	2.3 (1.4, 3.8)	0.857
Citations per year (IQR)	4.5 (2.5, 8)	4.5 (2, 7.5)	5 (3, 8)	0.174

*Statistically significant from Mann-Whitney U test. FWCI: field-weight citation impact.

Supplementary Table 7. Methodologies for included clinical studies on Thulium fiber laser for lithotripsy

Study	**Design**	**Sample size; age in years**	**Location**	**Technique**	**TFL type**	**Initial TFL settings**
Bergmann 2023 (1)	Prospective cohort	50; 52	Renal	Mini-PCNL	RevoLix Hybrid TFL (LISA Laser products GmbH, Katlenburg-Lindau, Germany)	0.4 J, 81 Hz
Cano-García 2024 (2)	Prospective cohort	60; NR	Ureter 28 (47%), Renoureter 5 (8%), Renal 27 (45%)	URSL	Tm:YAG (Dornier MedTech, GmbH, Katlenburg-Lindau, Germany)	Fragmenting 0.8 - 1.2 J, 10-15 Hz; dusting 0.4-0.5 J, 50-100 Hz
Carrera 2021 (3)	Retrospective cohort	76; 61	Renal 47 (62%), Ureter 28 (37%)	URSL	SP TFL (SOLTIVE, sOlympus, Southborough, MA, USA)	0.2 J, 228.9 Hz
Chandramohan 2023 (4)	RCT	90; 38	Ureter	URSL	Urolase SP TFL (IPG Photonics, Oxford, MA, USA)	1 J, 6-10 Hz
Corrales 2021 (5)	Prospective cohort	50; 61	Renal 41 (82%) Ureter 9 (18%)	RIRS	SP TFL (SOLTIVE Premium, Olympus, Tokyo, Japan)	Renal 0.3 J, 100 Hz; Ureter 0.4 J, 40 Hz
Delbarre 2023 (6)	Comparative prospective cohort	100; 60	Renal 88 (88%), Ureter 23 (23%)	URSL	SP TFL (SOLTIVE Premium, Olympus, TN, USA)	NR
Enikeev 2020a (7)	Prospective cohort	120; 52	Kidney	PCNL	TFL FiberLase (NTO IRE-Polus, Fryazino, Russia)	0.8 J, 31-38 Hz

Enikeev 2020b (8)	Prospective cohort	40; 56	Renal	RIRS	SP TFL (NTO IRE-Polus, Fryazino, Russia)	0.5 J, 30 Hz; or 0.15 J, 200 Hz
Enikeev 2021 (9)	Prospective cohort	149; NR	Ureter	URSL	SP TFL (NTO IRE-Polus, Fryazino, Russia)	NR
Fonseka 2023 (10)	Retrospective cohort	5; 60	Bladder	14F super-mini percutaneous cystolitholapaxy	NR	NR
Geavlete 2021 (11)	Retrospective cohort	17; NR	Renal 10 (59%), Ureter 5 (30%), Bladder 2 (12%)	URSL	SP TFL (SOLTIVE)	Fragmentation 1 J, 15Hz; dusting 0.5 J 30 Hz
Geavlete 2022 (12)	Comparative retrospective cohort	59; 49	Renal	RIRS	SP TFL (SOLTIVE)	Dusting 0.5 J, 30 Hz
Gupta 2024a (13)	RCT	40; 45	Ureter	URSL	IPG Photonics	0.8-1 J, 10-12 Hz
Gupta 2024b (14)	Retrospective cohort	30; 35	Bladder	Transurethral cystolithotripsy	NR	0.5-1 J, 15-30 W
Haas 2023 (15)	RCT	56; 59	Renal 39 (70%); Ureter 26 (46%)	URSL	SP TFL (SOLTIVE Premium, Olympus, TN, USA)	Fragmentation 0.8 J, 8 Hz; dusting 0.3 J, 80 Hz
Jaeger 2022 (16)	Retrospective cohort	32; NR	Ureter 8 (25%), Renal 8 (25%), lower pole 6 (38%), Renoureter 4 (13%)	URSL	SP TFL (SOLTIVE Premium, Olympus, TN, USA)	0.2 J, 100 Hz
Korolev 2021 (17)	Prospective cohort	125; 52	Renal	Mini-PCNL	SP TFL (NTO IRE-Polus, Fryazino, Russia)	0.1–6.0 J, 4–200 Hz

Mahajan 2022 (18)	RCT	59; 42	Renal	Mini-PCNL	Urolase SP TFL (IPG Photonics, Oxford, MA, USA)	1–1.5 J, 6–15 Hz
Martov 2021 (19)	RCT	87; 48	Ureter	URSL	TFL FiberLase U2 (NTO IRE-Polus, Fryazino, Russia)	1 J, 10 Hz
Michiels 2024 (20)	Comparative retrospective cohort	92; 58	Kidney, Ureter	URSL	Olympus SOLTIVE	NR
Nikoufar 2023 (21)	Comparative retrospective cohort	49; 63	Kidney	URSL	SP TFL (SOLTIVE, Olympus, Southborough, MA, USA)	Dusting 0.1–0.2 J,100–200 Hz; fragmentation:1 J,10 Hz
Panthier 2023 (22)	Prospective study	25; 55	Renal 22 (88%), Ureter 2 (8%), Bladder 1 (4%)	RIRS	Thulio p-Tm:YAG (Dornier MedTech GmbH, Wessling, Germany)	0.6 J, 15 Hz
Para 2023 (23)	RCT	238; 39	Ureter	URSL	IPG Photonics	0.4 J, 8 Hz
Pathak 2024 (24)	RCT	60; 43	Renal, Ureter	RIRS	IPG Photonics	0.1–1.0 J,10–100 Hz
Patil 2022a (25)	Comparative retrospective cohort	51; 41	Renal	Mini-PCNL	Urolase SP TFL (IPG Photonics, Oxford, MA, USA)	0.1–1.0 J, 100–250 Hz
Patil 2022b (26)	Comparative prospective cohort	30; 44	Renal	Mini-PCNL	NR	NR
Perri 2022 (27)	RCT	186; 54	Renal	RIRS or Mini-PCNL	Fiber Dust TFL (Quanta Systems, Milan, Italy)	200–300 mJ, 100 Hz
Ryan 2022 (28)	Retrospective cohort	51; NR	Renal and Ureter	URSL	Olympus SOLTIVE	NR
Shah 2021 (29)	Prospective cohort	54; 40	Renal	Mini-PCNL	Urolase SP TFL (IPG Photonics, Oxford, MA, USA)	0.2 J, 125–200 Hz

Sierra 2022 (30)	Prospective cohort	50; 55	Renal 40 (80%), Ureter 10 (20%)	RIRS	Fiber Dust TFL (Quanta Systems, Milan, Italy)	Renal 0.6 J, 15 Hz; Ureter 0.6 J,10 Hz
Singh 2023 (31)	Prospective cohort	76; 45	Renal	RIRS	SP TFL (IPG Photonics, Russia)	Fragmentation 1-1.5 J, 10–15 Hz); popcorning 0.1-0.2 J, 100–300); dusting 0.1-0.15 J, 100–200 Hz
Solano 2023 (32)	Prospective cohort	55; 52	Renal 40 (72%), Ureter 11 (20%), Bladder 2 (3%)	RIRS	TFL Drive (Coloplast, Humlebaek, Denmark)	NR
Taratkin 2021a (33)	Retrospective cohort	70; NR	Renal	RIRS and PCNL	SP TFL U2 (NTO IRE-Polus, Russia)	RIRS 0.15 J, 200 Hz; PCNL 0.8 J, 31–38 Hz
Taratkin 2022 (34)	Propective cohort	170; 54	Renal	RIRS	SP TFL (NTO IRE-Polus Russia)	NR
Taratkin 2023 (35)	RCT	32 and 34; 51	Renal	RIRS	SP TFL (NTO IRE-Polus, Russia)	Fragmentation 1.5 J, 20 Hz; dusting 0.5 J, 30 Hz; popcorning 0.15 J, 100 Hz

Ulvik 2022 (36)	RCT	60; 53	Renal 34 (57%), Ureter 26 (43%)	RIRS	SP TFL (SOLTIVE Premium, Olympus, TN, USA)	0.4 J, 6 Hz
Vaddi 2022 (37)	Prospective cohort	126; 45	Renal and Ureter	RIRS	Urolase SP TFL (IPG Photonics, Oxford, MA, USA)	Fragmentation 1–2 J, 10–20 Hz; popcorning 0.1-0.2 J, 200 Hz; dusting 0.1-0.2 J 100-150 Hz
Vergamini 2024 (38)	Comparative retrospective cohort	49; 59	Renal	Mini-PCNL	SP TFL (SOLTIVE Olympus, TN, USA)	1.0 J, 20 Hz

TFL: Thulium fiber laser, RCT: randomized controlled trial, PCNL: percutaneous nephrolithotomy, URSL: ureteroscopy lithotripsy, RIRS: retrograde intrarenal surgery, NR: not reported.

Supplementary Table 8. Findings for included clinical studies on Thulium fiber laser for lithotripsy

Study	**Stone character**	**LOT in min**	**Complication rate**	**Complications**	**SFR**	**SFR definition**
Bergmann 2023 (1)	242 mm^3; 833 HU	7.1	Total 16 (32%): Grade 1 n= 9 (18%), Grade 2 n= 6 (12%), Grade 3b n= 1 (2%)	clots 2 (4%), fever 5 (10%), AKI 2 (4%), UTI 4 (8%), blood transfusion 1 (2%), urine leakage 1 (2%), splenectomy 1 (2%)	84%	24 hr XR/CT
Cano-García 2024 (2)	16 mm, 1105 HU	12	2 (3.3%)	fever 2 (3%)	92%	NR
Carrera 2021 (3)	10 mm, 901 HU	10.4	8 (10.5%)	hematuria 1 (1%), fever 1 (1%), pain 2 (3%) pain, UTI 3 (4%), stent loss 1 (1%)	79%	12 week XR/US/CT
Chandramohan 2023 (4)	13 mm, 904 HU	7.4	Total 15 (17%): Grade 1 n= 10 (11.1%), Grade 2 n= 3 (3.3%), Grade 3 n= 2 (2.2%)	pain 10 (11%), fever 3 (3%), stent loss 2 (2%)	98%	1 month CT
Corrales 2021 (5)	Renal 1800 mm^3, 1200 HU; Ureter 486 mm^3, 998 HU	Renal 23, Ureter 9.3	Total 3 (6%): Grade 1-2 n= 3 (6%)	NR	NR	NR

Delbarre 2023 (6)	15 mm	NR	Total 14 (14%): Grade 1-2 n= 9 (9%), Grade 3-4 n= 4 (4%)	UTI 5 (5%)	72%	3 months US/CT
Enikeev 2020a (7)	13 mm,1019 HU	5	Total 25 (21%): Grade 1 n= 14 (12%), Grade 2 n= 5 (4%), Grade 3a n= 6 (5%)	fever 4 (3%), AKI 4 (3%), clots 6 (4%), urine leakage 2 (2%), UTI 2 (2%), wound infection 1 (0.8%), stent placement required for leakage 6 (5%)	85%	3 months CT
Enikeev 2020b (8)	17 mm, 883 mm^3, 880 HU	4	Total 4 (10%): Grade 1 n= 3 (7%), Grade 2 n= 1 (3%)	fever 2 (5%), AKI 1 (2.5%), UTI 1 (2.5%	93%	3 months CT
Enikeev 2021 (9)	179 mm^3; 985 HU	1.2	Total 8 (5%): Grade 1-2 n= 6 (4%)	mucosal damage 2 (1%)	90%	3 months CT
Fonseka 2023 (10)	30 mm	NR	0	0	81%	6 weeks US/CT
Geavlete 2021 (11)	Renal 13 mm, 926 HU; Ureter 8 mm, 911 HU; Bladder 31 mm, 1240 HU	NR	Total 2 (12%): Grade 1 n= 1 (6%), Grade 2 n= 2 (6%)	NR	Renal 95%, Ureter 100%, Bladder 100%	1 month XR/US/CT
Geavlete 2022 (12)	13 mm, 1045 HU	NR	Total 7 (12%)	hematuria 4 (6%), fever 3 (5%)	97%	3 months re-look fURS
Gupta 2024a (13)	283 mm^3, 1135 HU	10.2	Total 2 (5%): Grade 2 n= 2 (5%)	UTI 2 (5%)	100%	1 month CT
Gupta 2024b (14)	15 mm	NR	Total 6 (20%):	hematuria 5 (17%),	100%	5 days US

			Grade 1 n= 6 (20%)	urinary retention 1 (3%)		
Haas 2023 (15)	202 mm^3, 998 HU	5.1	Total 6 (11%)	obstructing fragment 2 (4%), stent colic 3 (6%), UTI 1 (2%)	77%	4–8 weeks XR/US/CT
Jaeger 2022 (16)	NR	11	Total 7 (25%)	obstructing fragment 1 (3%), UTI n=1 (3%)	70%	0 mm at 3 months US/CT
Korolev 2021 (17)	1337–2386 mm^3, 900–1170 HU	5.2–5.9	Total 6 (5%): mostly Grade 1-2	Transient fever, hematuria, minor infections	85%	3 months CT
Mahajan 2022 (18)	3710 mm^3, 1160 HU	11.3	Total 11 (19%): mostly Grade 1-2	hematuria 13 (22%)	95%	4 mm at 2 weeks XR/US
Martov 2021 (19)	12 mm, 1001 HU	8.4	Total 9 (10%)	fragment migration 3 (3%), hematuria 1 (1%), fever 9 (10%)	100%	0 mm 1 month CT
Michiels 2024 (20)	12 mm, 1008 HU	NR	Total 11 (12%)	UTI 8 (9%), perforation 1 (1%), stent loss 1 (1%)	NR	NR
Nikoufar 2023 (21)	529 mm^3, 668 HU	6.2	Total 9 (18%): Grade 1 n= 6 (12%), Grade 2 II n=3 (6%)	Stent symptoms, UTI, single ureteral injury	88%	4 mm at 3 months CT
Panthier 2023 (22)	2849 mm^3, 1000 HU	35	Total 1 (4%): Grade 2	Steinstrasse	95%	3 mm on CT
Para 2023 (23)	9 mm, 918 HU	9.3	Total 31 (13%)	bleeding impairing vision 21 (9%), mucosal	NR	2 week XR

				damage 18 (8%), perforation 2 (1%)		
Pathak 2024 (24)	10–20 mm, 1263 HU	NR	Total 8 (13%): Grade I n= 4 (7%)	hematuria 2 (3%), mucosal damage 2 (3%), fever 2 (3%), pain 2 (3%)	95%	2 mm at 1 month CT
Patil 2022a (25)	18 mm, 1232 HU	9.2	Total 3 (6%): Grade 2 n= 3 (6%)	UTI 3 (6%)	69% (48 hrs), 100% (1 mo)	0 mm at 48 hrs ana 1 month CT
Patil 2022b (26)	22 mm, 1309 HU	NR	Total 2 (7%): Grade 2 n=2 (7%)	UTI 2 (7%)	77% (48 hrs), 100% (1 mo)	NR
Perri 2022 (27)	10–20 mm	26.4–28.4	Total 10 (11%)	hematuria, UTI, Steinstrasse	73–84%	3 mm at 3 months CT
Ryan 2022 (28)	11 mm	NR	Total 3 (6%)	ED visits 3 (6%)	NR	NR
Shah 2021 (29)	2338 mm^3, 1301 HU	10.1	Total 3 (6%): Grade 2 n= 3 (6%)	UTI 3 (6%)	65% (48h), 100% (1 mo)	1 month XR/CT
Sierra 2022 (30)	347–1125 mm^3, 900–950 HU	26.4	Total 4 (8%)	UTI 4 (8%)	100%	8 weeks XR/CT
Singh 2023 (31)	1753 mm^3, 1104 HU	23.3	Total 16 (21%): Grade 2 n= 6(8%)	hematuria 11 (14%), UTI 7 (9%)	96%	2 mm at 3 months CT
Solano 2023 (32)	4438 mm^3, 988 HU	26.3	Total 4 (6%): all below Grade 2	NR	61%	3 mm at 3 months XR/US/CT

Taratkin 2021a (33)	RIRS 2743 mm^3, 834 HU; PCNL 3285 mm^3, 882 HU	RIRS 11.7, PCNL 10.0	Total 7 (10%): all below Grade 2	UTI 5 (7%), AKI 2 (3%)	87%	0 mm at 3 months CT
Taratkin 2022 (34)	2796 mm3, 1020 HU	2.7	Total 13 (8%): Grade 2 n= 3 (2%)	fever 6 (4%), UTI 3 (2%), AKI 4 (3%)	89%	0 mm at 3 months CT
Taratkin 2023 (35)	329 mm^3, 1155 HU	comparative 9.2	Total 1 (3%): Grade 2	UTI 1 (3%)	100%	3 mm at 3 months CT
Ulvik 2022 (36)	12 mm, 896 HU	NR	Total 8 (13%): only 1 above Grade 2 (2%)	UTI 4 (6%), obstruction 4 (6%), mucosal damage 2 (3%), urethral pain 1 (2%)	92%	3 mm at 3 months CT
Vaddi 2022 (37)	1061 mm^3, 985 HU	19.8	Total 21 (17%): all Grade 2 or below	hematuria 12 (9%), fever 9 (7%)	94%	2 mm at 3 months CT
Vergamini 2024 (38)	2450 mm^3, 1185 HU	17	Total 3 (6%)	mucosal damage 3 (6%)	78%	2 mm at 24 hr CT

LOT: Laser on time, SFR: stone free rate, HU: Hounsfield units for density, RIRS: retrograde intrarenal surgery, PCNL: percutaneous nephrolithotomy, complications are described as Clavien-Dindo classification grades when reported

Supplementary Table 9. Methodologies for included pre-clinical studies on thulium fiber laser for lithotripsy

Study	**Design**	**Focus**	**TFL type**	**Objective**
AEsoy 2022 (39)	Ex vivo	Ex vivo porcine model	TFL (Olympus SoltiveTM Premium 60 W, USA)	To investigate temperature profiles in both the renal pelvis and parenchyma during TFL and Ho:YAG laser activation
Amasyali 2024 (40)	In vitro	Silicone kidney model	SP TFL (SOLTIVE Premium, Olympus, PA, USA)	To compare lithotripsy performance of the 150 and 200 mm TFL in a lower pole benchtop kidney model
Andreeva 2020 (41)	In vitro	Stone samples alone	SP TFL (IPG Photonics, Oxford, MA, USA)	To evaluate the SP TFL parameters for treating stones in laboratory conditions and compare performance with Ho:YAG using for both fragmentation and dusting modes
Basulto-Martinez 2023 (42)	In vitro	Stone samples alone	Fiber Dust TFL (Quanta Systems, Samarate, Italy)	To analyze the ablation rates of Ho:YAG and TFL under different settings combinations
Belle 2022 (43)	In vitro	Silicone kidney model	Soltive Premium Super-pulsed TFL (Olympus, MA)	To compare ureteral temperatures generated by TFL and Ho:YAG lasers during ureteroscopic laser lithotripsy in a benchtop model
Blackmon 2010a (44)	In vitro	Stone samples alone	Model TLR 110–1908 (IPG Photonics, Oxford, MA, USA)	To describe a TFL and tapered optical fiber delivery system combination
Blackmon 2010b (45)	In vitro	Stone samples alone	Model TLR 110–1908 (IPG Photonics, Oxford, MA, USA)	To compare stone vaporization rates for Ho:YAG and TFL
Blackmon 2011 (46)	In vitro	Stone samples alone	Model TLR 110–1908 (IPG Photonics, Oxford, MA, USA)	To compare ablation thresholds, ablation rates, and retropulsion effects between Ho:YAG and TFL
Blackmon 2012 (47)	In vitro	Stone samples alone	Model TLR 110-1908 (IPG Photonics, Oxford, MA, USA)	To investigate the application of TFL micro pulsation for enhanced laser lithotripsy
Blackmon 2013 (48)	In vitro	Stone samples alone	Model TLR 110-1908 (IPG Photonics, Oxford, MA, USA)	To analyze the suction effect and determine its dependence on holmium laser pulse energy and TFL pulse rate

Blackmon 2014 (49)	In vitro	Stone samples alone	Model TLR 110-1908 (IPG Photonics, Oxford, MA, USA)	To compare the 50 µm to larger diameter TFL fibers in terms of lithotripsy efficacy
Buell 2022 (50)	In vitro	Silicone kidney model	SP TFL (SOLTIVE Premium, Olympus, MA, USA)	To compare TFL and Ho:YAG for fragment size, scope deflection, and irrigation flow rate during in situ lower pole lithotripsy
Chen 2023 (51)	In vitro	Stone samples alone	TFL-50/500-QCW-AC (IPG Photonics, Oxford, MA, USA)	To explore the stone ablation characteristics of TFL and examine the associated mechanisms
Chew 2023 (52)	In vitro	Stone samples alone	SP TFL (SOLTIVE, Olympus, Oxford, MA, USA)	To compare the fragmentation capabilities of the novel SP TFL with Ho:YAG lasers
Chicaud 2024 (53)	In vitro	Stone samples alone	Thulio p-Tm:YAG (Dornier-Medtech, Katlenburg-Lindau, Germany) and TFL (Coloplast, Humlebaek, Denmark)	To characterize the p-Tm-YAG laser, determine its ROF, and compare p-Tm:YAG, Ho:YAG, and TFL efficiency using ablation volumes
Ding 2024 (54)	Ex vivo	Ex vivo porcine model	SP TFL (A-ONE Laikai Medical Devices, Beijing, China)	To investigate the optimal temperature control and the irrigation flow rate for SP TFL
Fried 2005 (55)	In vitro	Stone samples alone	Model TLR-110-1940 (IPG Photonics, Oxford, MA, USA)	To test the feasibility of laser lithotripsy using a high-power Thulium fiber laser operated in pulsed mode
Hajiha 2023 (56)	In vitro	Silicone bladder model	TFL (SOLTIVE Premium, Olympus, Tokyo, Japan)	To compare time and cost efficiency of the TFL with laser powers and settings in the treatment of bladder stones in a bench-top model
Hall 2019 (57)	In vitro	Stone samples alone	Model TLR 100-1908 (IPG Photonics, Oxford, MA, USA)	To investigate an automated, vibrating fiber optic tip for dusting of kidney stones during TFL lithotripsy
Hardy 2014 (58)	In vitro	Silicone ureter model	Model TLR 100-1908 (IPG Photonics, Oxford, MA, USA)	To compare TFL and Ho:YAG laser times and total operation times necessary to fragment similar stones in an in vitro ureter model

Hutchens 2013a (59)	In vitro	Stone samples alone	Model TLR 100-1908 (IPG Photonics, Oxford, MA, USA)	To investigate the use of a hollow steel tip add-on for TFL lithotripsy
Hutchens 2013b (60)	In vitro	Stone samples alone	Model TLR 100-1908 (IPG Photonics, Oxford, MA, USA)	To investigate a low-profile, easily detachable distal fiber tip interface for potential use in TFL lithotripsy
Hutchens 2017 (61)	In vitro	Stone samples alone	Model TLR 100-1908 (IPG Photonics, Oxford, MA, USA)	To investigate a low profile, distal fiber tip "muzzle brake" to reduce stone retropulsion for potential use in TFL lithotripsy
Huusmann 2021 (62)	Ex vivo	Ex vivo porcine model	RevoLix HTL prototype (LISA Laser products GmbH, Katlenburg-Lindau, Germany)	To compare the tissue effects of the newly developed pulsed Tm:YAG laser with the established effects of CW Tm:YAG laser and the pulsed Ho:YAG laser
Jiang 2022 (63)	Ex vivo	Ex vivo porcine model	sTFL XLR Multi-kW Laser System (IPG Photonics, Oxford, MA, USA)	To compare ex vivo evaluations of TFL with Ho:YAG lasers, for stone fragmentation and stone clearance with a focus on dusting
Jiang 2023 (64)	In vivo	In vivo porcine model	sTFL XLR Multi-kW Laser System (IPG Photonics, Oxford, MA, USA)	To compare the effectiveness and efficiency of the SP TFL with the Ho:YAG laser for ureteroscopic "dusting" of renal stones in an in vivo porcine model
Johnson 2024 (65)	In vitro	Stone samples alone	TFL (Coloplast, Minneapolis, MN, USA)	To investigate the TFL's ablative efficiency across various stone types and laser settings
Kamal 2016 (66)	In vitro	Stone samples alone	Tm:YAG (Lisa laser products OHG, Katlenburg-Lindau, Germany)	To compare retropulsion between Ho: YAG and Tm: YAG in different power settings
Keller 2021 (67)	In vitro	Stone samples alone	TFL FiberLase U2 (IPG Photonics, Marlborough, MA, USA)	To evaluate if stone dust can be obtained from all prevailing stone composition types using TFL for lithotripsy
Kilinc 2024 (68)	In vitro	Stone samples alone	Fiber Dust Pro TFL (Quanta Systems, Samarate, Italy)	To analyze the chemical content of the gas products formed during the lithotripsy of cystine stone with TFL

Kraft 2022a (69)	In vitro	Stone samples alone	YLR-2000-U (IPG Photonics, IRE-Polus, Fryazino, Russia)	To compare the fragmentation efficiency of a novel, pulsed Tm:YAG to that of a chopped TFL and a pulsed Ho:YAG laser for lithotripsy
Kraft 2022b (70)	In vitro	Stone samples alone	TFL FiberLase U2 (IPG Photonics, Marlborough, MA, USA)	To compare the p-Tm:YAG's dusting efficiency with that of a chopped TFL
Kutchukian 2023 (71)	In vitro	Stone samples alone	TFL (NTO IRE-Polus, Fryazino, Russia)	To compare the Ho:YAG and TFL ablation volumes
Kwok 2023a (72)	In vitro	Stone samples alone	Thulio p-Tm:YAG (Dornier MedTech - GmbH, Wessling, Germany)	To evaluate whether stone dust can be obtained from all prevailing stone composition types using the novel p-Tm:YAG
Kwok 2023b (73)	In vitro	Stone samples alone	Thulio p-Tm:YAG (Dornier MedTech - GmbH, Wessling, Germany)	To evaluate p-Tm:YAG ablation efficiency for stone dust from human urinary stones of known compositions
Liu 2021 (74)	In vitro	Stone samples alone	SP TFL (Raykeen Laser Technology Limited Corporation, Shanghai, China)	To investigate the ablation efficiency of SP TFL with different laser settings and fiber usage
Li 2024 (75)	Ex vivo	Ex vivo porcine model	Urolase TFL (Raykeen, Shanghai, China)	To identify optimal parameters for using TFL in ureteral stone lithotripsy to ensure laser safety and maximize efficacy
Martov 2024 (76)	Ex vivo	Ex vivo porcine model	FiberLase U-MAX SP TFL (IPG Medical, Marlborogh, MA, USA)	To evaluate safety and efficacy of the SP TFL fragmentation mode in ureteroscopy and mini percutaneous nephrolithotomy
Miller 2023 (77)	In vitro	Silicone kidney model	SP TFL (SOLTIVE, Olympus)	To compare image distortion using different laser power settings and distances from the laser fiber tip to the scope for the SP TFL laser and high-power Ho:YAG laser
Mishra 2024 (78)	In vitro	Silicone kidney model	TFL (IPG Photonics, Oxford, MA, USA)	To explore the optimal laser settings and treatment strategies for TFL lithotripsy
Molina 2021 (79)	Ex vivo	Ex vivo porcine model	SP TFL (SOLTIVE, Olympus, MA, USA)	To compare the temperature profile of both the 120 W Ho:YAG and the 60 W SP TFL

				systems during ureteral lithotripsy
Nakao 2024 (80)	In vitro	Stone samples alone	Rovolix HTL p-Tm:YAG laser (LISA Laser Products GmbH, Katlenburg-Lindau, Germany)	To evaluate the efficacy of the p-Tm:YAG laser versus pulse-modulated Ho:YAG laser for dusting lithotripsy using an optical motion capture system
Okhunov 2021 (81)	In vivo	In vivo porcine model	NR	To examine the intrarenal fluid and tissue temperature alterations during dusting and fragmentation with the TFL in an in vivo porcine kidney
Pal 2019 (82)	In vitro	Stone samples alone	In-house	To investigate a continuous wave (CW), as well as quasi-CW (QCW) all-fiber thulium laser at 1.94 µm in air-cooled operation
Panthier 2021 (83)	In vitro	Stone samples alone	TFL (IPG Photonics, Russia)	To compare ablation rates, fissures and fragments' size with 150µm or 272µm with different laser settings using TFL and Ho:YAG lithotripsy
Panthier 2022 (84)	In vitro	Stone samples alone	TFL generator (IPG Photonics, Russia)	To evaluate the optimal displacement velocity for both Ho:YAG and Tm-Fiber laser within the laser settings
Panthier 2024 (85)	In vitro	Stone samples alone	TFL (IPG Photonics, Russia)	To evaluate the ablation volume per pulse and required energy needed to ablate 1 cubic mm of various stone types at different laser settings with TFL
Peng 2020 (86)	In vitro	Stone samples alone	SP TFL (Raykeen Laser Technology Limited Corporation, Shanghai, China)	To investigate the thermal effect on the water by a SP TFL designed for lithotripsy and evaluate the safety of this laser for clinical use
Peteinaris 2023 (87)	In vivo	In vivo porcine model	Fibre Dust TFL (Quanta Systems, Samarate, Italy)	To evaluate the possible histopathological alterations that occur in the kidneys due to a continuous temperature increase using a newly introduced TFL

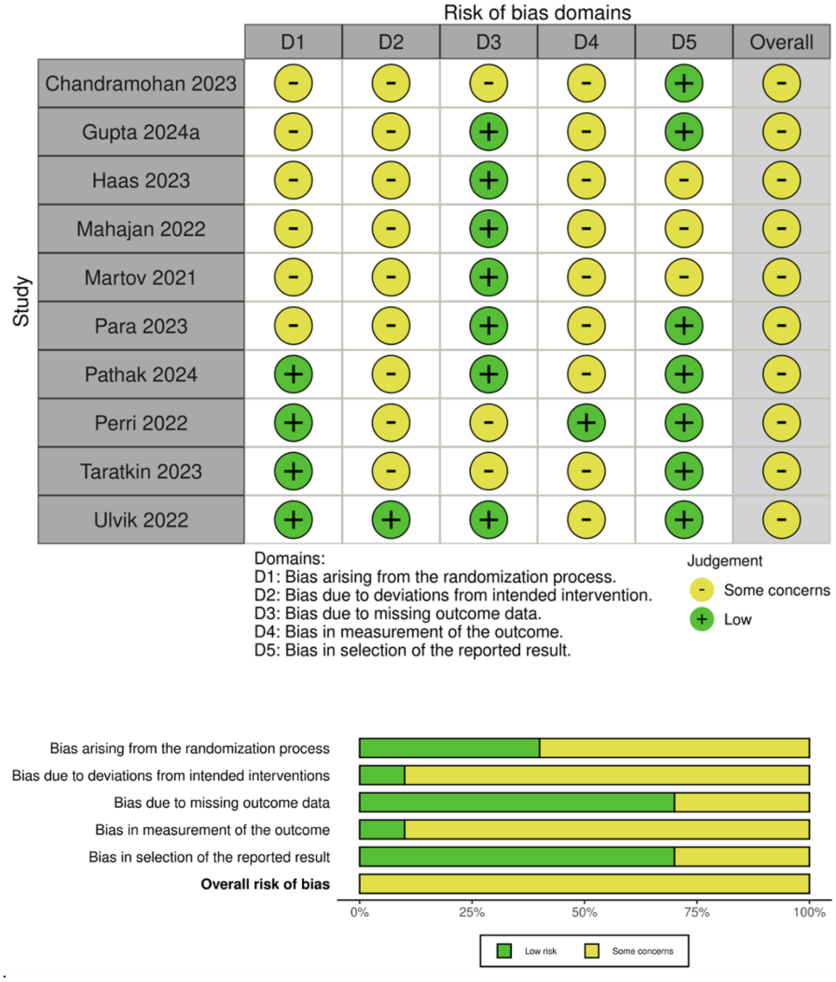
Petzold 2021a (88)	In vitro	Stone samples alone	Dornier MedTech Laser GmbH, Wessling, Germany	To investigate retropulsion forces generated by two laser lithotripsy devices, a standard Ho:YAG and a new pulsed solid-state Thulium laser device
Petzold 2021b (89)	In vitro	Stone samples alone	Dornier MedTech Laser GmbH, Wessling, Germany	To examine the dusting performance of a novel solid state Thulium laser device compared to a standard Ho:YAG device
Petzold 2021c (90)	In vitro	Stone samples alone	Dornier MedTech Laser GmbH, Wessling, Germany	To examine gas bubbles generated by two laser lithotripsy devices, a pulsed Thulium solid-state laser and a Ho:YAG device, and their possible effects in lithotripsy
Scott 2009 (91)	In vitro	Stone samples alone	Model TLR 110-1908 (IPG Photonics, Oxford, MA, USA)	To investigate the use of TFL compared to Ho:YAG lithotripsy in terms of fibre damage, irrigation, and efficiency
Shen 2024 (92)	Ex vivo	Ex vivo porcine model	LAKH Medical Instrument Co., Beijing, China	To assess the ablation efficiency of the SP TFL and investigate the thermal effects of SP TFL
Sierra 2022b (93)	In vitro	Silicone ureter model	Fiber Dust TFL (Quanta Systems, Samarate, Italy)	To evaluate using an inanimate model the thermal injury and laser efficiency in hands of junior and experienced urologists during Ho:YAG and TFL lithotripsy
Sierra 2023 (94)	In vitro	Silicone ureter model	Fiber Dust TFL (Quanta Systems, Samarate, Italy)	To evaluate low-power settings to manage TFL lithotripsy dusting efficiency
Sierra 2024a (95)	In vitro	Silicone ureter model	Thulio p-Tm:YAG (Dornier MedTech - GmbH, Wessling, Germany) and TFL (Olympus, Tokyo, Japan)	To evaluate the ablation speed, laser efficiency and direct thermal lesions during urinary stone lithotripsy with the current available laser technologies including TFL
Sierra 2024b (96)	In vitro	Silicone ureter model	TFL (Coloplast, Humlebaek, Denmark)	To evaluate the stone ablation rate and direct thermal damage from TFL lithotripsy using continuous and burst

				techniques on an in vitro ureteral model
Soto-Palou 2023 (97)	In vitro	Stone samples alone	TLR-50 (IPG Photonics, Oxford, MA, USA)	To assess the efficiency of the TFL platform in an automated in vitro dusting model
Taratkin 2020 (98)	In vitro	Stone samples alone	SP TFL (NTO IRE-Polus, Fryazino, Russia)	To compare the thermal effects of Ho:YAG and Tm-fiber lasers during lithotripsy in an in vitro model via real-time temperature measurement
Taratkin 2021b (99)	In vitro	Silicone kidney model	SP TFL (NTO IRE-Polus, Fryazino, Russia)	To investigate the thermal effects, stone retropulsion and ablation rate of SP TFL with two different surgical fibers of 200 and 150 µm
Taratkin 2021c (100)	In vitro	Stone samples alone	SP TFL (NTO IRE-Polus, Fryazino, Russia)	To identify the prevailing mechanism of stone ablation by evaluating the stone mass-loss after laser lithotripsy in different media
Tianfu 2023 (101)	In vitro	Silicone kidney model	SP TFL (LAKH Medical Instrument Co., Beijing, China)	To investigate temperature changes around the fibres of the SP TFL during in vitro lithotripsy
Wanderling 2024 (102)	in vitro	Hydrogel kidney model	TFL (SOLVITE Premium, Olympus)	To evaluate performance of TFL compared to Ho:YAG lithotripsy in different settings in a hydrogel model
Wilson 2015a (103)	Ex vivo	Ex vivo porcine ureteral tissue	Model TLR 110-1908 (IPG Photonics, Oxford, MA, USA)	To provide safety data on use of the TFL during lithotripsy, concerning induced damage to the porcine ureter wall and to typical instrumentation such as Nitinol stone baskets
Wilson 2015b (104)	In vitro	Stone samples alone	Model TLR 110-1908 (IPG Photonics, Oxford, MA, USA)	To describe testing of a novel miniaturized and integrated hollow steel tip fiber and stone basket device with TFL
Wilson 2016 (105)	In vitro	Stone samples alone	Model TLR 110-1908 (IPG Photonics, Oxford, MA, USA)	To investigate a miniature ball-tip fiber design for TFL lithotripsy
Yang 2023 (106)	In vitro	Stone samples alone	NR	To investigate stone ablation rate between TFL and Ho:YAG lasers in an automated benchtop model

Zhang 2015 (107)	In vitro	Stone samples alone	In-house Tm:YAG	To investigate ablation lithotripsy with novel Q-switch Tm:YAG laser

TFL: Thulium fiber laser, Ho:YAG: Holmium-YAG.

Supplementary Figure 1. Risk of bias assessment for randomized clinical studies using RoB 2 tool.



Risk of bias domains

Study	D1	D2	D3	D4	D5	Overall
Chandramohan 2023	-	-	-	-	+	-
Gupta 2024a	-	-	+	-	+	-
Haas 2023	-	-	+	-	-	-
Mahajan 2022	-	-	+	-	-	-
Martov 2021	-	-	+	-	-	-
Para 2023	-	-	+	-	+	-
Pathak 2024	+	-	+	-	+	-
Perri 2022	+	-	-	+	+	-
Taratkin 2023	+	-	-	-	+	-
Ulvik 2022	+	+	+	-	+	-

Domains:
D1: Bias arising from the randomization process.
D2: Bias due to deviations from intended intervention.
D3: Bias due to missing outcome data.
D4: Bias in measurement of the outcome.
D5: Bias in selection of the reported result.

Judgement
- Some concerns
+ Low

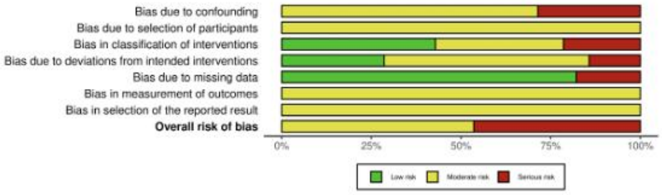
Supplementary Figure 2. Risk of bias assessment for non-randomized cohort clinical studies using ROBINS-I tool.

Risk of bias domains

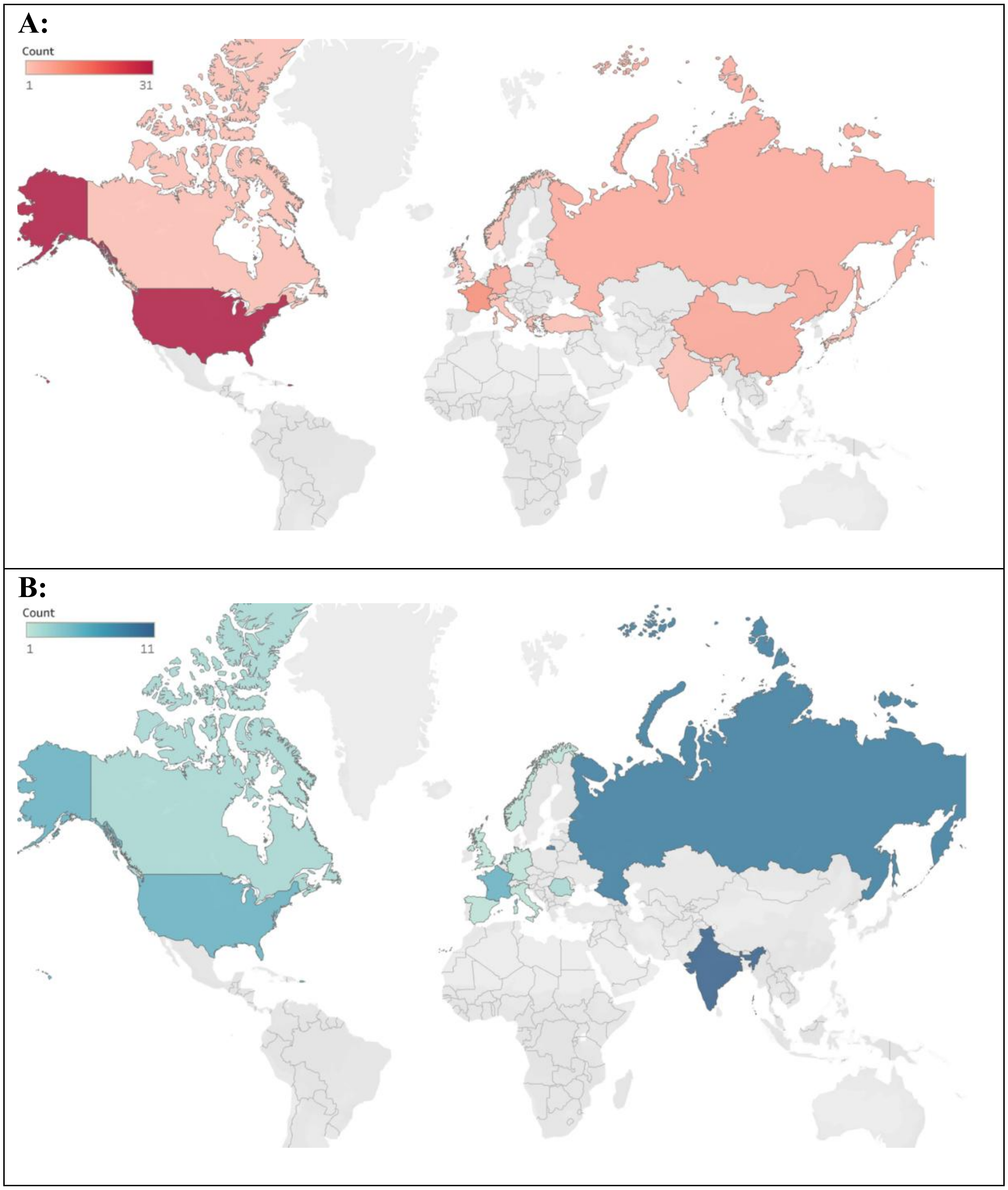
Study	D1	D2	D3	D4	D5	D6	D7	Overall
Bergmann 2023	-	-	-	-	X	-	-	X
Cano-Garcia 2024	X	-	-	-	X	-	-	X
Carrera 2021	-	-	-	+	+	-	-	-
Corrales 2021	-	-	X	+	+	-	-	X
Delbarre 2023	-	-	+	-	+	-	-	-
Enikeev 2020a	-	-	-	+	+	-	-	-
Enikeev 2020b	-	-	-	+	+	-	-	-
Enikeev 2021	-	-	X	X	+	-	-	X
Fonseka 2023	X	-	-	X	+	-	-	X
Geavlete 2021	X	-	X	-	+	-	-	X
Geavlete 2022	-	-	+	-	+	-	-	-
Gupta 2024b	X	-	-	-	+	-	-	X
Jaeger 2022	-	-	+	-	X	-	-	X
Korolev 2021	-	-	+	+	+	-	-	-
Michiels 2024	-	-	+	-	+	-	-	-
Nikoufar 2023	-	-	+	+	+	-	-	-
Panthier 2023	X	-	X	+	X	-	-	X
Patil 2022a	-	-	+	-	+	-	-	-
Patil 2022b	-	-	+	-	+	-	-	-
Ryan 2022	-	-	-	X	X	-	-	X
Shah 2021	-	-	-	-	+	-	-	-
Sierra 2022	X	-	X	-	+	-	-	X
Singh 2023	X	-	-	-	+	-	-	X
Solano 2023	X	-	X	X	+	-	-	X
Taratkin 2021	-	-	+	-	+	-	-	-
Taratkin 2022	-	-	+	-	+	-	-	-
Vaddi 2022	-	-	+	-	+	-	-	-
Vergamini 2024	-	-	+	+	+	-	-	-

Domains:
D1: Bias due to confounding.
D2: Bias due to selection of participants.
D3: Bias in classification of interventions.
D4: Bias due to deviations from intended interventions.
D5: Bias due to missing data.
D6: Bias in measurement of outcomes.
D7: Bias in selection of the reported result.

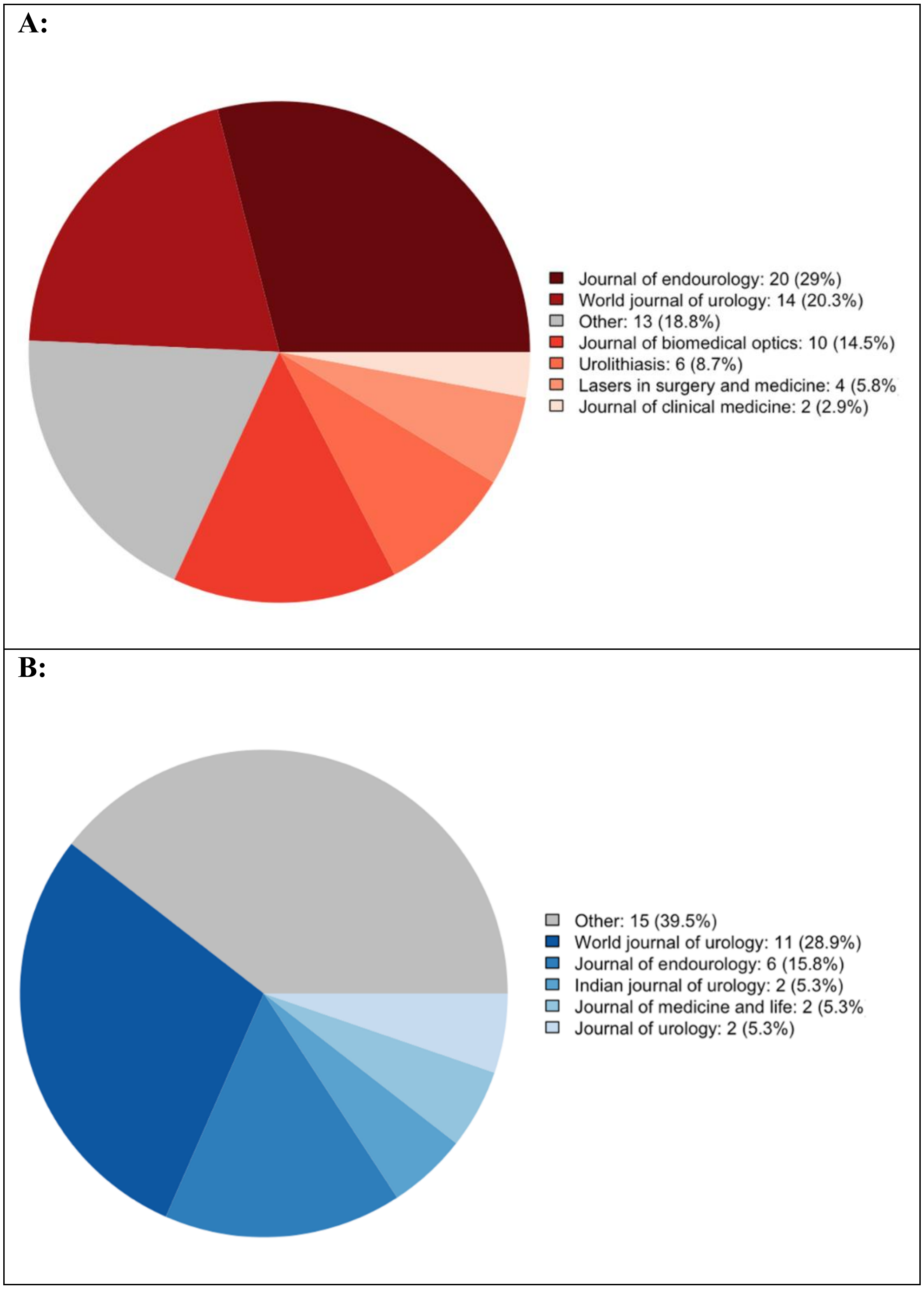
Judgement
X Serious
- Moderate
+ Low



Supplementary Figure 3. Choropleth maps showing counts by country of lead for pre-clinical (A) and clinical (B) thulium fibre laser lithotripsy studies.



Supplementary Figure 4. Pie charts showing journal distributions for pre-clinical (A) and clinical (B) thulium fibre laser lithotripsy studies. Singleton journal entries are counted under Other.



REFERENCES FOR APPENDIX S1:

1. Bergmann J, Rosenbaum CM, Netsch C, Gross AJ, Becker B. First Clinical Experience of a Novel Pulsed Solid-State Thulium:YAG Laser during Percutaneous Nephrolithotomy. J Clin Med. 2023 Mar 29;12(7):2588.
2. Cano-García MC, Abad Rodríguez-Hesles C, Yuste-Mascarós V, Arrabal Polo MÁ. Initial results of pulsed thulium fiber laser (Dornier®) for the treatment of renal and ureteral stones with ureteroscopy. Actas Urol Esp. 2024 Jul;48(6):484–5.
3. Carrera RV, Randall JH, Garcia-Gil M, Knudsen BE, Chew BH, Thompson JA, et al. Ureteroscopic Performance of High Power Super Pulse Thulium Fiber Laser for the Treatment of Urolithiasis: Results of the First Case Series in North America. Urology. 2021 Jul;153:87–92.
4. Chandramohan V, Swamy PMS, Ramakrishna P, Ganesan S, Babu M, Anandan H, et al. Ureteroscopic lithotripsy by thulium fiber laser versus holmium laser: A single-center prospective randomized study. Urol Ann. 2023 Jul;15(3):285–8.
5. Corrales M, Traxer O. Initial clinical experience with the new thulium fiber laser: first 50 cases. World J Urol. 2021 Oct;39(10):3945–50.
6. Delbarre B, Baowaidan F, Culty T, Khelfat L, Brassier M, Ferragu M, et al. Prospective Comparison of Thulium and Holmium Laser Lithotripsy for the Treatment of Upper Urinary Tract Lithiasis. Eur Urol Open Sci. 2023 May;51:7–12.
7. Enikeev D., Taratkin M., Klimov R., Alyaev Y., Rapoport L., Gazimiev M., et al. Thulium-fiber laser for lithotripsy: first clinical experience in percutaneous nephrolithotomy. World J Urol. 2020;38(12):3069–74.
8. Enikeev D., Taratkin M., Klimov R., Inoyatov J., Azilgareeva C., Ali S., et al. Superpulsed Thulium Fiber Laser for Stone Dusting: In Search of a Perfect Ablation Regimen-A Prospective Single-Center Study. J Endourol. 2020;34(11):1175–9.
9. Enikeev D., Grigoryan V., Fokin I., Morozov A., Taratkin M., Klimov R., et al. Endoscopic lithotripsy with a SuperPulsed thulium-fiber laser for ureteral stones: A single-center experience. Int J Urol. 2021;28(3):261–5.
10. Fonseka T, Melchionna A, De Luyk N, Arumuham V, Noah AO, Choong S. 14F Super-Mini Percutaneous Cystolitholapaxy: A Novel Technique in the Treatment of Bladder Stones. J Endourol. 2023 Apr 1;37(4):422–7.
11. Geavlete B., Multescu R., Iordache V., Geavlete P. Romanian National premiere with the new Thulium SuperPulsed Laser in the endourological treatment of urolithiasis. J Med Life. 2021;14(3):316–22.
12. Geavlete B, Mareș C, Mulțescu R, Georgescu D, Geavlete P. Second-look flexible ureteroscopy after RIRS – Holmium Moses versus TFL (Soltive). J Med Life. 2022 Oct;15(10):1218–23.
13. Gupta A, Ganpule AP, Puri A, Singh AG, Sabnis RB, Desai MR. Comparative study of thulium fiber laser versus holmium:yttrium-aluminum-garnet laser for ureteric stone management with semi-rigid ureteroscopy: A prospective, single-center study. Asian J Urol. 2024 Jul;11(3):460–5.
14. Gupta R, Rahman Y, Mahajan A, Mehta A. Thulium fiber laser cystolithotripsy under local anesthesia: A day care procedure. Urol J. 2024 Feb;91(1):112–6.
15. Haas CR, Knoedler MA, Li S, Gralnek DR, Best SL, Penniston KL, et al. Pulse-modulated Holmium:YAG Laser vs the Thulium Fiber Laser for Renal and Ureteral

Stones: A Single-center Prospective Randomized Clinical Trial. J Urol. 2023 Feb;209(2):374–83.

16. Jaeger CD, Nelson CP, Cilento BG, Logvinenko T, Kurtz MP. Comparing Pediatric Ureteroscopy Outcomes with SuperPulsed Thulium Fiber Laser and Low-Power Holmium:YAG Laser. J Urol. 2022 Aug;208(2):426–33.
17. Korolev D, Akopyan G, Tsarichenko D, Shpikina A, Ali S, Chinenov D, et al. Minimally invasive percutaneous nephrolithotomy with SuperPulsed Thulium-fiber laser. Urolithiasis. 2021 Oct;49(5):485–91.
18. Mahajan A.D., Mahajan S.A. Thulium fiber laser versus holmium:yttrium aluminum garnet laser for stone lithotripsy during mini-percutaneous nephrolithotomy: A prospective randomized trial. Indian J Urol. 2022;38(1):42–7.
19. Martov AG, Ergakov DV, Guseynov M, Andronov AS, Plekhanova OA. Clinical Comparison of Super Pulse Thulium Fiber Laser and High-Power Holmium Laser for Ureteral Stone Management. J Endourol. 2021;35(6):795–800.
20. Michiels T, Niemeijer AS, Poerink JGH. Kortere operatieduur ongeacht hardheid van de steen met thulium fiber laser versus Holmium:YAG-laser. Tijdschr Voor Urol. 2024 Jan;14(1):2–7.
21. Nikoufar P, Hodhod A, Fathy M, Zakaria AS, Shabana W, Abdul Hadi R, et al. Thulium Fiber Laser *vs* Pulse-Modulated Holmium MOSES Laser in Flexible Ureteroscopy for the Management of Kidney Stones: A Single-Center Retrospective Analysis. J Endourol. 2023 Oct 1;37(10):1081–7.
22. Panthier F, Solano C, Chicaud M, Kutchukian S, Candela L, Doizi S, et al. Initial clinical experience with the pulsed solid-state thulium YAG laser from Dornier during RIRS: first 25 cases. World J Urol. 2023 Jul 6;41(8):2119–25.
23. Para SA, Hamid A, Ahmad Malik S, Rouf Khawaja A, Mehdi S. Incidence of Ureteric strictures Following Ureteroscopic Laser Lithotripsy: Holmium:YAG Versus Thulium Fiber Laser. Urol Res Pract. 2023 May 18;49(3):198–204.
24. Pathak N, Gowda N, Coelho V, Shete N, Singh A, Ganpule A, et al. Prospective Randomized Controlled Trial to Compare Dusting *vs* Fragmentation Using Thulium Fiber Laser in Retrograde Intrarenal Surgery. J Endourol. 2024 Feb 1;38(2):102–7.
25. Patil A, Reddy N, Shah D, Singh A, Ganpule A, Sabnis R, et al. High-Power Holmium with MOSES Technology or Thulium Fiber Laser in MiniPerc with Suction: A New Curiosity. J Endourol. 2022 Oct 1;36(10):1348–54.
26. Patil A., Sharma R., Shah D., Gupta A., Singh A., Ganpule A., et al. A prospective comparative study of mini-PCNL using TrilogyTM or thulium fibre laser with suction. World J Urol. 2022;40(2):539–43.
27. Perri D, Berti L, Pacchetti A, Morini E, Maltagliati M, Besana U, et al. A comparison among RIRS and MiniPerc for renal stones between 10 and 20 mm using thulium fiber laser (Fiber Dust): a randomized controlled trial. World J Urol. 2022 Aug 27;40(10):2555–60.
28. Ryan JR, Nguyen MH, Linscott JA, Nowicki SW, James E, Jumper BM, et al. Ureteroscopy with thulium fiber laser lithotripsy results in shorter operating times and large cost savings. World J Urol. 2022 Jun 21;40(8):2077–82.
29. Shah D, Patil A, Reddy N, Singh A, Ganpule A, Sabnis R, et al. A clinical experience of thulium fibre laser in miniperc to dust with suction: a new horizon. World J Urol. 2021 Jul 1;39(7):2727–32.

30. Sierra A, Corrales M, Kolvatzis M, Traxer O. Initial clinical experience with the thulium fiber laser from Quanta System: First 50 reported cases. World J Urol. 2022 Jul 21;40(10):2549–53.
31. Singh A, Vaddi CM, Ganesan S, Batra R, Ramakrishna P, Swamy S, et al. A multicentric non-randomized prospective observational study on the clinical efficiency of thulium fibre laser in large volume stones (> 1000 mm3). World J Urol. 2023 Jul 7;41(8):2289–95.
32. Solano C, Candela L, Panthier F, Corrales M, Traxer O. Initial experience with the graphical user interface for laser parameters setting of a new thulium fibre laser source device for urinary pathologies treatment. World J Urol. 2023 Oct 13;41(12):3765–71.
33. Taratkin M, Azilgareeva C, Chinenov D, Mikhailov V, Inoyatov J, Ali S, et al. Retrograde intrarenal surgery versus percutaneous nephrolithotomy in larger kidney stones. Could SuperPulsed Thulium-fiber laser change the game? Cent Eur J Urol. 2021;74(2):229–34.
34. Taratkin M, Azilgareeva C, Korolev D, Barghouthy Y, Tsarichenko D, Akopyan G, et al. Prospective Single-Center Study of SuperPulsed Thulium Fiber Laser in Retrograde Intrarenal Surgery: Initial Clinical Data. Urol Int. 2022;106(4):404–10.
35. Taratkin M, Azilgareeva C, Petov V, Morozov A, Ali S, Babaevskaya D, et al. Thulium fiber laser vs Ho:YAG in RIRS: a prospective randomized clinical trial assessing the efficacy of lasers and different fiber diameters (150 µm and 200 µm). World J Urol. 2023 Oct 19;41(12):3705–11.
36. Ulvik Ø, Æsøy MS, Juliebø-Jones P, Gjengstø P, Beisland C. Thulium Fibre Laser versus Holmium:YAG for Ureteroscopic Lithotripsy: Outcomes from a Prospective Randomised Clinical Trial. Eur Urol. 2022 Jul 1;82(1):73–9.
37. Vaddi CM, Ramakrishna P, Ganeshan S, Swamy S, Anandan H, Babu M, et al. The clinical efficiency and safety of 60W superpulse thulium fiber laser in retrograde intrarenal surgery. Indian J Urol. 2022 Jul;38(3):191–6.
38. Vergamini LB, Ito W, Choi B N, Du HE, Sardiu ME, Neff D, et al. Holmium:yttrium-aluminium-garnet laser with MOSES technology is more efficient than thulium fibre laser in supine mini-percutaneous nephrolithotomy. BJU Int. 2024 Aug;134(2):276–82.
39. Æsøy MS, Juliebø-Jones P, Beisland C, Ulvik Ø. Temperature profiles during ureteroscopy with thulium fiber laser and holmium:YAG laser: Findings from a pre-clinical study. Scand J Urol. 2022 Jul 4;56(4):313–9.
40. Amasyali AS, Clark T, Chen N, Farkouh A, Jhang D, Cheng KW, et al. Is Bigger Better? Comparison of 150 µm and 200 µm Thulium Fiber for In Situ Lower-Pole Lithotripsy. J Endourol. 2024 Oct 1;38(10):1104–9.
41. Andreeva V, Vinarov A, Yaroslavsky I, Kovalenko A, Vybornov A, Rapoport L, et al. Preclinical comparison of superpulse thulium fiber laser and a holmium:YAG laser for lithotripsy. World J Urol. 2020;38(2):497–503.
42. Basulto-Martínez M, Proietti S, Pavia MP, Yeow Y, Eisner BH, Giusti G. Understanding the ablation rate of Holmium:YAG and thulium fiber lasers. Perspectives from an in vitro study. Urolithiasis. 2023 Jan 17;51(1):32.
43. Belle JD, Chen R, Srikureja N, Amasyali AS, Keheila M, Baldwin DD. Does the Novel Thulium Fiber Laser Have a Higher Risk of Urothelial Thermal Injury than

the Conventional Holmium Laser in an In Vitro Study? J Endourol. 2022 Sep 1;36(9):1249–54.
44. Blackmon RL, Irby PB, Fried NM. Thulium fiber laser lithotripsy using tapered fibers. Lasers Surg Med. 2010;42(1):45–50.
45. Blackmon RL, Irby PB, Fried NM. Holmium:YAG (lambda = 2,120 nm) versus thulium fiber (lambda = 1,908 nm) laser lithotripsy. Lasers Surg Med. 2010;42(3):232–6.
46. Blackmon RL, Irby PB, Fried NM. Comparison of holmium:YAG and thulium fiber laser lithotripsy: ablation thresholds, ablation rates, and retropulsion effects. J Biomed Opt. 2011;16(7):071403.
47. Blackmon RL, Irby PB, Fried NM. Enhanced thulium fiber laser lithotripsy using micro-pulse train modulation. J Biomed Opt. 2012;17(2):028002.
48. Blackmon RL, Case JR, Trammell SR, Irby PB, Fried NM. Fiber-optic manipulation of urinary stone phantoms using holmium:YAG and thulium fiber lasers. J Biomed Opt. 2013;18(2):28001.
49. Blackmon RL, Hutchens TC, Hardy LA, Wilson CR, Irby PB, Fried NM. Thulium fiber laser ablation of kidney stones using a 50-µm-core silica optical fiber. Opt Eng. 2014 Aug 5;54(1):011004.
50. Buell MI, Amasyali AS, Chen N, Belle JD, Keheila M, Baldwin EA, et al. Thulium versus holmium for in situ lower pole laser lithotripsy. Can J Urol. 2022;29(6):11371–7.
51. Chen J, Mishra A, Medairos R, Antonelli J, Preminger GM, Lipkin ME, et al. In vitro investigation of stone ablation efficiency, char formation, spark generation, and damage mechanism produced by thulium fiber laser. Urolithiasis. 2023 Nov 2;51(1):124.
52. Chew BH, Koo KC, Halawani A, Lundeen CJ, Knudsen BE, Molina WR. Comparing dusting and fragmenting efficiency using the new SuperPulsed thulium fiber laser versus a 120 W Holmium:YAG laser. Investig Clin Urol. 2023;64(3):265.
53. Chicaud M, Kutchukian S, Berthe L, Corrales M, Solano C, Candela L, et al. In Vitro Comparison of Pulsed-Thulium:YAG, Holmium:YAG, and Thulium Fiber Laser. J Endourol. 2024 Dec 1;38(12):1427–35.
54. Ding T, Xu Z, Huang Z, Xiao B, Hu W, Li J. An in vitro study of irrigation rate, operator duty cycle and intrarenal temperature in superpulse fiber thulium laser lithotripsy. World J Urol. 2024 Oct 23;42(1):588.
55. Fried NM. Thulium fiber laser lithotripsy: An in vitro analysis of stone fragmentation using a modulated 110-watt Thulium fiber laser at 1.94 µm. Lasers Surg Med. 2005 Jul;37(1):53–8.
56. Hajiha M, Farkouh A, Amasyali AS, Buell MI, Leu R, Groegler J, et al. Which Laser System Is Optimal for Cystolithotripsy of Large Bladder Calculi? J Endourol. 2023 Nov 1;37(11):1221–7.
57. Hall LA, Gonzalez DA, Fried NM. Thulium fiber laser ablation of kidney stones using an automated, vibrating fiber. J Biomed Opt. 2019 Mar 26;24(03):1.
58. Hardy LA, Wilson CR, Irby PB, Fried NM. Thulium fiber laser lithotripsy in an in vitro ureter model. J Biomed Opt. 2014;19(12):128001.

59. Hutchens TC, Blackmon RL, Irby PB, Fried NM. Hollow steel tips for reducing distal fiber burn-back during thulium fiber laser lithotripsy. J Biomed Opt. 2013;18(7):078001.
60. Hutchens TC, Blackmon RL, Irby PB, Fried NM. Detachable fiber optic tips for use in thulium fiber laser lithotripsy. J Biomed Opt. 2013;18(3):038001.
61. Hutchens TC, Gonzalez DA, Irby PB, Fried NM. Fiber optic muzzle brake tip for reducing fiber burnback and stone retropulsion during thulium fiber laser lithotripsy. J Biomed Opt. 2017;22(1):18001.
62. Huusmann S, Lafos M, Meyenburg I, Muschter R, Teichmann HO, Herrmann T. Tissue effects of a newly developed diode pumped pulsed Thulium:YAG laser compared to continuous wave Thulium:YAG and pulsed Holmium:YAG laser. World J Urol. 2021 Sep;39(9):3503–8.
63. Jiang P, Peta A, Brevik A, Arada R, Ayad M, Afyouni A, et al. Ex Vivo Renal Stone Dusting: Impact of Laser Modality, Ureteral Access Sheath, and Suction on Total Stone Clearance. J Endourol. 2022 Apr 1;36(4):499–507.
64. Jiang P, Okhunov Z, Afyouni AS, Ali S, Hosseini Sharifi SH, Bhatt R, et al. Comparison of Superpulse Thulium Fiber Laser vs Holmium Laser for Ablation of Renal Calculi in an In Vivo Porcine Model. J Endourol. 2023 Mar 1;37(3):335–40.
65. Johnson J, Lee J, Movassaghi M, Han D, Pingle SR, Williams J, et al. Comparative Analyses and Ablation Efficiency of Thulium Fiber Laser by Stone Composition. J Urol. 2024 Mar;211(3):445–54.
66. Kamal W, Kallidonis P, Koukiou G, Amanatides L, Panagopoulos V, Ntasiotis P, et al. Stone Retropulsion with Ho: YAG and Tm: YAG Lasers: A Clinical Practice-Oriented Experimental Study. J Endourol. 2016;30(11):1145–9.
67. Keller EX, De Coninck V, Doizi S, Daudon M, Traxer O. Thulium fiber laser: ready to dust all urinary stone composition types? World J Urol. 2021 Jun;39(6):1693–8.
68. Kılınç MT, Özkent MS, Pişkin MM, Göger YE. Investigation of gaseous end products produced by thulium fiber laser lithotripsy of cystine, uric acid, and calcium oxalate monohydrate stones: A gas chromatographic and electron microscopic analysis. Urolithiasis. 2024 Sep 6;52(1):125.
69. Kraft L, Petzold R, Suarez-Ibarrola R, Miernik A. In vitro fragmentation performance of a novel, pulsed Thulium solid-state laser compared to a Thulium fibre laser and standard Ho:YAG laser. Lasers Med Sci. 2022;37(3):2071–8.
70. Kraft L, Yilmaz M, Petzold R, Gratzke C, Suarez-Ibarrola R, Miernik A. Dusting Efficiency of a Novel Pulsed Thulium:Yttrium Aluminum Garnet Laser vs a Thulium Fiber Laser. J Endourol. 2022;36(2):259–65.
71. Kutchukian S, Doizi S, Lapouge P, Germain T, Dragos L, Berthe L, et al. Ablation rates with Holmium:YAG and Thulium Fiber Laser: Influence of the stone phantom homogeneity. An in vitro study. Prog En Urol. 2023 Aug;33(8–9):456–62.
72. Kwok JL, Ventimiglia E, De Coninck V, Corrales M, Sierra A, Panthier F, et al. Pulsed thulium:YAG laser—ready to dust all urinary stone composition types? Results from a PEARLS analysis. World J Urol. 2023 Aug 16;41(10):2823–31.
73. Kwok JL, Ventimiglia E, De Coninck V, Panthier F, Barghouthy Y, Danilovic A, et al. Pulsed Thulium:YAG laser – What is the lithotripsy ablation efficiency for stone dust from human urinary stones? Results from an in vitro PEARLS study. World J Urol. 2023 Oct 13;41(12):3723–30.

74. Liu M, Peng Y, Wang Z, Li L, Ming S, Fang Z, et al. Ablation Efficiency of a Novel Thulium Fiber Laser: An In Vitro Study on Laser Setting and Fiber Usage. J Endourol. 2021 Aug 1;35(8):1211–6.
75. Li Z, Wu S, Liu T, Li S, Wang X. Optimal parameter settings of thulium fiber laser for ureteral stone lithotripsy: a comparative study in two different testing environments. Urolithiasis. 2024 May 27;52(1):78.
76. Martov A, Adilkhanov M, Andronov A, Altshuler G, Yaroslavsky I, Kovalenko A, et al. Treatment of Urolithiasis with Thulium Fiber Laser in Fragmentation Mode Using Optimized Pulse Sequences. J Endourol. 2024 Oct 1;38(10):1097–103.
77. Miller CS, Whiles BB, Ito WE, Machen E, Thompson JA, Duchene DA, et al. Image Distortion During Flexible Ureteroscopy: A Laboratory Model Comparing Super Pulsed Thulium Fiber Laser vs High-Power Ho:YAG Laser. J Endourol. 2023 Jan 1;37(1):99–104.
78. Mishra A, Medairos R, Chen J, Soto-Palou F, Wu Y, Antonelli J, et al. Exploring optimal settings for safe and effective thulium fibre laser lithotripsy in a kidney model. BJU Int. 2024 Feb;133(2):223–30.
79. Molina WR, Carrera RV, Chew BH, Knudsen BE. Temperature rise during ureteral laser lithotripsy: comparison of super pulse thulium fiber laser (SPTF) vs high power 120 W holmium-YAG laser (Ho:YAG). World J Urol. 2021;39(10):3951–6.
80. Nakao K, Yoshida T, Takayasu K, Chuman K, Matsunaga T, Kinoshita H. Comparison of the efficacy of a pulsed thulium:YAG laser versus a holmium: YAG laser on dusting lithotripsy: In vitro analysis using an optical motion capture system. Int J Urol. 2024 Nov;31(11):1288–90.
81. Okhunov Z., Jiang P., Afyouni A.S., Ayad M., Arada R., Brevik A., et al. Caveat Emptor: The Heat Is ON-An in Vivo Evaluation of the Thulium Fiber Laser and Temperature Changes in the Porcine Kidney during Dusting and Fragmentation Modes. J Endourol. 2021;35(11):1716–22.
82. Pal D., Chowdhury S.D., Dhar A., Saraf S., Maiti K., Pal D.K., et al. Ex vivo testing of air-cooled CW/modulated 30W thulium fiber laser for lithotripsy. Appl Opt. 2019;58(25):6720–4.
83. Panthier F, Doizi S, Lapouge P, Chaussain C, Kogane N, Berthe L, et al. Comparison of the ablation rates, fissures and fragments produced with 150 microm and 272 microm laser fibers with superpulsed thulium fiber laser: an in vitro study. World J Urol. 2021;39(6):1683–91.
84. Panthier F., Germain T., Gorny C., Berthe L., Doizi S., Traxer O. Laser fiber displacement velocity during tm-fiber and ho:Yag laser lithotripsy: Introducing the concept of optimal displacement velocity. J Clin Med. 2022;11(1):181.
85. Panthier F, Chicaud M, Doizi S, Kutchukian S, Lapouge P, Solano C, et al. How much energy do we need to ablate 1 cubic millimeter of stone during Thulium Fiber Laser lithotripsy? An in vitro study. World J Urol. 2024 Jan 27;42(1):57.
86. Peng Y, Liu M, Ming S, Yu W, Li L, Lu C, et al. Safety of a Novel Thulium Fiber Laser for Lithotripsy: An In Vitro Study on the Thermal Effect and Its Impact Factor. J Endourol. 2020 Jan 1;34(1):88–92.
87. Peteinaris A, Tsaturyan A, Bravou V, Tatanis V, Faria-Costa G, Pagonis K, et al. High-power laser lithotripsy – do we treat or harm? Histological evaluation of

temperature effects in an in vivo study with thulium fibre laser. Cent Eur J Urol. 2023;76(1):44–8.

88. Petzold R, Miernik A, Suarez-Ibarrola R. Retropulsion force in laser lithotripsy-an in vitro study comparing a Holmium device to a novel pulsed solid-state Thulium laser. World J Urol. 2021;39(9):3651–6.
89. Petzold R, Miernik A, Suarez-Ibarrola R. In Vitro Dusting Performance of a New Solid State Thulium Laser Compared to Holmium Laser Lithotripsy. J Endourol. 2021;35(2):221–5.
90. Petzold R, Suarez-Ibarrola R, Miernik A. Gas Bubble Anatomy During Laser Lithotripsy: An Experimental In Vitro Study of a Pulsed Solid-State Tm:YAG and Ho:YAG Device. J Endourol. 2021;35(7):1051–7.
91. Scott NJ, Cilip CM, Fried NM. Thulium Fiber Laser Ablation of Urinary Stones Through Small-Core Optical Fibers. IEEE J Sel Top Quantum Electron. 2009;15(2):435–40.
92. Shen Z, Liang J, Xie L, Liu C. Ablation efficiency and laser safety of a novel superpulsed thulium fiber laser: a in vitro study. World J Urol. 2024 Oct 4;42(1):561.
93. Sierra A, Corrales M, Kolvatzis M, Panthier F, Piñero A, Traxer O. Thermal Injury and Laser Efficiency with Holmium YAG and Thulium Fiber Laser—An In Vitro Study. J Endourol. 2022 Dec 1;36(12):1599–606.
94. Sierra A, Corrales M, Somani B, Traxer O. Laser Efficiency and Laser Safety: Holmium YAG vs. Thulium Fiber Laser. J Clin Med. 2022 Dec 24;12(1):149.
95. Sierra A, Panthier F, Castillo E, Mercadé A, Peri L, Alcaraz A, et al. Assessment of Holmium:YAG, Pulsed-Thulium:YAG and Thulium Fiber Lasers for Urinary Stone Ablation. In Vitro Study. J Endourol. 2024 Sep 24;end.2024.0349.
96. Sierra A, Solano C, Corrales M, Ventimiglia E, Panthier F, Kwok JL, et al. Steady-state versus burst lasing techniques for thulium fiber laser. World J Urol. 2024 Aug 19;42(1):487.
97. Soto-Palou F, Chen J, Medairos R, Zhong P, Antonelli J, Preminger GM, et al. In Pursuit of the Optimal Dusting Settings with the Thulium Fiber Laser: An In Vitro Assessment. J Endourol. 2023 Aug 1;37(8):914–20.
98. Taratkin M, Laukhtina E, Singla N, Kozlov V, Abdusalamov A, Ali S, et al. Temperature changes during laser lithotripsy with Ho:YAG laser and novel Tm-fiber laser: a comparative in-vitro study. World J Urol. 2020;38(12):3261–6.
99. Taratkin M., Azilgareeva C., Corrales M., Teoh J.Y.-C., Allenov S., Inoyatov J., et al. Superpulse thulium fiber laser lithotripsy: an in vitro comparison of 200 mum and 150 mum laser fibers. World J Urol. 2021;39(12):4459–64.
100. Taratkin M, Laukhtina E, Singla N, Tarasov A, Alekseeva T, Enikeev M, et al. How Lasers Ablate Stones: In Vitro Study of Laser Lithotripsy (Ho:YAG and Tm-Fiber Lasers) in Different Environments. J Endourol. 2021;35(6):931–6.
101. Tianfu D, Bo X, Xue Z, Lei L, Chaoyue J, Jianxing L. Study of Temperature Changes around Fibres in Super Pulse Thulium Fibre Laser in Vitro Lithotripsy. Urol J. 2023 Jan 4;20(2):96–101.
102. Wanderling C, Saxton A, Phan D, Doersch KM, Shepard L, Schuler N, et al. Getting hot in here! Comparison of Holmium vs. thulium laser in an anatomic hydrogel kidney model. Urolithiasis. 2024 Mar 23;52(1):49.

103. Wilson CR, Hardy LA, Irby PB, Fried NM. Collateral damage to the ureter and Nitinol stone baskets during thulium fiber laser lithotripsy. Lasers Surg Med. 2015;47(5):403–10.
104. Wilson CR, Hutchens TC, Hardy LA, Irby PB, Fried NM. A Miniaturized, 1.9F Integrated Optical Fiber and Stone Basket for Use in Thulium Fiber Laser Lithotripsy. J Endourol. 2015;29(10):1110–4.
105. Wilson CR, Hardy LA, Kennedy JD, Irby PB, Fried NM. Miniature ball-tip optical fibers for use in thulium fiber laser ablation of kidney stones. J Biomed Opt. 2016 Jan 19;21(1):018003.
106. Yang B, Ray A, Zhang JJ, Peng S, O'Brien M, Turney B. Stone ablation efficacy: a comparison of a thulium fibre laser and two pulse-modulated holmium:YAG lasers. Urolithiasis. 2023 Jan 12;51(1):31.
107. Zhang JJ, Rajabhandharaks D, Xuan JR, Wang H, Chia RWJ, Hasenberg T, et al. Water content contribution in calculus phantom ablation during Q-switched Tm:YAG laser lithotripsy. J Biomed Opt. 2015 Dec 10;20(12):128001.