Supplementary Table S1. PRISMA-S Checklist

Section/topic	#	Checklist item	Location(s) Reported
INFORMATION SOURCES AND METHODS			
Database name	1	Name each individual database searched, stating the platform for each.	1,3-4,7
Multi-database searching	2	If databases were searched simultaneously on a single platform, state the name of the platform, listing all of the databases searched.	NR
Study registries	3	List any study registries searched.	4
Online resources and browsing	4	Describe any online or print source purposefully searched or browsed (e.g., tables of contents, print conference proceedings, web sites), and how this was done.	NR
Citation searching	5	Indicate whether cited references or citing references were examined, and describe any methods used for locating cited/citing references (e.g., browsing reference lists, using a citation index, setting up email alerts for references citing included studies).	NR
Contacts	6	Indicate whether additional studies or data were sought by contacting authors, experts, manufacturers, or others.	NR
Other methods	7	Describe any additional information sources or search methods used.	NR
SEARCH STRATEGIES			
Full search strategies	8	Include the search strategies for each database and information source, copied and pasted exactly as run.	7
Limits and restrictions	9	Specify that no limits were used, or describe any limits or restrictions applied to a search (e.g., date or time period, language, study design) and provide justification for their use.	3-4
Search filters	10	Indicate whether published search filters were used (as originally designed or modified), and if so, cite the filter(s) used.	NR
Prior work	11	Indicate when search strategies from other literature reviews were adapted or reused for a substantive part or all of the search, citing the previous review(s).	NR

Updates	12	Report the methods used to update the search(es) (e.g., rerunning searches, email alerts).	3-4
Dates of searches	13	For each search strategy, provide the date when the last search occurred.	3-4
PEER REVIEW			
Peer review	14	Describe any search peer review process.	NR
MANAGING RECORDS			
Total Records	15	Document the total number of records identified from each database and other information sources.	4,8
Deduplication	16	Describe the processes and any software used to deduplicate records from multiple database searches and other information sources.	4

NR= Not reported

Supplementary Table S2. Bibliographic search strategy.

Engine	Strategy	Results
PUBMED	#1= ("Robotic Surgical Procedures" OR "Procedure, Robot-Enhanced" OR "Procedure, Robotic Surgical" OR "Procedures, Robot-Enhanced" OR "Procedures, Robotic Surgical" OR "Robot Assisted Surgery" OR "Robot Enhanced Procedures" OR "Robot Enhanced Surgery" OR "Robot Surgeries" OR "Robot Surgery" OR "Robot-Assisted Surgeries" OR "Robot-Assisted Surgery" OR "Robot-Enhanced Procedure" OR "Robot-Enhanced Procedures" OR "Robot-Enhanced Surgeries" OR "Robot-Enhanced Surgery" OR "Robotic Assisted Surgery" OR "Robotic Surgical Procedure" OR "Robotic-Assisted Surgeries" OR "Robotic-Assisted Surgery" OR "Surgeries, Robot-Enhanced" OR "Surgery, Robot" OR "Surgery, Robot-Assisted" OR "Surgery, Robot-Enhanced" OR "Surgery, Robotic-Assisted" OR "Surgical Procedure, Robotic" OR "Surgical Procedures, Robotic")	2
	#2= ("Education, Medical, Graduate" OR "Education, Graduate Medical" OR "Graduate Medical Education" OR "Medical Education, Graduate")	
	#3 = #1 AND #2	
SCOPUS	#1= TITLE-ABS-KEY ("Robotic Surgical Procedures" OR "Procedure, Robot-Enhanced" OR "Procedure, Robotic Surgical" OR "Procedures, Robot-Enhanced" OR "Procedures, Robotic Surgical" OR "Robot Assisted Surgery" OR "Robot Enhanced Procedures" OR "Robot Enhanced Surgery" OR "Robot Surgeries" OR "Robot Surgery" OR "Robot-Assisted Surgeries" OR "Robot-Assisted Surgery" OR "Robot-Enhanced Procedure" OR "Robot-Enhanced Procedures" OR "Robot-Enhanced Surgeries" OR "Robot-Enhanced Surgery" OR "Robotic Assisted Surgery" OR "Robotic Surgical Procedure" OR "Robotic-Assisted Surgeries" OR "Robotic-Assisted Surgery" OR "Surgeries, Robot-Enhanced" OR "Surgery, Robot" OR "Surgery, Robot-Assisted" OR "Surgery, Robot-Enhanced" OR "Surgery, Robotic-Assisted" OR "Surgical Procedure, Robotic" OR "Surgical Procedures, Robotic")	1
	#2= TITLE-ABS-KEY ("Education, Medical, Graduate" OR "Education, Graduate Medical" OR "Graduate Medical Education" OR "Medical Education, Graduate")	
	#3 = #1 AND #2	
WEB OF SCIENCE	#1= ("Robotic Surgical Procedures" OR "Procedure, Robot-Enhanced" OR "Procedure, Robotic Surgical" OR "Procedures, Robot-Enhanced" OR "Procedures, Robotic Surgical" OR "Robot Assisted Surgery" OR "Robot Enhanced Procedures" OR "Robot	2

	Enhanced Surgery" OR "Robot Surgeries" OR "Robot Surgery" OR "Robot-Assisted Surgeries" OR "Robot-Assisted Surgery" OR "Robot-Enhanced Procedure" OR "Robot-Enhanced Procedures" OR "Robot-Enhanced Surgeries" OR "Robot-Enhanced Surgery" OR "Robotic Assisted Surgery" OR "Robotic Surgical Procedure" OR "Robotic-Assisted Surgeries" OR "Robotic-Assisted Surgery" OR "Surgeries, Robot-Enhanced" OR "Surgery, Robot" OR "Surgery, Robot-Assisted" OR "Surgery, Robot-Enhanced" OR "Surgery, Robotic-Assisted" OR "Surgical Procedure, Robotic" OR "Surgical Procedures, Robotic")	
	#2= ("Education, Medical, Graduate" OR "Education, Graduate Medical" OR "Graduate Medical Education" OR "Medical Education, Graduate")	
	#3 = #1 AND #2	

Supplementary Table S3. Characteristics of included studies (part 1).

Author(s)	Year of publication	Country of origin	Aim/purpose	Population and sample size	Methodology/ study design	Intervention Type and Comparator (if applicable)	Intervention Duration (if applicable)	Outcomes (and how measured)
Mehmet Emin Aksoy, Kurtulus Izzetoglu, Nihat Zafer Utkan, Atahan Agrali, Serhat Ilgaz Yoner, Ashley Bishop, Patricia A. Shewokis	2025	Türkiye (Acibadem Mehmet Ali Aydinlar University) and USA (Drexel University)	To compare the cognitive workload levels of general surgery residents by measuring prefrontal cortex hemodynamic activity during robotic-assisted and laparoscopic simulated tasks.	22 general surgery residents (mean age 29.45 ± 2.40 years; 81.82% male).	Experimental comparative study with randomized order of simulation tasks; data collected over a one-month period.	Robotic-assisted surgery (Da Vinci Surgical System Si simulator) vs laparoscopic surgery (LapVR simulator).	1-month training period; each participant performed repeated peg transfer tasks with breaks.	Performance time, prefrontal cortex oxygenated hemoglobin (fNIRS), Relative Neural Efficiency (RNE), Relative Neural Involvement (RNI).
Kevin Neuzil, Eric Wallen, John R. Potts III, Molly E. DeWitt-Foy	2025	USA (University of North Carolina, Medical University of South Carolina, Accreditation Council for Graduate Medical Education, Cleveland Clinic Foundation)	To describe changes in resident-reported case log data for reconstructive urology surgeries, specifically female reconstructive cases, from 2010 to 2022.	Graduating urology residents (national-level ACGME case logs, aggregated data 2010–2022). Exact sample size not specified as individual data unavailable.	Retrospective analysis of national ACGME case log data for urology residents, categorized by procedure type and resident-reported role.	Comparison across time (2010–2022) of reconstructive urology cases logged by residents, by role (surgeon, assistant, teaching assistant).	2010–2022 (12-year retrospective study period).	Trends in case logs by role and category; Spearman's correlation for time trends; subgroup analysis by male, female, and intestinal diversion procedures.

Charles Evans, Taner Shakir, Charlotte El-Sayed, Deena P. Harji, Danilo Miskovic, Irshad Shaikh, Jim Khan, James Kinross, Richard Justin Davies, on behalf of The Dukes' Club and The Association of Coloproctology of Great Britain and Ireland (ACPGBI) Robotic Clinical Advisory Group	2025	United Kingdom and Ireland	To provide a position statement by the ACPGBI on robotic-assisted colorectal surgical training, addressing inequalities in access, impact on trainees, and proposing a structured training framework.	Not applicable (position statement; includes trainees, trainers, consultants, and surgical education stakeholders in the UK and Ireland).	Expert consensus and position statement informed by national policy documents, surgical organizations, and ACPGBI advisory groups.	Position statement outlining recommendations for training at basic, advanced, and trainer levels. No direct comparator.	NR	Framework recommendations for robotic training: basic training (simulation and theoretical modules), advanced training (component-based procedures, accredited courses, fellowships), and training the trainers (structured courses).
Samuel S. Kim, Lana Schumacher, David T. Cooke, Elliot Servais, David Rice, Inderpal Sarkaria, Stephen Yang, Abbas Abbas, Manu Sanchetti, Jason Long, Svetlana Kotova, Bernard J. Park, Desmond D'Souza, Mansi Shah-Jadeja, Hana Ajouz, Luis Godoy, Nataliya Bahatyrevich, Jeremiah Hayanga, John Lazar, on behalf of The Society of Thoracic Surgeons Task Force on Robotic Thoracic Surgery and Workforce on E-learning and Educational Innovation	2025	United States (multicenter, representing STS institutions nationwide)	To provide an expert consensus statement from The Society of Thoracic Surgeons on a standardized national robotic curriculum for thoracic surgery trainees, addressing program expectations, training components, and assessment/feedback strategies.	Not applicable (expert consensus document; stakeholders include thoracic surgery educators, trainees, and program directors).	Expert consensus using a modified Delphi process, supported by literature review (2004–2024), and structured into three domains: program expectations, training components, and assessment/feedback.	Framework recommendations for standardized robotic thoracic training; no comparator group.	NR	Twelve consensus recommendations including: requirement for standardized national curriculum, use of dual console, bedside assistant training, VR and wet lab simulations, annual emergency conversion training, case-specific milestones, video-based preparation and review, GEARS and OSATS for assessment, and Entrustable Professional Activities (EPAs).
Michael G. Fadel, Josephine Walshaw, Francesca Pecchini, Marina Yiasemidou, Matthew Boal, Muhammed Elhadi, Matyas Fehervari, Lisa H. Massey, Francesco Maria	2025	Pan-European (38 European countries; major contributions	To capture the current state of robotic training in gastrointestinal surgery across Europe and identify	1045 valid responses from 1360 participants: 284 experts/indepe	Cross-sectional pan-European online survey (December 2023–March 2024), distributed via	Not applicable; survey-based study with comparative subgroup analyses	Data collection over 3 months (Dec 2023–Mar	Reported access to training, simulator availability, dual console use, training frequency, assessment methods, barriers

Carrano, Stavros A. Antoniou, Felix Nickel, Silvana Perretta, Hans F. Fuchs, George B. Hanna, Christos Kontovounisios, Nader K. Francis, on behalf of the European Robotic Surgery Consensus (ERSC) study group		from Germany, Italy, UK, Greece, France)	challenges, barriers, and potential solutions, in order to guide the development of a standardized robotic training curriculum.	ndent surgeons, 258 trainees with robotic access, 480 trainees without access, 23 industry representatives.	surgical societies, industry contacts, and social media; analyzed with descriptive and comparative statistics.	(experts, trainees with/without access, industry).	2024).	encountered, and opinions on timing of training and competency milestones.
Robert B. Laverty, Charles H. Chesnut, Joseph R. Karam, Joseph C. L'Huillier, Alexander Bonte, Julie M. Clanahan, Jisuk Park, Brian Yoon, Robert W. Krell	2025	United States (multi-institutional: Brooke Army Medical Center, University at Buffalo, Hackensack University Medical School, Washington University in St. Louis, etc.)	To evaluate the validity of C-SATS (Crowd-Sourced Assessment of Technical Skill) platform using the Global Evaluative Assessment of Robotic Skills (GEARS) rubric in robotic-assisted cholecystectomy (RAC) and inguinal hernia repair (RIHR), correlating scores with surgeon experience and case volume.	48 surgeons (senior residents, fellows, practicing physicians) who submitted 70 videos (RAC and RIHR).	Multi-institutional cross-sectional cohort study; blinded video reviews via C-SATS platform; correlation of GEARS scores with case volume and operative time.	Comparison of GEARS scores between residents/fellows and practicing surgeons, and between surgeons with <50 vs ≥50 prior cases.	NR (single submission per participant; videos performed within the year prior to submission).	Primary outcome: correlation of GEARS scores with historic case volume. Secondary: construct validity of GEARS scores as proficiency metric. Measurements: GEARS domain scores, case duration, correlation coefficients.
Matthew Harris, Aidan Bannon, Justin W. Collins, on behalf of the Association of Surgeons in Training and the Robotic and Digital Surgery Trainee's Committee	2025	United Kingdom	To determine consensus among UK surgical trainees on the essential components of procedural robotic training, including curricula, credentialing,	85 surgical trainees representing multiple specialties and grades (medical students, FY1–FY2, CST1–2,	Trainee-led Delphi consensus study with three survey rounds; consensus defined as ≥80% agreement or disagreement.	Consensus process; no comparator group.	27-day Delphi process (three iterative rounds).	Consensus achieved for 82 of 141 statements. Key recommendations included: integration of robotic training into surgical curricula, platform-agnostic training, benchmarking,

			assessment standards, error metrics, and access to training.	clinical fellows, ST3–ST8, post-CCT fellows).				proficiency-based progression, video-based assessments, revalidation every 5 years, and central registries for robotic cases.
Shujaa T. Khan, Benjamin E. Jevnikar, Ahmed K. Emara, Peter G. Delaney, Khaled A. Elmenawi, Peter A. Surace, Nicolas S. Piuzzi, Matthew Deren	2025	United States (Cleveland Clinic Foundation, Orthopedic and Rheumatology Institute)	To synthesize current literature on the educational impact of robotic-assisted total joint arthroplasty (RA-TJA) on residency and fellowship training in orthopedics, with focus on technical skill acquisition, case exposure, autonomy, cognitive engagement, and simulation integration.	Not applicable (narrative review synthesizing empirical studies, surveys, and expert opinion).	Narrative literature review of PubMed, MEDLINE, and Google Scholar studies (empirical, survey, expert consensus) regarding RA-TJA and surgical education.	Narrative synthesis of RA-TJA education; comparator is conventional manual arthroplasty in discussed studies.	NR	Improved implant positioning accuracy, alignment, and gap balancing; early technical proficiency; use of intraoperative metrics for competency; concerns regarding reduced manual skills and autonomy; varied institutional access; benefits of simulation and VR for training.
Noama Iftekhar, Kathryn Cataldo, Seungwon Jong Seo, Brett Allen, Casey Giles, Matthew William Kelecy, Joshua MacDavid, Richard C. Baynosa	2025	United States (University of Nevada, Las Vegas School of Medicine)	To report institutional outcomes of robotic-assisted rectus abdominis myoperitoneal (RRAM) flap for posterior vaginal wall reconstruction and review current literature on robotic-assisted pelvic reconstruction.	32 patients underwent robotic pelvic reconstruction; 5 patients (mean age 56.2 years, range 32–78; mean BMI 30.0, range 24–39.9) underwent posterior vaginal wall	IRB-approved retrospective review (2014–2024) of patients undergoing robotic pelvic reconstruction at a single institution, with descriptive statistics and case-based qualitative	Robotic-assisted rectus abdominis myoperitoneal flap harvest and reconstruction; no direct comparator group (literature comparisons to open VRAM	2014–2024 (10-year review period).	Successful flap integration, minor wound complications (40%), vaginal stenosis (20% after 8 years), no major complications or reoperations; outcomes measured by complication rates and postoperative healing.

				reconstruction using RRAM flap.	analysis.	techniques).		
Noriyuki Abe, Takashige Abe, Kanta Hori, Junya Abe, Kazufumi Okada, Keita Takahashi, Shigeru Harada, Masafumi Kon, Jun Furumido, Kohei Hashimoto, Sachiyo Murai, Hiroshi Kikuchi, Naoya Masumori, Hidehiro Kakizaki, Nobuo Shinohara	2025	Japan	To clarify the current state and challenges in urological surgical training in Japan and identify areas requiring improvement.	169 participants (85 trainees with <15 years of experience, 84 instructors with >15 years of experience) from 3 university hospitals and 34 affiliated hospitals in Hokkaido.	Cross-sectional needs assessment survey via web-based and paper questionnaires; quantitative and qualitative analysis with Likert scales and narrative responses.	Needs assessment survey; no direct comparator group.	Survey conducted in 2021 over a 2-month period with follow-up reminders.	High response rate (98.2%). Key findings: surgical training largely based on 'on-the-job' methods; 87.1% of trainees and 96.4% of instructors lacked dedicated training time; open surgery undertrained according to 58.8% of trainees; 54.8% of instructors acknowledged limitations of current program. Measurements included Likert scale ratings and frequency analyses.

NR = Not Reported

Supplementary Table S3. Characteristics of included studies (part 2).

Author(s)	Access	Curriculum	Support	Experience	Evaluation	Barriers	Outcomes
Mehmet Emin Aksoy, Kurtulus Izzetoglu, Nihat Zafer Utkan, Atahan Agrali, Serhat Ilgaz Yoner, Ashley Bishop, Patricia A. Shewokis	All participants had access to both laparoscopic and robotic simulators; none had prior RAS experience, most had laparoscopic experience.	Simulation-based tasks (peg transfer/peg board exercises) with standard familiarization and instructor briefing.	Study conducted at a simulation center (CASE, Acibadem University) with expert instructor support.	Residents were console operators in simulations; prior laparoscopic experience (1 month–4 years); no RAS experience.	Objective simulator metrics, fNIRS cognitive workload measurement, and neurophysiological indices (RNE, RNI). No credentialing process mentioned.	Lack of prior RAS exposure among residents; only short-term training assessed; generalizability limited to simulated environment.	Robotic tasks had shorter task times, lower cognitive workload, higher RNE and RNI compared to laparoscopic tasks, indicating better efficiency and reduced mental demand.
Kevin Neuzil, Eric Wallen, John R. Potts III, Molly E. DeWitt-Foy	All urology residents required to log cases in the ACGME system; national-level exposure evaluated.	ACGME-mandated case logging system; case minimums defined by CPT categories; STROBE reporting checklist followed.	Data aggregated nationally; institutional or program-level support not specified (NR).	Residents self-reported role in cases as surgeon, assistant, or teaching assistant; trends showed declining surgeon roles and increasing assistant roles, especially in female	Assessment through ACGME case logs, categorized by CPT codes and resident-reported role; no formal credentialing included.	Decreased opportunities for independent surgeon role in female reconstructive cases; increased reliance on robotic surgery limiting console experience; overlap with urogynecology; COVID-19	Overall reconstructive case volume increased, but residents reported fewer cases as primary surgeon, particularly in female cases. Trends suggest risk of reduced preparedness for independent practice.

				reconstructive cases.		pandemic disruptions; rise of subspecialty fellows; limited teaching consoles.	
Charles Evans, Taner Shakir, Charlotte El-Sayed, Deena P. Harji, Danilo Miskovic, Irshad Shaikh, Jim Khan, James Kinross, Richard Justin Davies, on behalf of The Dukes' Club and The Association of Coloproctology of Great Britain and Ireland (ACPGBI) Robotic Clinical Advisory Group	Highlighted inequalities in robotic access across the UK and Ireland; centralized access in Scotland and Wales but variable elsewhere; limited simulator and trainer availability for junior trainees.	Structured training proposed at three levels: basic (simulation, theoretical modules), advanced (component-based colorectal procedures, accredited courses, fellowships), and train-the-trainer programs.	Supported by ACPGBI, Dukes' Club, Royal Colleges, NHS England, and industry partnerships. Accredited standardized courses and fellowships proposed.	Reported frustrations of trainees regarding limited access to robotic platforms and training opportunities; emphasis on early exposure, simulator use, bedside assistance, and progression through structured curriculum.	Recommendations for objective assessments of robotic skills and procedural competence; emphasis on standardized accreditation and platform-agnostic training. No direct credentialing system yet in place.	Inequalities in access to robotic systems, lack of national regulation, dependence on industry pathways, limited access to simulators and trainers, overlap between consultant and trainee training needs, and medico-legal challenges.	ACPGBI framework aims to ensure safer, better-trained robotic colorectal surgeons, improved trainee satisfaction, equitable access to robotic training, and ultimately better patient outcomes.
Samuel S. Kim, Lana Schumacher, David T. Cooke, Elliot Servais, David Rice, Inderpal Sarkaria, Stephen Yang, Abbas Abbas, Manu Sanchetti, Jason Long, Svetlana Kotova, Bernard	Noted variability across ACGME programs; approximately half with structured	Proposed standardized national robotic curriculum including online modules, in-	Endorsed and developed by The Society of Thoracic Surgeons, with input from Thoracic Surgery	Expectations for trainees to progress from bedside assistant to console surgeon; requirement to	Objective assessment tools recommended (GEARS, OSATS, ARCS, binary metrics); video-based evaluations;	Educational gap due to lack of standardized curriculum; reliance on costly industry-sponsored training;	Framework aims to standardize training, reduce variability, improve safety and patient outcomes, enhance trainee

J. Park, Desmond D'Souza, Mansi Shah-Jadeja, Hana Ajouz, Luis Godoy, Nataliya Bahatyrevich, Jeremiah Hayanga, John Lazar, on behalf of The Society of Thoracic Surgeons Task Force on Robotic Thoracic Surgery and Workforce on E-learning and Educational Innovation	robotic curricula; reliance on industry-sponsored training; disparities in access to dual consoles and simulators across institutions.	service training, VR simulation, wet labs, bedside assisting, case-specific milestones for anatomic resections, emergency conversion simulations, and video review.	Directors' Association; recommendation for institutional adoption of structured robotic training and provision of resources (dual consoles, wet labs, video libraries).	complete VR modules with proficiency, bedside assisting (≥10 cases, ≥5 thoracic), and graded autonomy with case milestones; emphasis on preparedness and self-assessment via video review.	development of Entrustable Professional Activities (EPAs) for pulmonary resections; annual video-based evaluations proposed.	variability across ACGME programs; absence of tactile feedback in robotic systems; limited institutional resources; medico-legal and economic challenges in sustaining bedside assistants and dual consoles.	proficiency and autonomy, and address disparities in robotic thoracic surgical education across institutions.
Michael G. Fadel, Josephine Walshaw, Francesca Pecchini, Marina Yiasemidou, Matthew Boal, Muhammed Elhadi, Matyas Fehervari, Lisa H. Massey, Francesco Maria Carrano, Stavros A. Antoniou, Felix Nickel, Silvana Perretta, Hans F. Fuchs, George B. Hanna, Christos Kontovounisios, Nader K. Francis, on behalf of the European Robotic Surgery Consensus (ERSC) study group	Only 64.3% of respondents reported having a robotic console in their hospital; simulator access limited (32.2% trainees had access during working hours); 68.0% unaware of a dedicated curriculum;	Currently fragmented; some trainees use Da Vinci Technology Training Pathway, FRS, FSRS, or ad hoc training; ERSC calls for a standardized European curriculum integrating VR, wet labs, bedside assisting, and	Oversight varied: 41.5% cited institutional oversight, 22.1% industry, 27.5% surgical societies, and 21.5% national training bodies; ERSC recommends greater role for societies and national bodies.	Many trainees with access had not performed robotic cases (48.2%); bedside assisting common (11–20 cases before console use recommended); experts and trainees agreed training should start earlier, within the first 4 years; significant	Assessment underused: 29.0% reported no tools used; tools include subjective assessment (41.3%), case logs (36.1%), video assessment (35.1%), summative tools (12.3%); stakeholders favored broader use of GEARS,	Lack of accredited trainers (52.7%), insufficient training lists (51.6%), high cost of simulators/courses (47.3%), competition for opportunities, limited access to wet labs, geographical barriers to training centers; industry representatives often did not	Highlighted urgent need for a standardized pan-European robotic training curriculum; emphasized early exposure, structured mentorship, and robust assessment methods; identified inequities and barriers to ensure better preparedness of

	significant disparities across institutions and countries.	console training with assessment milestones.		interest from trainees without access (94.6%).	OSATS, and summative assessments; no standard certification system yet.	include trainees in programs (56.5%).	future GI surgeons.
Robert B. Laverty, Charles H. Chesnut, Joseph R. Karam, Joseph C. L'Huillier, Alexander Bonte, Julie M. Clanahan, Jisuk Park, Brian Yoon, Robert W. Krell	Participants had varied backgrounds; 81% completed formal robotic curriculum; access to robotic training varied across institutions.	Not standardized across institutions; participants with prior robotic exposure (simulation or formal courses) included.	Study supported by Defense Health Agency and U.S. Air Force Graduate Medical Education Fund; conducted across multiple academic centers with IRB exempt approval.	Residents and fellows comprised 54% of RAC group and 45% of RIHR group; served as primary operators in video submissions; prior robotic case experience varied widely (mean robotic case volume 71 for RAC, 103 for RIHR).	Evaluation using GEARS rubric via C-SATS; included domains: depth perception, bimanual dexterity, efficiency, force sensitivity, autonomy, robotic control; binary and continuous statistical analyses applied. No credentialing pathway implemented.	C-SATS unable to differentiate novices from experts; lack of discriminatory power for early learning curve; ceiling effect of GEARS scores; limited generalizability due to single platform; small sample size; absence of inter-rater reliability data disclosed by C-SATS.	C-SATS-derived GEARS scores correlated with historic case volume overall but not among novice performers; no significant differences between residents/fellows and practicing surgeons; methodology insufficient to establish proficiency benchmarks; highlighted need for improved, high-fidelity evaluation platforms for robotic trainees.
Matthew Harris, Aidan	Noted	Consensus for	Validation	Trainees had	Consensus for	Limited access to	Established

Bannon, Justin W. Collins, on behalf of the Association of Surgeons in Training and the Robotic and Digital Surgery Trainee's Committee	disparities in access to robotic systems; trainees advocated flexible access beginning at higher specialty training (ST3+).	a standardized curriculum including device training, basic skills, procedural training, non-technical skills, video-based learning, modular approaches, simulation (wet lab, cadaveric, high-fidelity).	recommended through Surgical Royal Colleges and Joint Committee for Surgical Training (JCST). Endorsed involvement of professional societies.	varied robotic experience; most were naïve to robotic training but supported structured integration from ST3+; involvement as bedside assistants and console operators expected as training progresses.	metrics-based, objective assessments (GEARS, OSATS, video-based evaluations). Proficiency benchmarks defined by expert performance. Credentialing should include case minimums (observed, assisted, performed), video submissions, error differentiation, and revalidation every 5 years.	robotic platforms, lack of standardization across programs, resistance to additional credentialing requirements, and resource constraints (cost, training infrastructure).	robust trainee consensus supporting credentialing in robotic surgery; provided framework for equitable, standardized national training pathways with objective assessment and benchmarking, aiming to improve trainee preparedness and patient outcomes.
Shujaa T. Khan, Benjamin E. Jevnikar, Ahmed K. Emara, Peter G. Delaney, Khaled A. Elmenawi, Peter A. Surace, Nicolas S. Piuzzi, Matthew Deren	Access to RA-TJA during training is inconsistent and institution-dependent; global	Proposed hybrid curricula combining robotic and manual training; integration of	Institutional variability in faculty mentorship and program culture; need for faculty development,	Robotic platforms enhance cognitive engagement (planning, templating, decision-	System-derived intraoperative metrics (implant accuracy, resection error, ligament balance) proposed as	Inconsistent access to robotic systems, reduced manual arthroplasty training, lack of standardized curricula, dependence on	RA-TJA enhances technical accuracy, supports competency-based training, and improves conceptual

	disparities noted with limited access in LMICs; telesimulation and VR considered potential equalizers.	competency-based models with objective metrics; emphasis on VR, simulation, and vendor-neutral curricula.	global partnerships, and endorsement by professional societies (AAHKS, AAOS, ACGME).	making) and accelerate skill acquisition but may reduce autonomy and conventional technique exposure; autonomy varies across programs.	competency benchmarks; integration into CBME; no universal credentialing framework yet.	vendor platforms, disparities in LMICs, and risk of premature cognitive offloading in early trainees.	understanding, but risks undermining manual skill development and autonomy without hybrid models; calls for standardization, balanced exposure, and global equity in training.
Noama Iftekhar, Kathryn Cataldo, Seungwon Jong Seo, Brett Allen, Casey Giles, Matthew William Kelecy, Joshua MacDavid, Richard C. Baynosa	NR (study focused on surgical outcomes, not educational access).	NR (no structured educational program described).	Institutional review board approval; supported by Graduate Medical Education Open Article Fund at UNLV; procedures conducted by faculty plastic surgeons.	NR (study did not describe trainee involvement in robotic procedures).	NR (no mention of credentialing or structured assessment tools).	Learning curve and initial operative time with robotic harvest, lack of haptic feedback, higher cost, and need for specialized infrastructure. Radiation-related tissue damage contributed to complications in some patients.	Robotic RRAM flap was feasible, safe, and effective for posterior vaginal wall reconstruction, preserving minimally invasive benefits. Complication rates were favorable compared to open VRAM literature. Suggested future applications in reconstructive pelvic surgery, including

							gynecologic oncology and gender-affirming surgery.
Noriyuki Abe, Takashige Abe, Kanta Hori, Junya Abe, Kazufumi Okada, Keita Takahashi, Shigeru Harada, Masafumi Kon, Jun Furumido, Kohei Hashimoto, Sachiyo Murai, Hiroshi Kikuchi, Naoya Masumori, Hidehiro Kakizaki, Nobuo Shinohara	Variable access; ~67% of institutions had surgical robots, but training resources unevenly distributed. 22.6% of instructors lacked any training resources at their institutions.	Training mostly unstructured; dependent on rotations across hospitals. 'On-the-job' training dominant, with limited 'off-the-job' opportunities such as simulation or journal clubs.	Limited infrastructure and insufficient institutional support reported. Instructors identified lack of specific curriculum, insufficient number of trainers, and time constraints as major issues.	Trainees reported insufficient exposure to open surgery, infertility, and female urology. Most learning through operative guidance and review of surgical videos. Lack of regular meetings to evaluate progress (84.7% of trainees).	Assessments mainly based on clinical performance and conference presentations; limited use of case-log data; no standardized structured evaluation framework in place.	Insufficient infrastructure, lack of specific curriculum, time shortages for both trainees and instructors, uneven access to simulation resources, insufficient funding, and shortage of qualified trainers.	Highlighted significant gaps in training, particularly for open surgery and certain subspecialties. Recommended structured curricula, increased simulation use, cadaveric training, and institutional investment to overcome barriers and enhance surgical education in Japan.

NR = Not Reported