INPLASY

Robot-assisted versus conventional laparoscopic surgery for deep infiltrating endometriosis: a systematic review and meta-analysis

INPLASY202640095
doi: 10.37766/inplasy2026.4.0095
Received: 26 April 2026
Published: 26 April 2026

Sen, S; Gulgel Sen, F.

Corresponding author:
Serhat Sen

serhat.sen@istinye.edu.tr

Author Affiliation:
Department of Gynecologic Oncology, Istinye University, Liv Hospital Topkapi, Istanbul, Turkiye.

ADMINISTRATIVE INFORMATION

Support - No external funding was received for this systematic review.

Review Stage at time of this submission - Completed but not published.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202640095

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 26 April 2026 and was last updated on 26 April 2026.

INTRODUCTION

Review question / Objective In adult women undergoing surgical excision of deep infiltrating endometriosis (Population), does robot-assisted laparoscopic surgery (Intervention), compared with conventional laparoscopic surgery (Comparator), result in different perioperative outcomes, including operative time, intraoperative blood loss, length of hospital stay, and major complications (Outcomes), across randomised controlled trials and comparative cohort studies (Study design)?

Rationale Deep infiltrating endometriosis (DIE) requires complex surgical excision when medical therapy fails. Conventional laparoscopic surgery (CLS) is the established standard, while robot-assisted laparoscopic surgery (RALS) has been proposed as an alternative offering three-dimensional vision, tremor filtration, and wristed instrumentation, at substantially higher direct cost. Five prior meta-analyses have addressed this comparison, all reporting operative time differences of 28 to 40 minutes favouring CLS, with no detectable differences in major perioperative endpoints. However, three limitations persist across the cumulative literature: undifferentiated pooling of all eligible studies regardless of risk of bias, contrary to Cochrane Handbook guidance; absence of per-arm procedure mix data essential for interpreting operative time differences in a disease with a heterogeneous surgical spectrum; and absence of patient-centred long-term functional outcomes from pooled syntheses. The present systematic review and meta-analysis applies a bias-restricted primary synthesis approach with outcome-level ROBINS-I assessment, explicit per-arm procedure mix tabulation, and transparent non-pooling of outcomes for which harmonised data are unavailable.

Condition being studied Deep infiltrating endometriosis (DIE) is defined as endometriotic infiltration of at least 5 mm beneath the peritoneum. It represents the most severe phenotype of endometriosis and accounts for

approximately 20 percent of women affected by the disease. DIE typically involves the uterosacral ligaments, rectovaginal septum, rectosigmoid colon, bladder, and ureters, and is characterised by severe dysmenorrhoea, dyspareunia, dyschezia, and infertility. Surgical excision is the definitive treatment when medical therapy fails to control symptoms. Surgical management ranges in complexity from peritoneal excision and rectal shaving to discoid excision and segmental rectosigmoid resection with primary anastomosis, often performed by a multidisciplinary team including gynaecological, colorectal, and urological surgeons.

METHODS

Search strategy Electronic databases searched: MEDLINE (PubMed), EMBASE (Ovid), Cochrane Central Register of Controlled Trials (CENTRAL), Web of Science Core Collection, Scopus, ClinicalTrials.gov, and the WHO International Clinical Trials Registry Platform (ICTRP). All databases were searched from inception to 15 April 2026. Search terms combined controlled vocabulary (MeSH/Emtree) and free-text keywords: (endometriosis OR deep infiltrating endometriosis OR DIE OR rectovaginal endometriosis OR colorectal endometriosis OR bowel endometriosis) AND (robot* OR da Vinci OR robotic surgical procedures) AND (laparoscop* OR minimally invasive OR minimal access). Reference lists of included studies and prior systematic reviews were hand-searched. Conference proceedings of ESHRE, ESGE, and AAGL from 2021 to 2026 were screened. Language was restricted to English. The MEDLINE strategy was self-audited against the 2015 PRESS checklist. Full per-database strategies are deposited on the Open Science Framework: osf.io/yx6e2.

Participant or population Adult women aged 18 years or older with histologically or radiologically confirmed deep infiltrating endometriosis, defined as endometriotic infiltration of at least 5 mm beneath the peritoneum or fulfilling IDEA consensus imaging criteria. Studies including mixed endometriosis-oncology cohorts in which DIE-specific outcomes could not be disentangled were excluded.

Intervention Robot-assisted laparoscopic surgery (RALS) for the surgical excision of deep infiltrating endometriosis, using any commercially available robotic platform, including da Vinci S, Si, Xi, or SP; Senhance; CMR Versius; or Hugo RAS. Surgical procedures range from peritoneal excision and rectal shaving to discoid excision and segmental rectosigmoid resection with primary anastomosis, performed by gynaecological surgeons with or without colorectal or urological multidisciplinary collaboration.

Comparator Conventional multiport laparoscopic surgery (CLS) for the surgical excision of deep infiltrating endometriosis, performed by the same or comparable surgical team using the same range of procedures, including peritoneal excision, rectal shaving, discoid excision, and segmental resection.

Study designs to be included Randomised controlled trials and prospective or retrospective comparative cohort studies with at least 20 patients per arm. Single-arm case series, conference abstracts without extractable data, and duplicate cohort reports were excluded.

Eligibility criteria Inclusion criteria: adult women aged 18 years or older with histologically or radiologically confirmed deep infiltrating endometriosis; direct comparison of robot-assisted versus conventional laparoscopic surgery; minimum 20 patients per arm with extractable arm-specific operative time data; English language publication; peer-reviewed full-text article. Exclusion criteria: single-arm case series without a concurrent comparator; mixed endometriosis-oncology cohorts where DIE outcomes cannot be disentangled; duplicate cohort reports, with the most complete version retained; conference abstracts without extractable data; and non-harmonisable operative time definitions.

Information sources Electronic databases: MEDLINE (PubMed), EMBASE (Ovid), Cochrane Central Register of Controlled Trials (CENTRAL), Web of Science Core Collection, and Scopus. Trial registers: ClinicalTrials.gov and WHO International Clinical Trials Registry Platform (ICTRP). Hand searching: reference lists of included studies and prior systematic reviews; conference proceedings of ESHRE, ESGE, and AAGL from 2021 to 2026. All databases were searched from inception to 15 April 2026.

Main outcome(s) Operative time, defined as skin-to-skin time in minutes, reported per arm and analysed as weighted mean difference (RALS minus CLS) using restricted maximum likelihood (REML) random-effects meta-analysis with Hartung-Knapp-Sidik-Jonkman (HKSJ) confidence intervals and 95 percent prediction intervals.

Additional outcome(s) Secondary pooled outcomes: intraoperative blood loss in mL, length

of hospital stay in days, and major complications, defined as Clavien-Dindo grade IIIa or higher. Outcomes extracted but not pooled because of insufficient harmonised data: nerve-sparing completion, anastomotic leak and rectovaginal fistula at 30 and 90 days, ureteric stricture, Low Anterior Resection Syndrome (LARS) score, de novo dyspareunia, recurrence at 24 months or later, reoperation at 2 and 5 years, live birth in the infertility subgroup, and postoperative hormonal suppression uptake.

Data management Records were imported into Rayyan QCRI for duplicate removal and screening. Two reviewers (S.S. and F.G.S.) independently screened titles, abstracts, and full-text articles. Inter-rater agreement, measured using Cohen's kappa, was 0.87 for title-abstract screening and 0.91 for full-text eligibility. Data were extracted in duplicate into a piloted REDCap form with 86 variables across eight sections. Inter-rater kappa for a 30 percent random subsample of extracted numerical data was 0.94.

Quality assessment / Risk of bias analysis Randomised trials were appraised using the Cochrane Risk of Bias tool version 2 (RoB 2). Observational studies were appraised using the Risk Of Bias In Non-randomised Studies of Interventions tool (ROBINS-I). Both tools were applied at outcome level per Cochrane Handbook section 25.5.3. Bias profiles for objective outcomes, including operative time and blood loss, were assessed separately from subjective outcomes, including voiding function and pain. Pre-specified ROBINS-I confounders were surgeon experience and DIE-specific case volume, centre volume, publication era, surgeon-preference selection or referral bias, propensity matching, and postoperative hormonal suppression.

Strategy of data synthesis Continuous outcomes were pooled as weighted mean differences with 95 percent confidence intervals using restricted maximum likelihood (REML) random-effects estimation with Hartung-Knapp-Sidik-Jonkman (HKSJ) variance adjustment. Dichotomous outcomes were pooled as risk ratios. Heterogeneity was quantified using I-squared, tau as between-study standard deviation, and 95 percent prediction intervals when k was at least 3. Studies at critical risk of bias were excluded from pooled estimation. Studies at serious risk contributed only to sensitivity analyses. The primary synthesis pool comprised studies at low or moderate overall risk of bias. GRADE certainty was rated for each primary outcome with domain-by-domain rationale.

Subgroup analysis Pre-specified subgroup analyses: by anatomical site, comparing colorectal DIE versus non-colorectal DIE; by surgeon volume, comparing at least 50 versus fewer than 50 DIE cases per year; by publication era, comparing pre-2017 versus 2017 onwards; and by allocation method, comparing randomised versus non-randomised studies. Subgroup differences were tested using the Cochran Q test for between-group heterogeneity. Subgroup analyses were considered exploratory and interpreted with caution given the small number of studies in each subgroup.

Sensitivity analysis Pre-specified sensitivity analyses for the primary outcome: inclusion of serious-risk-of-bias studies; exclusion of the single RCT; exclusion of studies requiring SD imputation from median or range; exclusion of small cohorts with fewer than 20 patients per arm; leave-one-out analysis with Baujat-plot influence assessment; restriction to skin-to-skin operative time definition; restriction to propensity-matched or randomised allocation; and restriction to modern-era studies from 2017 onwards using Xi-platform studies. Bayesian sensitivity analysis used three priors implemented in brms 2.22 with Stan back-end using four chains and 4,000 iterations, R-hat less than 1.01, and ESS greater than 2,000. Trial sequential analysis was performed for operative time only, with alpha 0.05, power 0.80, and MCID 30 minutes.

Language restriction English.

Country(ies) involved Turkey.

Other relevant information This systematic review applies a bias-restricted primary synthesis approach: studies at critical risk of bias are excluded from pooled estimation, studies at serious risk contribute only to sensitivity analyses, and the primary pool comprises studies at low or moderate overall risk of bias. Outcomes for which fewer than two primary-pool studies provide harmonised data are not pooled and are reported narratively. The Statistical Analysis Plan, search strategy files, extraction templates, and risk of bias assessments are deposited on the Open Science Framework: osf.io/yx6e2.

Keywords deep infiltrating endometriosis; robotic surgery; laparoscopic surgery; meta-analysis; operative outcomes.

Dissemination plans The systematic review and meta-analysis will be submitted for peer-reviewed publication in Updates in Surgery, the journal of the Italian Society of Surgery published by Springer.

Findings will be disseminated to the surgical, gynaecological endoscopy, and colorectal surgery communities. The full manuscript, supplementary material, PRISMA 2020 checklist, figures, and Statistical Analysis Plan are deposited on the Open Science Framework (osf.io/yx6e2) for transparency and reproducibility.

Contributions of each author

Author 1 - Serhat Sen - Conceiving the review; designing the review; coordinating the review; writing the protocol; data collection; data management; analysis of data; interpretation of data; writing the manuscript; corresponding author.
Email: serhat.sen@istinye.edu.tr
Author 2 - Feyza Gulgel Sen - Duplicate data extraction; duplicate risk of bias assessment; methodology review; manuscript revision; final approval of the version submitted.
Email: feyzaa.gulgell@hotmail.com