Controversies in Minimally Invasive Surgery for Gynecologic Cancers & Latest Trial Results

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DECLARATION OF INTERESTS

Nothing to declare

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Part 1

Why the debate again? — perioperative gain vs oncologic safety

수술 주변 결과(perioperative outcome)의 이점은 일관적이지만, oncologic safety는 암종·병기·술기에 따라 다르게 판정되고 있습니다

Consistent perioperative benefit

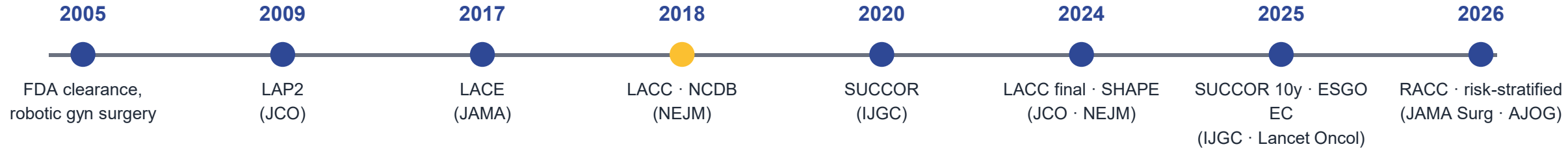
- **LAP2**: moderate–severe postoperative AE 14% vs 21%; hospital stay >2 days 52% vs 94%
- **LACE** (QoL substudy n=332): grade ≥3 postoperative AE 11.6% vs 23.2%; QoL 개선 6개월 지속
- **SHAPE** (simple hysterectomy): urinary incontinence·retention 감소 — MIS 77%로 시행 (탐색 분석, Mahner 2025)

Where oncologic safety faltered

- **LACC 2018**: MIS 4.5-y DFS 86.0% vs 96.5% (HR 3.74)
- **NCDB**: 4-y mortality 9.1% vs 5.3% (HR 1.65)
- 가설: uterine manipulator, colpotomy 시 tumor exposure, CO_2·Trendelenburg, learning curve, tumor size

New questions, 2024–2026

- LACC final (2024): OS HR 2.71 — 결론 유지
- SUCCOR 10-year (2025): 접근법 간 survival 차이 없음 (p=0.12), 관찰 연구의 한계
- Risk-stratified cohort (2026): recurrence HR low-risk 0.88 vs high-risk 2.32 (death HR 3.22)
- ESGO 2025: presumed stage I–II에서 high-risk까지 MIS preferred (I, A; 2021 권고 유지)
- RACC (2026, n=900 RCT): robotic RH 수술 중 합병증 5.7 vs 10.0%, 회복 이득 미미 — RFS 1차 완료 2027-03 (등록 기준)

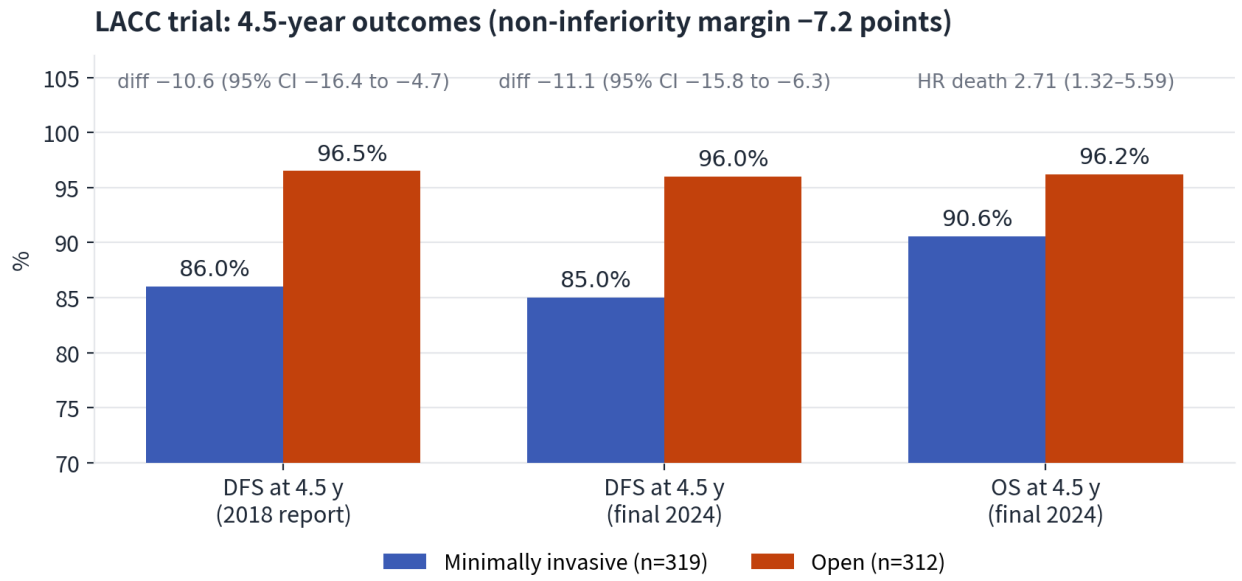


Walker JL, JCO 2009/2012 · Janda M, Lancet Oncol 2010 & JAMA 2017 · Plante M, NEJM 2024 · Mahner S, Int J Surg 2025 · Ramirez PT, NEJM 2018 & JCO 2024 · Melamed A, NEJM 2018 · Manzour N, IJGC 2025 · Cusimano MC, AJOG 2026 · Concin N, Lancet Oncol 2025 · Salehi S, JAMA Surg 2026

Part 2 · Cervix

Cervical cancer ① LACC trial — the RCT that reset the standard

Ramirez PT et al. NEJM 2018;379:1895 · final analysis JCO 2024;42:2741 (NCT00614211) — oncologic 결과를 보고한 유일한 phase III RCT



Ramirez PT et al. N Engl J Med 2018;379:1895 · J Clin Oncol 2024;42:2741

Design

- FIGO 2009 Stage IA1 (LVSI+)–IB1, squamous·adeno·adenosquamous · n=631 (MIS 319 / open 312) · 33 centers
- MIS arm: laparoscopy 84.4%, robotic 15.6% · non-inferiority margin **−7.2%p**

Results (final analysis 2024)

- 4.5-y DFS 85.0% vs 96.0% → **difference −11.1%p** (95% CI −15.8 to −6.3), **HR 3.91** (2.02–7.58)
- 4.5-y OS 90.6% vs 96.2%, **HR for death 2.71** (1.32–5.59), p=0.007
- 2018 report: DFS HR 3.74 (1.63–8.58), OS HR 6.00 (1.77–20.30)

Criticisms & limitations

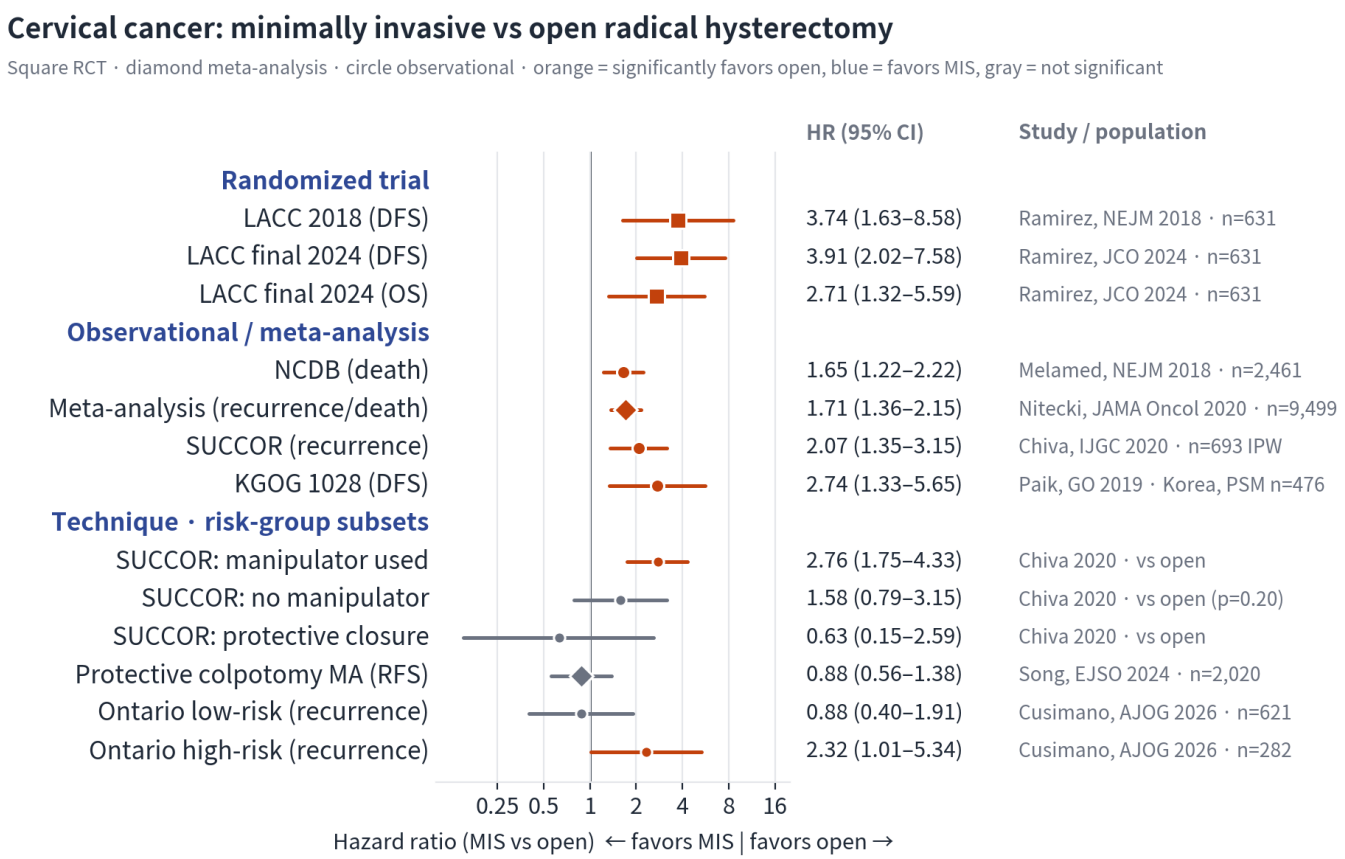
- 조기 종료 (631/740), open arm의 예상보다 낮은 recurrence, 술기 표준화 (manipulator·colpotomy) 부재, 기관 간 recurrence 편중
- LACC 최종 생존분석은 개복 근치자궁절제술을 표준으로 지지

Ramirez PT et al. N Engl J Med 2018;379:1895-1904 · Ramirez PT et al. J Clin Oncol 2024;42:2741-2746

Part 2 · Cervix

Cervical cancer ② Evidence after LACC — direction, exceptions

관찰연구·meta-analysis는 open 우위를 재현; protective technique 적용군과 low-risk 군은 유의한 차이 없음 (사건 수 적음·검정력 제한)



How to read

- HR>1 = MIS 불리. Orange = significantly favors open, gray = not significant

Key numbers

- NCDB n=2,461: 4-y mortality 9.1% vs 5.3%, **HR 1.65**
- Meta-analysis 15 studies, n=9,499: recurrence/death **HR 1.71**, death **HR 1.56** — robotic 비율과 무관
- SUCCOR (Europe, n=1,272; IPW cohort 693): recurrence **HR 2.07**, death HR 2.45
- KGOG 1028 (no adjuvant, IB–IIA): DFS **HR 2.74**, OS 차이 없음

Pattern of exceptions

- No manipulator·vaginal closure before colpotomy → open과 유의한 차이 없음 (SUCCOR, NS; protective colpotomy meta-analysis RFS HR 0.88, 0.56–1.38)
- SHAPE-criteria low-risk: 차이 없음; high-risk: recurrence **HR 2.32**, death **HR 3.22** (Ontario 2026)

Melamed A, NEJM 2018 · Nitecki R, JAMA Oncol 2020 · Chiva L, IJGC 2020 · Paik ES, Gynecol Oncol 2019 · Song YL, EJSO 2024 · Cusimano MC, AJOG 2026

Part 2 · Cervix

Cervical cancer ③ Why was MIS inferior? — four hypotheses

술기 요인(manipulator·tumor exposure), 환자 요인(tumor size·residual tumor), 술자 요인(learning curve)이 겹쳐 있습니다

Uterine manipulator

Technique

- SUCCOR: manipulator 사용 시 recurrence **HR 2.76** (1.75–4.33) vs 미사용 **HR 1.58** (0.79–3.15, p=0.20)
- ROCC protocol: transcervical manipulator 금지 · tumor containment 의무 (vaginal closure 후 colpotomy 등 4가지 중 택1)
- RACC: uterine manipulator 금지 · vaginal closure 권고(의무 아님) — FIGO Cancer Report 2025 기준

Tumor exposure at colpotomy · spillage

Technique

- SUCCOR: protective vaginal closure 시 recurrence **HR 0.63** (0.15–2.59)
- Meta-analysis (8 retrospective cohorts, n=2,020): protective colpotomy MIS RFS **HR 0.88** (0.56–1.38), OS **HR 0.78** (0.42–1.44) — open과 유의한 차이 없음
- 국내 SOLUTION: endoscopic stapler로 vaginal closure (phase II 진행 중)

Tumor size · residual tumor · conization

Patient

- COBRA-R (국내 6기관, n=1,254): **>2 cm MIS** (PSM)에서 **preoperative conization** 시 3-y DFS SCC 96.3 vs 87.4%, non-SCC 97.0 vs 74.8%; **≤2 cm**는 차이 없음
- SHAPE exploratory analysis: **LEEP/cone margin negative**이면 접근법과 무관하게 extrapelvic recurrence·death 0

Learning curve · surgeon proficiency

Surgeon

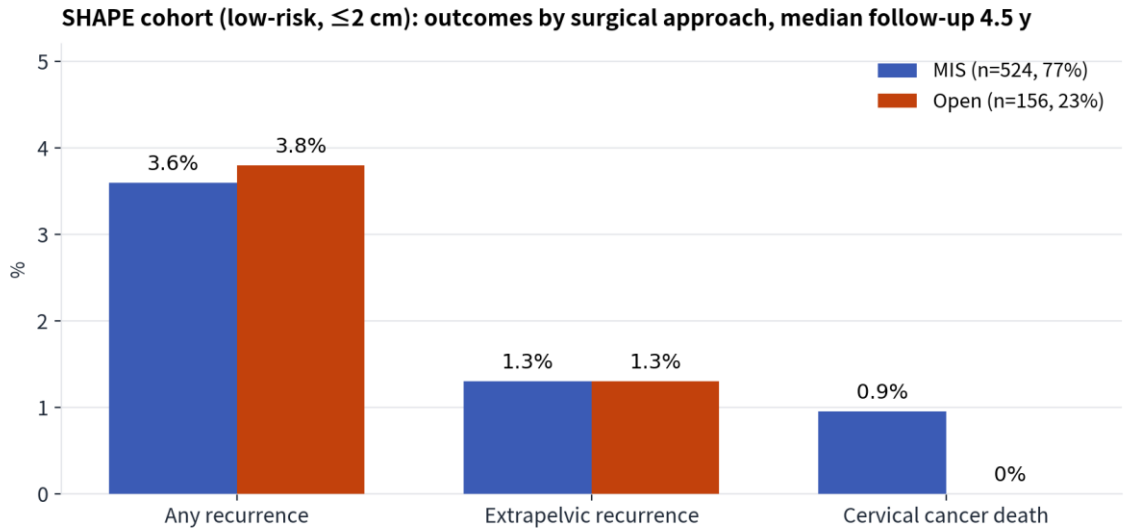
- Yonsei cohort (open 280 / MIS 282): learning period open 30 vs MIS 60 cases; skilled period DFS HR 0.392
- ≥2 cm에서는 skilled period에도 MIS 불리 → **tumor size**가 technique를 압도, 60례는 단일기관 추정치이며 보편적 자격 기준은 아님

Chiva L, IJGC 2020;30:1269 · Song YL, EJSO 2024;50:108240 · Kim SI, Gynecol Oncol 2023;173:88 (COBRA-R) · Mahner S, Int J Surg 2025;111:8099 · Li LY & Kim SW, Cancer Res Treat 2021;53:243 · Mun J, JGOHR 2021 (SOLUTION)

Part 2 · Cervix

Cervical cancer ④ Low-risk disease — SHAPE and risk strata

≤2 cm low-risk의 표준이 simple hysterectomy로 이동 → 'simple hysterectomy는 어떤 approach가 적절한가'가 새 질문



Mahner S et al. Int J Surg 2025;111:8099 (exploratory, approach at surgeon's discretion; 19 vs 6 recurrences; 5 vs 0 deaths)

Interpretation

- Low-risk 군은 event가 매우 적어 'proof of safety'가 아니라 **'absence of harm signal'**; deaths 5/524 vs 0/156은 무시할 수 없는 관찰
- Low-risk에서의 MIS는 conditional — cone margin negative·protective technique·counseling 전제 (→ ⑧)

SHAPE (NEJM 2024, n=700)

- ≤2 cm, stromal invasion <10 mm (or <50%): simple vs radical hysterectomy → 3-y pelvic recurrence 2.52% vs 2.17%, non-inferior
- Exploratory analysis (2025): MIS 524 (77%) vs open 156 — recurrence 3.6% vs 3.8%, extrapelvic 1.3% vs 1.3%; cervical cancer death 5명 모두 MIS 군 (5/524, 0.95%; 접근법은 술자 재량·비무작위)
- LEEP/cone margin negative: 접근법과 무관하게 extrapelvic recurrence·death 0

Ontario cohort by risk group (AJOG 2026, n=903)

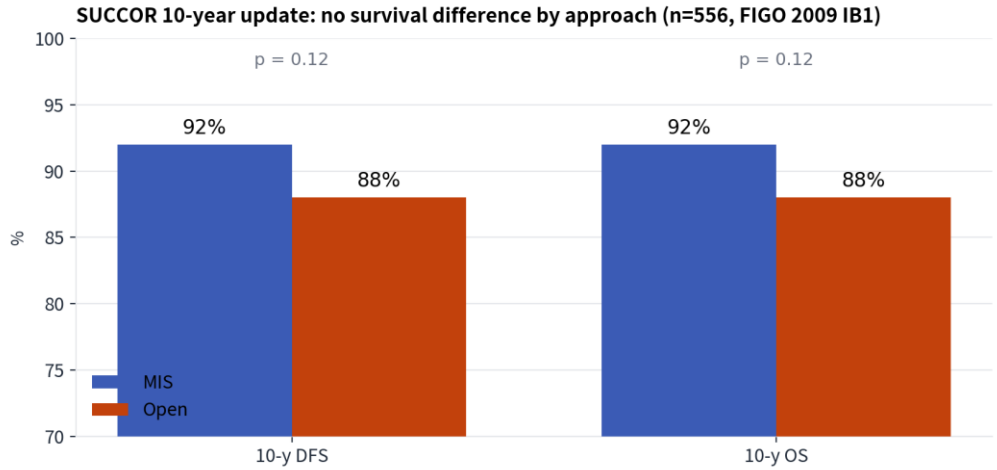
- Low-risk (SHAPE criteria, n=621): MIS death **HR 0.88** (0.39–2.01), recurrence HR 0.88 (0.40–1.91) — median follow-up 10 y
- High-risk (n=282): death **HR 3.22** (1.37–7.58), cancer death **HR 4.88**, recurrence **HR 2.32** (1.01–5.34)

Plante M, NEJM 2024;390:819 · Mahner S, Int J Surg 2025;111:8099 · Cusimano MC, Am J Obstet Gynecol 2026;235:1081

Part 2 · Cervix

Cervical cancer ⑤ Long-term follow-up and Korean data

SUCCOR 10-year의 '차이 없음'은 selection bias를 함께 고려해야 하며, 국내 자료는 LACC 전후로 결이 다릅니다



Manzour N et al. Int J Gynecol Cancer 2025;35:101690 · whole cohort: 5-y OS 97%, 10-y OS 89%, recurrence 9% (78% within 5 y)

SUCCOR 10-year (IJGC 2025, n=556)

- Whole cohort: 5-y DFS 93%, 10-y DFS 90%; OS 97% at 5 y, 89% at 10 y; recurrence 9% (78% within 5 y)
- **10-y DFS/OS** MIS 92% vs open 88% (**p=0.12**) — 2020 report (recurrence HR 2.07)와 방향이 다름
- 주의: follow-up 완료 cohort (**556/1,272**), 기관·술기 heterogeneity → 해석 신중

Study	Design · population	Key result
Kim JH, CRT 2019	HIRA claims 2011–14, n=6,335 (LRH 3,100)	LRH 사용 46→52%; complication·cost ↓; OS HR 0.74 (pre-LACC, claims data 한계)
KGOG 1028 ancillary (Paik, GO 2019)	IB–IIA, no adjuvant, PSM 119 vs 357	DFS HR 2.74 (1.33–5.65); pelvic recurrence HR 5.11; OS 차이 없음
Yonsei (Li & Kim SW, CRT 2021)	Open 280 vs MIS 282, CUSUM learning curve	5-y DFS 91.8 vs 89.0% (p=0.098); MIS learning period 60 cases; ≥2 cm는 skilled period에도 불리
COBRA-R (Kim SI, GO 2023)	6 centers, IB1, type C RH, n=1,254	>2 cm MIS (PSM, SCC): **conization** 시 3-y DFS 96.3 vs 87.4%; **residual tumor 클수록 DFS** ↓
KGOG 1048 (Kim JH, GO 2026)	Radical trachelectomy n=283 (2004–22)	DFS 88.3%, OS 96.1%; MIS는 DFS (p=0.118)·OS (p=0.840)와 무관; LEEP protective (HR 0.34)
SOLUTION / SOLUTION2 (SNUH)	Stapler vaginal closure MIS · multicenter single-arm phase II (n=124) → multicenter RCT	IB2–IIA1, n=494, 4.5-y PFS non-inferiority; 등록상 시작 예정 2026-01이었으나 2026-10-21 기준 아직 'not yet recruiting' (NCT07256977)

Manzour N, IJGC 2025;35:101690 · Kim JH, Cancer Res Treat 2019;51:788 · Paik ES, Gynecol Oncol 2019;154:547 · Li LY, Cancer Res Treat 2021;53:243 · Kim SI, Gynecol Oncol 2023;173:88 · Kim JH, Gynecol Oncol 2026;208:113 · ClinicalTrials.gov NCT04370496/NCT07256977

Part 2 · Cervix

Cervical cancer ⑥ Ongoing RCTs — what they will answer, when

설계 원칙 (MITOR·단일군 연구 제외): manipulator 금지·tumor containment (vaginal closure·stapler), non-inferiority, DFS/RFS/PFS primary

Trial (NCT)	Sponsor · country	Comparison	Population · n	Primary endpoint	Primary completion	Notes
ROCC / GOG-3043 NCT04831580	GOG Foundation · US·Brazil·Canada·Korea	**Robotic vs open**	IA2–IB2 ≤4 cm · 840	3-y DFS (non-inferiority)	2029-03	Transcervical manipulator 금지, **vaginal closure 후 colpotomy**; 국내 9개 기관 참여
RACC NCT03719547	Karolinska · Europe 다국가	**Robotic vs open**	IB1–IB2/IIA1 · 900 randomized (→최대 1,092; 등록상 800)	5-y RFS	2027-03	**JAMA Surg 2026-10: 수술 중 합병증 5.7 vs 10.0%**, 회복 차이 미미 (→ ⑦)
G-LACC NCT06489795	Hannover · Germany, 14 sites	Lap/robotic vs open (radical or simple)	IA2–IB2 <4 cm · 756	5-y DFS (non-inferiority)	2033-07	LEEP/cone 또는 vaginal closure 필수, transcervical manipulator 금지; SHAPE 기준 simple hysterectomy 허용
SOLUTION NCT04370496	SNUH · Korea	Single-arm phase II (stapler MIS)	IB1 (FIGO 2009, ≤4 cm) · 124	4.5-y DFS (single-arm)	2028-12	Endoscopic stapler vaginal closure 표준화
SOLUTION2 NCT07256977	SNUH + 12 Korean centers	Stapler MIS vs open	IB2–IIA1 (≥2, <4 cm) · 494	4.5-y PFS (non-inferiority)	2034-12	Not yet recruiting (2026-10-21 확인); 국내 주도 첫 approach RCT
PUMCH tumor-free LRH NCT06836869	Peking Union · China, 17 sites	Tumor-free technique LRH vs open	IB2 · 524	4.5-y DFS (non-inferiority)	2032-07	2025-02 개시, recruiting
MITOR NCT04999696	Chang Gung · Taiwan	MIS vs open	Early-stage · 820	5-y DFS / OS	2031-07	Not yet recruiting (개시 예정 2023-09 경과; 등록 최종 갱신 2023-02-10)
LASH NCT06416748	Gemelli · Italy	Single-arm MIS simple hysterectomy	SHAPE low-risk ≤2 cm · 974	3-y DFS	2027-07	SHAPE 기준에서 MIS approach 안전성 검증 (recruiting), 접근법 간 무작위 비교 아님

ClinicalTrials.gov, verified 2026-10-21 (등록 상태 'Unknown'인 중국 RCT 4건 제외) · Ramirez PT et al. BJOG 2023;130:851 (overview of ongoing trials) · Santía MC et al. Cancers 2025;17:2259

Part 2 · Cervix

Cervical cancer ⑦ RACC 2026 and new cohort data

RACC 900명 무작위 배정 (2019–25; 최대 1,092명 확대 등록 중) · 2026-10 JAMA Surg: perioperative·QoL 결과 · RFS는 2027년 이후

RACC (NCT03719547) — secondary analysis, JAMA Surg 2026-10-07

- Design: FIGO 2018 IB1–IB2·IIA1, robotic vs open RH, European tertiary centers · n=900 randomized (→1,092 for RFS) · primary 5-y RFS (non-inferiority), PCD 2027-03
- Intraoperative complications 5.7% (24/419) vs 10.0% (39/390) — RD −4.3%p (95% CI −8.0 to −0.6); 대부분 minor, major 유사
- 30-day postoperative complications 33.4% vs 34.8% (RD −1.4%p); readmission·reoperation 유사
- 1-month HRQOL: physical +5, role +8, pain +5점 (사전 정의 'small' MID 5–9 충족) — global health 등 나머지 영역은 MID 미달

Interpretation

- 저자 결론 'no improvement in clinically consequential postoperative outcomes or recovery' — robotic RH의 회복 이득이 RCT에서 축소
- 접근법 결정의 일차 근거는 RFS (PCD 2027-03, 발표는 그 후) — perioperative 이득만으로 robotic 선택은 정당화되지 않음 (저자)

Study (2026)	Design · n	Result
Wu J, BMC Surg (meta-analysis)	15 studies, open vs MIS RH	5-y DFS OR 1.70 (1.27–2.27) **open 우위 · OS 차이 없음** (OR 1.08)
Theodoridis TD, FVVO (ESGE)	29 RCTs, n=6,127 (EC+CC)	CC: MIS OS RR 0.94, DFS RR 0.89 · EC: 동등
Deng L, Gynecol Oncol (China)	PSM 539 vs 539, no manipulator + vaginal transection	DFS HR 0.86 (0.48–1.55), OS NS — f/u MIS 18.9 vs open 31.3 mo (단기)
Kim S, J Gynecol Oncol (Korea)	MIRH vaginal pipe 77 vs none 104	Recurrence 3.9 vs 11.5%; aHR 0.31 (0.09–1.09, p=0.068)
Hamada K, Int J Clin Oncol (JSOG registry)	T1B1–T1B2, n=16,054	2018 이후 MIS 회피 (LNM+·T1B2) · MIS–OS aHR 0.96 (0.89–1.04)
Agusti N, AJOG (NCDB)	≤2 cm: inadvertent/inadequate SH 688 vs planned 4,920	5-y OS 91.5 vs 96.2% (HR 1.89) · salvage (C)RT로 만회 안 됨 (HR 1.33, NS) → 계획된 oncologic surgery 전제
Plante M, IJGC (SHAPE exploratory)	LEEP/cone → MRI, n=480	MRI–pathology concordance 64.4%, residual disease sensitivity 30.5% → MRI 단독 판단 한계; margin(−) 시 일치도↑ (76.6 vs 57.3%)

Salehi S et al. JAMA Surg 2026 (doi 10.1001/jamasurg.2026.4625) · Wu J, BMC Surg 2026;26 · Theodoridis TD, Facts Views Vis Obgyn 2026;18:195 · Deng L, Gynecol Oncol 2026;213:41 · Kim S, J Gynecol Oncol 2027;38:e22 · Hamada K, Int J Clin Oncol 2026;31:1441 · Agusti N, AJOG 2026;234:1639 · Plante M, IJGC 2026;36:104835

Part 2 · Cervix

Cervical cancer ⑧ Guidelines in 2026 and practical principles

표준 approach는 open. 예외는 'low-risk + informed counseling + protective technique + experienced center'의 조합으로만 성립

NCCN Version 1.2027	Open abdominal approach = **RH standard·recommended (category 1);** MIS 시 oncologic risk counseling. Type B/C는 laparotomy, 보존적 수술 기준 Type A는 vaginal·laparotomy·MIS 허용, RT MIS cat. 2B (유지). v1.2027 변경: IA1–IB1 보존적 수술에서 SLN 'preferred', SLN ≥2–4 cm 허용 (RH는 SLN 또는 PLND, cat. 1)
ESGO/ESTRO/ESP 2023 update	**Laparotomy가 표준 (I, A)**. MIS는 low-risk (<2 cm + conization 후 free margin), ESGO quality criteria 충족 high-volume center, 충분한 설명 후 환자 동의 시에만 고려 (IV, C) — protective technique은 명시 안 함
FIGO · ESMO · NICE	**LACC 이후 open approach 권고** (Ramirez, BJOG 2023 요약; FIGO 2025 cancer report는 small tumor에서 MIS 역할 재검토 언급); low-risk의 simple hysterectomy + nodal assessment는 SHAPE·NCCN 기준
JSGO 2022 (JGO 2024)	≤2 cm: tumor spread 예방 술기를 전제로 MIS 제안 (weak, evidence C); >4 cm: MIS 비권장 (weak, evidence B) — 크기 기준을 명시한 아시아 가이드라인

Practical checklist — if MIS is considered

- ☐ Tumor ≤2 cm, superficial stromal invasion, MRI로 확인
- ☐ Preoperative conization/LEEP로 negative margin 확보 (ESGO 조건; COBRA-R 이득은 >2 cm MIS, ≤2 cm는 NS)
- ☐ Transcervical uterine manipulator 사용 금지 (ROCC·G-LACC protocol)
- ☐ Colpotomy 전 vaginal closure (clamp·stapler·suture) 및 retrieval bag 사용
- ☐ 술자·기관의 MIS RH 경험 확인 (학습곡선 ~60례, Li LY 2021), outcome registry·audit
- ☐ LACC·SHAPE 근거를 문서화하여 counseling

하나라도 충족하지 못하면 →

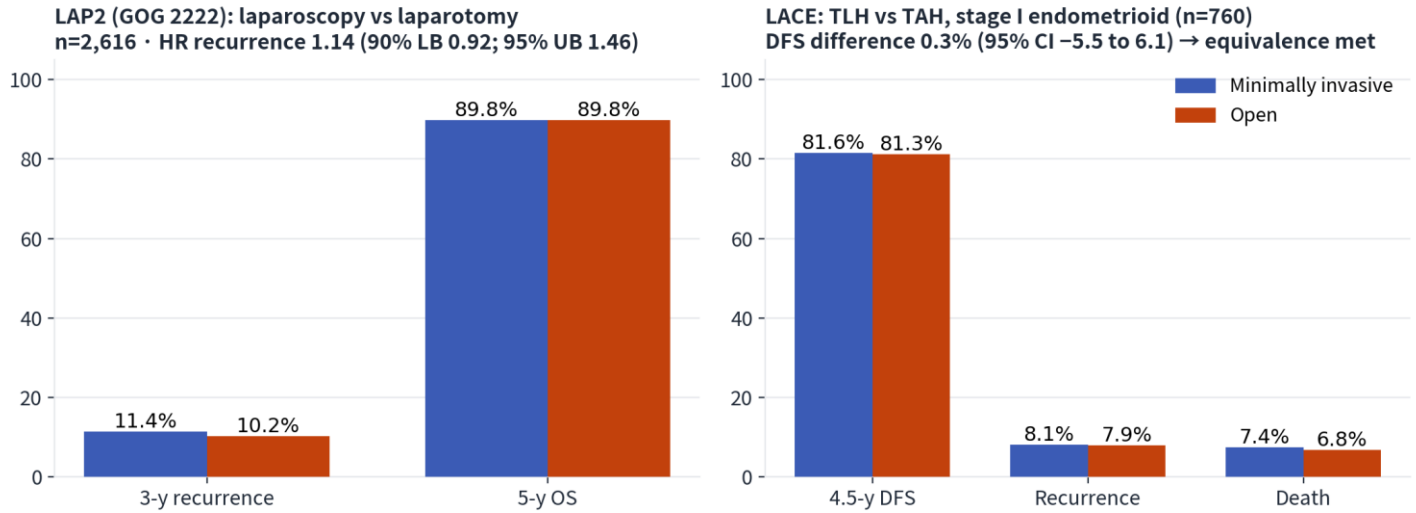
open radical hysterectomy

NCCN Guidelines: Cervical Cancer, Version 1.2027 (10/15/26; 전문 확인 2026-10-21: CERV-C 2·6·7 of 9, CERV-2–5, Updates; Abu-Rustum NR et al. JNCCN 2025;23:549 = v2.2026) · Cibula D et al. IJGC 2023;33:649 · Ramirez PT et al. BJOG 2023;130:851 · Bhatla N, FIGO Cancer Report 2025, IJGO 2025;171(S1):87 · JSGO 2022 guidelines, J Gynecol Oncol 2024;35:e15 · Plante M, NEJM 2024 · Kim SI, Gynecol Oncol 2023;173:88 (COBRA-R) · Li LY, Cancer Res Treat 2021;53:243

Part 3 · Endometrium

Endometrial cancer ① LAP2 · LACE — why MIS is standard

LAP2·LACE (n=3,376): **recurrence·survival 차이 없음** (LAP2는 통계적 NI 미충족) → ESGO 2021·2025: high-risk 포함 MIS preferred (I, A)



Walker JL et al. J Clin Oncol 2012;30:695 · Janda M et al. JAMA 2017;317:1224

Perioperative · QoL

- LAP2: moderate–severe postoperative AE 14 vs 21%, hospital stay >2 d 52 vs 94% · 6주 QoL 우위
- LACE: grade ≥3 postoperative AE 11.6 vs 23.2%; 9년(중앙값) 단면조사 (n=259)에서도 physical·functional well-being TLH 우위 (small effect)

LAP2 (GOG 2222)

- Clinical stage I–IIA, n=2,616 (laparoscopy 1,696 / laparotomy 920), conversion 25.8%
- Recurrence HR 1.14 — 사전 정의 non-inferiority (HR 1.4) 기준은 미충족이나 3-y recurrence 차이 1.14%p, 5-y OS 89.8% 동일

LACE

- Stage I endometrioid, n=760, equivalence margin 7%
- 4.5-y DFS 81.6 vs 81.3% (TLH vs TAH), recurrence 8.1 vs 7.9%, death 7.4 vs 6.8% → equivalent

ESGO/ESTRO/ESP 2025 (2021 권고 유지)

- **High-risk를 포함한** 모든 위험군에서 **MIS가 preferred approach (I, A)**
- Tumor spillage·morcellation (in-bag 포함) 회피 (III, A); 자궁 밖 전이 (LN 제외)는 relative contraindication (III, B)

Walker JL, J Clin Oncol 2009;27:5331 & 2012;30:695 · Janda M, Lancet Oncol 2010;11:772 & JAMA 2017;317:1224 · Sanjida S, IJGC 2021 · Concin N, Lancet Oncol 2025;26:e423 (ESGO/ESTRO/ESP 2025)

Part 3 · Endometrium

Endometrial cancer ② Robotic vs laparoscopic platform

RCT·cohort: robotic vs lap oncologic **차이 없음** (Tampere 10-y OS 우위는 소규모·가설 수준); robotic 이점은 conversion↓·obese feasibility

Study	Design · n	Key result
Tampere RCT (Mäenpää, AJOG 2016 · Kivekäs, AJOG 2025, 10-y)	Robotic vs laparoscopic, **n=99** (low-grade)	OR time 139 vs 170 min; conversion 0 vs 5; 10-y OS 85.4 vs 75.5% (multivariable HR 0.39, p=0.047), PFS 차이 없음; trocar-site hernia 18.2 vs 4.1%
RASHEC (Salehi, EJC 2017)	Robotic vs open, high-risk, n=120	Para-aortic node count 20.9 vs 22 (non-inferior); blood loss·LoS ↓; 12-mo self-reported lymphedema 50 vs 61% (NS, p=0.31; IJGC 2019)
ROBOGYN-1004 (Narducci, GO 2020)	Robotic vs laparoscopic, gyn cancers, n=369	Severe morbidity 28 vs 21% (p=0.15) → **superiority 실패**; 경험 적은 기관에서 complex surgery 시 morbidity ↑ (OR 3.31, 95% CI 1.0–11; secondary analysis, Lambaudie ASO 2024)
Korean 5-center (Eoh, Front Oncol 2023)	Robotic 452 vs laparoscopic 551	**Complication 7.7 vs 13.8% (p=0.002)**; 5-y DFS 91.2 vs 90.0%, OS 97.9 vs 96.8% (차이 없음)
Korean NHIS cohort (Eoh, CRT 2021)	n=5,065 (robotic 315 / laparoscopic 3,248 / open 1,503)(2012-2016)	5-y OS 94.8 vs 91.9 vs 86.9% (claims data·selection bias 주의; Intuitive 공동저자)
NCDB type II (Lamiman, Cancers 2024)	High-risk histology, MIS n=7,168	Robotic conversion 2.7 vs 12%; 90-day mortality 1.3 vs 2.2%; OS 차이 없음
Ongoing RCTs	RObese (n=566, BMI ≥30) · ROBOT-ECO-GYN (등록 총 n=1,680; RCT+cohort)	Primary endpoint: conversion rate · cost-utility — oncologic superiority trial은 없음

Mäenpää MM, AJOG 2016;215:588 · Kivekäs E, AJOG 2025;232:304 · Salehi S, Eur J Cancer 2017;79:81 · Narducci F, Gynecol Oncol 2020;158:382 · Lambaudie E, Ann Surg Oncol 2024;31:4566 · Salehi S, IJGC 2019;29:86 · Eoh KJ, Front Oncol 2023;13:1219371 · Eoh KJ, CRT 2021;53:549 · Lamiman K, Cancers 2024;16:2584 · NCT05974995 · NCT06348719

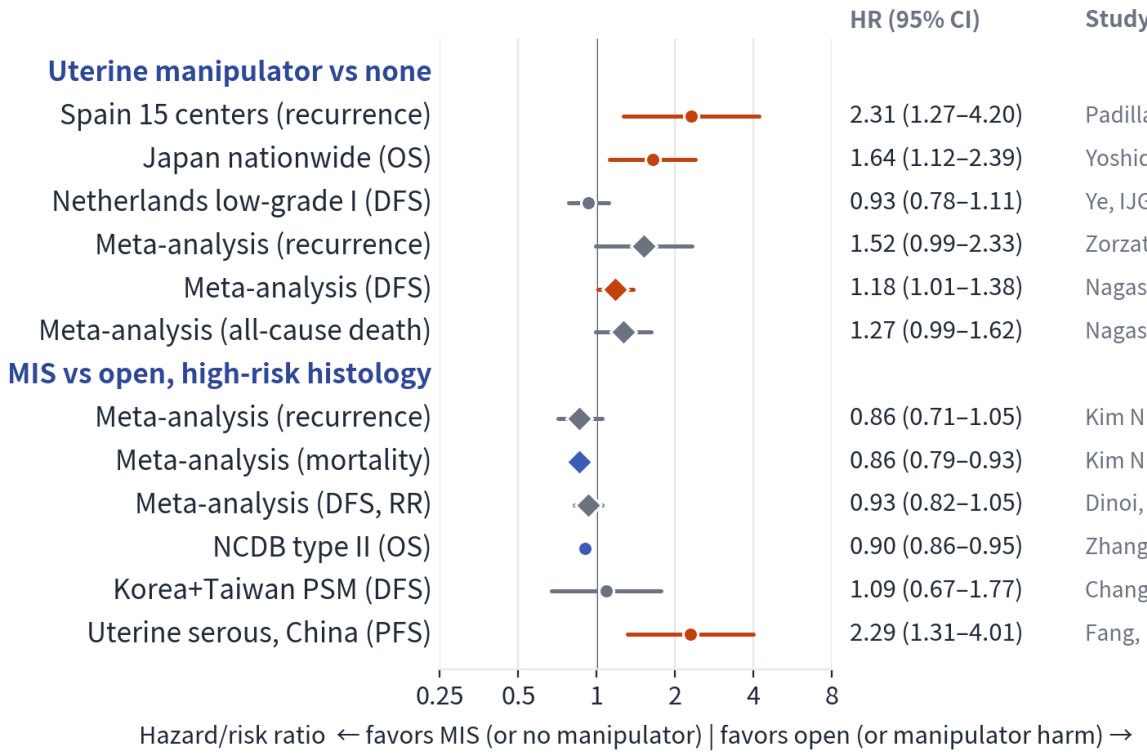
Part 3 · Endometrium

Endometrial cancer ③ Manipulator and high-risk histology

Manipulator: cohort harm signal vs RCT 2건 (Lee 2013·ROMANHY) null · High-risk histology: meta-analyses·registries는 '차이 없음'

Endometrial cancer: the two remaining controversies

Upper: manipulator vs none (HR>1 = harm with manipulator) · Lower: MIS vs open in high-risk histology (HR>1 = worse with MIS)



Uterine manipulator

- Cohort harm signal — Spain (recurrence HR 2.31), Japan (LVSI aOR 1.35, cytology aOR 1.77) vs Netherlands low-grade stage I null (DFS HR 0.93)
- Meta-analysis 2026 (12 studies, n=10,805): unadjusted DFS HR 1.18 (1.01–1.38), OS HR 1.27 NS — risk of bias 중등도–높음
- RCT 2건 — Lee 2013 (국내 n=110) · ROMANHY (n=154, 8-y f/u) 모두 null, survival 검정력 없음 → MANEC (n=1,030, 2031 RFS) · MAN-U (2027 복강 세포진)

High-risk histology

- Meta-analyses (Kim NR 2022 n=14,628: mortality HR 0.86; Dinoi 2023 NS)·registries: MIS 불리하지 않음 → ESGO 2025 MIS preferred (I, A)
- Contrarian signals: China serous PFS HR 2.29; Québec high-grade + manipulator HR 12.1 (CI 1.52–96.6, 단일기관 소집단) → 이 조합은 신중

Padilla-Iserte P, AJOG 2021 · Yoshida H, IJGC 2024 · Ye Y, IJGC 2025 · Nagase Y, Obstet Gynecol 2026;147:463 · Lee M, IJGC 2013 · Gueli Alletti S, Front Oncol 2021 (ROMANHY) · Perrone E, JMIG 2026 · Uccella S, IJGC 2024 (MANEC) · Kim NR, Gynecol Oncol 2022 · Dinoi G, Obstet Gynecol 2023 · Koek RCG, IJGC 2025 · Fang Y, Front Oncol 2025 · Côté M, Cancers 2025

Part 3 · Endometrium

Endometrial cancer ④ Korean data · molecular era · trials

국내 자료는 대체로 MIS safety 지지; stage III 소규모 반대 신호; p53abn subtype의 MIS safety는 미검증

Korean study	Population · n	Result
SMC + NTUH (Chang, ASO 2023)	High-risk EC, PSM n=284	MIS vs open DFS HR 1.09 (0.67–1.77), OS HR 0.67
SNUH (Hwang, EJSO 2024)	Non-endometrioid, n=91	5-y PFS 58.7 vs 58.5%, OS 73.6 vs 80.3% (NS); LOS 8.2 vs 15.4 d
Yonsei (Eoh, JCM 2023)	Manipulator 213 / vaginal tube 147 / open 214	PSM 후 PFS·OS 차이 없음
Ajou (Lee, JOGR 2025)	Stage III, n=79 (MIS 20)	5-y OS 50.6 vs 74.3% (open 우위, p=0.008) — 소규모, selection bias
Catholic 5-center (Kim, IJMS 2021)	Advanced stage, n=138	Recurrence 25.8 vs 43.1% (MIS 우위); OS p=0.051
KGOG 2021 (Jeong, JOGR 2025)	Very-low-risk EC, prospective n=153	MIS >90%, conversion 1%, nodal metastasis 1%

Gap in the molecular era

- **p53abn subtype에서 MIS vs open survival을 직접 비교한 published study 없음** (2026-09 기준)
- TCGA analysis (Dai 2021): MIS cohort에서만 subtype 간 survival 차이 → hypothesis level
- 유일한 registered RCT: NCT05894915 (PKU, non-hypermutated, n=390) — status unknown
- SLN mapping failure는 BMI가 아니라 tumor factor (substantial LVSI OR 3.58, MMRd/p53abn OR 3.02)와 연관 — 단일기관 obese MIS cohort n=367; 다기관 n=2,592에서는 molecular subtype 독립 예측인자 아님 (Scarpelli, IJGC 2026)

Ongoing trial (NCT)	Comparison	n	Primary endpoint	Primary completion
MANEC (NCT05687084)	Laparoscopic hysterectomy with vs without manipulator	1,030	4-y RFS	2031-12
MAN-U (NCT04586959)	MIS with vs without manipulator (non-inferiority)	278	Positive peritoneal cytology	2027-07
RObese (NCT05974995)	Robotic vs laparoscopic, BMI ≥30	566	Conversion rate	2026-09
ROBOT-ECO-GYN (NCT06348719)	Robotic vs laparoscopic, low/intermediate risk	1,680	Cost-utility	2028-03
SELYE (NCT04845828, Asan)	ICG SLN vs pelvic lymphadenectomy (MIS)	810	3-y DFS	2027-12
ENDO-3 (NCT04073706)	SLNB vs no nodal dissection (MIS)	760	Recovery · 4.5-y DFS	2031-01

Chang CS, ASO 2023 · Hwang DW, EJSO 2024 · Eoh KJ, JCM 2023 · Lee J, JOGR 2025 · Kim SI, IJMS 2021 · Jeong DH, JOGR 2025 · Dai Y, Front Oncol 2021 · Baydemir ŞK, EJSO 2026 · Scarpelli E, IJGC 2026;36:104502 · ClinicalTrials.gov 2026-10-20

Part 3 · Endometrium

Endometrial cancer ⑤ 2026 update — platform data at scale, vNOTES

NCDB·meta-analysis 2026: robotic ≈ lap (oncologic), robotic → conversion ↓ · vNOTES ≈ lap for SLN mapping (소규모 cohort)

Study (2026)	Design · n	Key result
Boyle SJ, Gynecol Oncol 2026;207:66	NCDB stage I 2010–17, n=127,342 (robotic 74.5%)	5-y OS 91.7 vs 91.4%; aHR 1.00 (0.96–1.04) — **platform 간 생존 차이 없음** (late recurrence는 추적 한계)
Keymeulen S (Matsuo), AJOG 2026;235:833	NCDB stage I–III 2012–23, n=210,615, IPTW	Conversion 1.5 vs 6.3% (IRR 0.22) · readmission IRR 0.89 · 30-d mortality 2.0 vs 2.6/1,000 (IRR 0.80) · conversion 추세 ↓ (robotic 2.1→1.0%, lap 9.0→4.8%); tumor ≥4–5 cm에서 ↑
Kalas N, EJSO 2026;52:111861 (meta-analysis)	42 studies, n=91,151	Recurrence·PFS·OS 차이 없음 · EBL·conversion ↓ (robotic) · intraoperative complication 소폭 ↑ (robotic)
De Angelis E, J Robot Surg 2026 (RCT pooled)	8 RCTs, n=647 (robotic 322 / lap 244 / open 81)	Conversion 0.7 vs 8.4% (OR 0.17, p=0.03) · 기타 perioperative 결과 유사 · direct cost ↑
Karadeniz O, IJGC 2026 (vNOTES vs lap, SLN)	4 cohorts, n=349 (vNOTES 148)	Bilateral SLN detection 86.8 vs 88.3% (OR 0.87) · LoS ↓ · conversion 2.7% — RCT·oncologic 자료 없음
Theodoridis TD, FVVO 2026 (RCT meta-analysis)	29 RCTs, n=6,127	EC: OS·DFS·DSS 동등 · (EC+CC 통합) bladder injury RR 1.84, vaginal injury ↑, wound dehiscence ↓ (MIS)
Trial status (ClinicalTrials.gov 2026-10-20)	RObese NCT05974995 · MANEC NCT05687084 · ROBOT-ECO-GYN NCT06348719	RObese: 등록상 primary completion 2026-09, 결과·갱신 없음 (최종 갱신 2024-10) · MANEC recruiting (2026-05 갱신, PCD 2031-12) · ROBOT-ECO-GYN recruiting (PCD 2028-03)

Implication — platform 선택은 oncologic 결과가 아니라 conversion·obesity·cost·training으로 결정; manipulator 연구는 교란 통제가 선결 (Matsuo, IJGC 2026 editorial 'call for research') · SGO Clinical Practice Committee의 endometrial cancer evidence-based review I·II (Urban, Gynecol Oncol 2026) 발간 — 2021년 이후 첫 전면 개정

Boyle SJ, Gynecol Oncol 2026;207:66 · Keymeulen S, AJOG 2026;235:833 · Kalas N, EJSO 2026;52:111861 · De Angelis E, J Robot Surg 2026;20 · Karadeniz O, IJGC 2026;104985 · Theodoridis TD, FVVO 2026;18:195 · Matsuo K, IJGC 2026;104890 (editorial) · Urban R, Gynecol Oncol 2026;209:15 & 120 · ClinicalTrials.gov 2026-10-20

Part 4 · Ovary

Ovarian cancer ① Early-stage staging — spillage and selection

RCT는 없으며, meta-analysis는 MIS에서 tumor spillage가 2배 많음을 보이지만 recurrence·upstaging 차이는 없습니다

OR 2.15
Tumor spillage, MIS vs open
(1.27–3.64), 13-study meta-analysis

82.3%
5-y DFS, MIS staging n=612
10 European centers (REMISSION)

48.7%
Upstaging in REMISSION
LN metastasis 9.6% (serous 15.3%)

HR 0.92
Rupture vs DFS, stage I (REMISSION)
(0.38–2.20; wide CI; limited relevance)

Nature of the evidence

- 모두 retrospective·selected patients (expert/referral center; Kamei 단일기관은 tumor <10 cm) — recurrence·complication·upstaging 차이 없음 (Kamei 2023)
- REMISSION (2026): recurrence 13.2% (71.6% peritoneal); retroperitoneal staging 여부는 high·low grade 모두 DFS와 무관 → individualization 근거
- Capsule rupture는 IC1 upstaging과 adjuvant chemotherapy 결정에 영향 → rupture 자체를 최소화하는 술기 (retrieval bag, no fragmentation)가 전제
- SENTOV II (NCT06963268, 2025–2028): early-stage OC SLN validation phase III — de-escalation 흐름

Practical principles

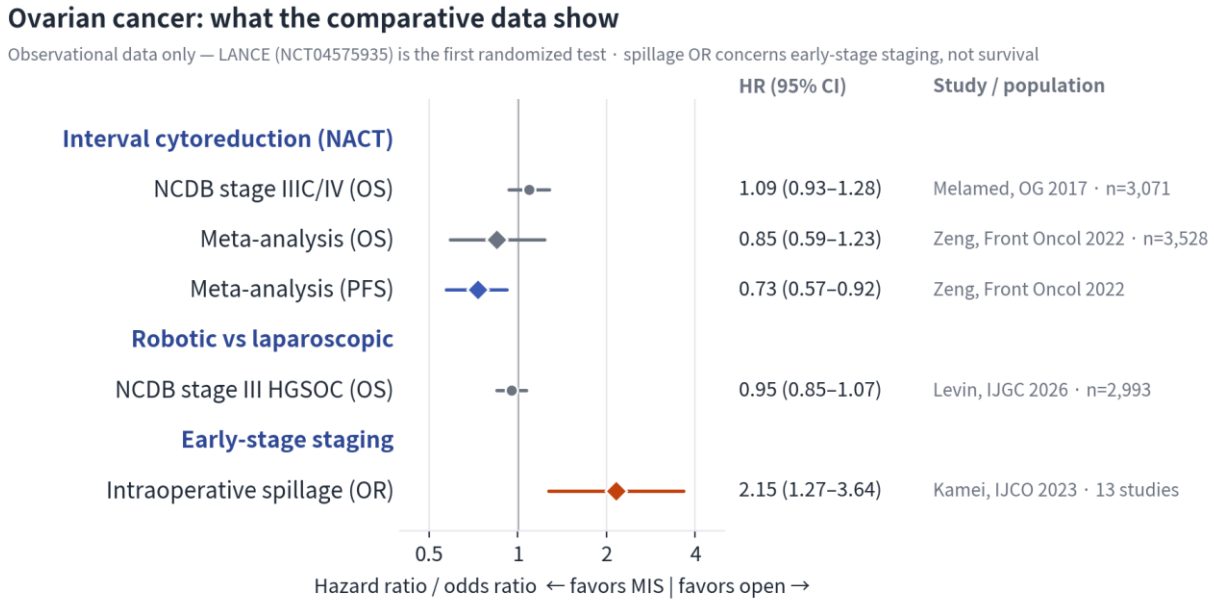
- MIS staging은 expert center에서, apparent early stage·적절한 크기·유착 없는 경우로 제한
- Specimen retrieval은 반드시 endobag, intraperitoneal cutting·morcellation 금지, trocar site 관리
- Frozen section malignancy 확인 시 같은 수술에서 complete staging (omentectomy·peritoneal biopsy·washing cytology ± nodes)
- Spillage risk가 높다고 판단되면 conversion을 주저하지 않을 것 — conversion은 실패가 아니라 원칙

Kamei Y, Int J Clin Oncol 2023;28:794 · Casarin J, IJGC 2026 (REMISSION, doi 10.1016/j.ijgc.2026.104987) · Lago V, IJGC 2026;36:102821 (SENTOV II; epub 2025-11)

Part 4 · Ovary

Ovarian cancer ② MIS interval cytoreduction after NACT

선택된 환자에서 **MIS-ICS의 survival은 open과 유사**하나, 첫 randomized trial (LANCE)의 결과는 2028년 이후에 나옵니다



Observational evidence

- NCDB IIIC/IV n=3,071 (laparoscopy 15%): **3-y OS 47.5 vs 52.6% (p=0.12), aHR 1.09**; LOS 4 vs 5 d
- INTERNATIONAL MISSION n=127: R0 96.1%, conversion 3.9%, median PFS 23 mo, 5-y OS 52%
- Meta-analysis (2022): OS HR 0.85 (NS), PFS HR 0.73 (0.57–0.92) — **selection bias 반영**
- NCDB HGSOC stage III n=2,993 (2026): robotic vs laparoscopic OS 48 vs 45 mo (aHR 0.95); conversion 4.0 vs 14.9%

Candidate selection for MIS-ICS (관찰연구·LANCE 공통)

- Good response to NACT + CA-125 normalization · ascites 호전 (trace 허용) · imaging에서 bowel·diaphragm·spleen·liver·mesentery 침범 없음
- Diagnostic laparoscopy로 resectability 확인 · 언제든 conversion 준비

LANCE (NCT04575935) — phase III non-inferiority

- MD Anderson·NCI · stage IIIC–IV high-grade EOC · NACT 3–4 cycles 후 MIS vs laparotomy · n=580 · primary DFS
- Eligibility = selection criteria 왼쪽과 동일 (CA-125 normalization or ≤500 + diagnostic laparoscopy)
- 2020-08 start · **primary completion 2028-12** · 5 countries recruiting

Melamed A, Obstet Gynecol 2017;129:861 · Fagotti A, IJGC 2019;29:5 · Zeng S, Front Oncol 2022;12:900256 · Levin G, IJGC 2026;36:104768 · Agusti N, IJGC 2026 (review) · ClinicalTrials.gov NCT04575935 (2026-10-20)

Part 4 · Ovary

Ovarian cancer ③ 2026 update — rupture revisited, LARGES, JSGO 2025

NCDB 2026: rupture 없는 MIS는 open과 OS 동등 (aHR 0.94); rupture 후 OS 저하는 MIS군에서만 유의 (aHR 1.52; open군 NS)

Capsule rupture — NCDB 2018–2023 (Matsuo, JAMA Oncol 2026;12:664)

- 일측 stage IA·IC1 upfront surgery n=11,425 · MIS 50.5% (robotic 24.9%, 2018→2023 17.9→31.9%)
- Rupture 21.9% (MIS) vs 19.4% (open), IRR 1.17 (1.07–1.27)
- Rupture → OS: **MIS aHR 1.52** (1.13–2.06; 3.5-y OS 92.6 vs 94.7%) · open aHR 1.30 (0.94–1.79, NS)
- 가설: Trendelenburg·CO_2 pneumoperitoneum에서 spill 확산, port-site 노출

No-rupture adnexectomy — NCDB (Matsuo, IJGC 2026;36:104871)

- Stage IA, rupture 없는 adnexectomy n=15,572 (MIS 5,867 / open 9,705), IPTW
- 5-y OS 92.4 vs 92.0%, **aHR 0.94** (0.80–1.11) — type I·II EOC, sex cord-stromal, germ cell, robotic/lap 모두 일관
- REMISSION (MIS staging 5-y DFS 82.3%)과 종합하면 조건은 'approach'가 아니라 'intact removal' — 단 rupture 예후는 REMISSION (HR 0.92)·NCDB (aHR 1.52)가 상반

Korean data — LARGES / GORILLA-3005 (Kong TW, Gynecol Oncol 2026;210:148)

- Stage I adult granulosa·Sertoli-Leydig n=337 (lap 180 / open 157), median f/u 53 mo
- 10-y DFS 53.9% (lap) vs 74.3% (open), p=0.040 — 다변량: stage IC OR 3.06, morcellation OR 2.85; **MIS 자체는 독립 인자 아님**
- MIS군에서 morcellation 多 → sex cord-stromal에서도 endobag·no morcellation 원칙

Guidance and trials, 2025–2026

- JSGO ovarian 2025 (JGO 2026;37:e150) CQ09: 경험 있는 gyn oncologist·학회 지침·scientific validation 전제로 MIS 권고 — strength 1 (↑↑), evidence C, consensus 91%; CQ05 diagnostic laparoscopy 권고 (2↑, B)
- MIS-ICS BMI-stratified PSM (Liu H, Surg Endosc 2026, n=256): PFS·OS 차이 없음; BMI ≥24에서 bowel injury ↓·R0 ↑ (selection bias)
- LANCE recruiting (PCD 2028-12) · SENTOV II recruiting (2025-11 개시) · PIPAC-OVPAC not yet recruiting (2025-12 이후 미갱신)

Matsuo K, JAMA Oncol 2026;12:664 · Matsuo K, IJGC 2026;36:104871 · Kong TW, Gynecol Oncol 2026;210:148 (GORILLA-3005) · Shoji T, J Gynecol Oncol 2026;37:e150 (JSGO 2025) · Liu H, Surg Endosc 2026;40:5064 · Casarin J, IJGC 2026 (REMISSION) · ClinicalTrials.gov 2026-10-20

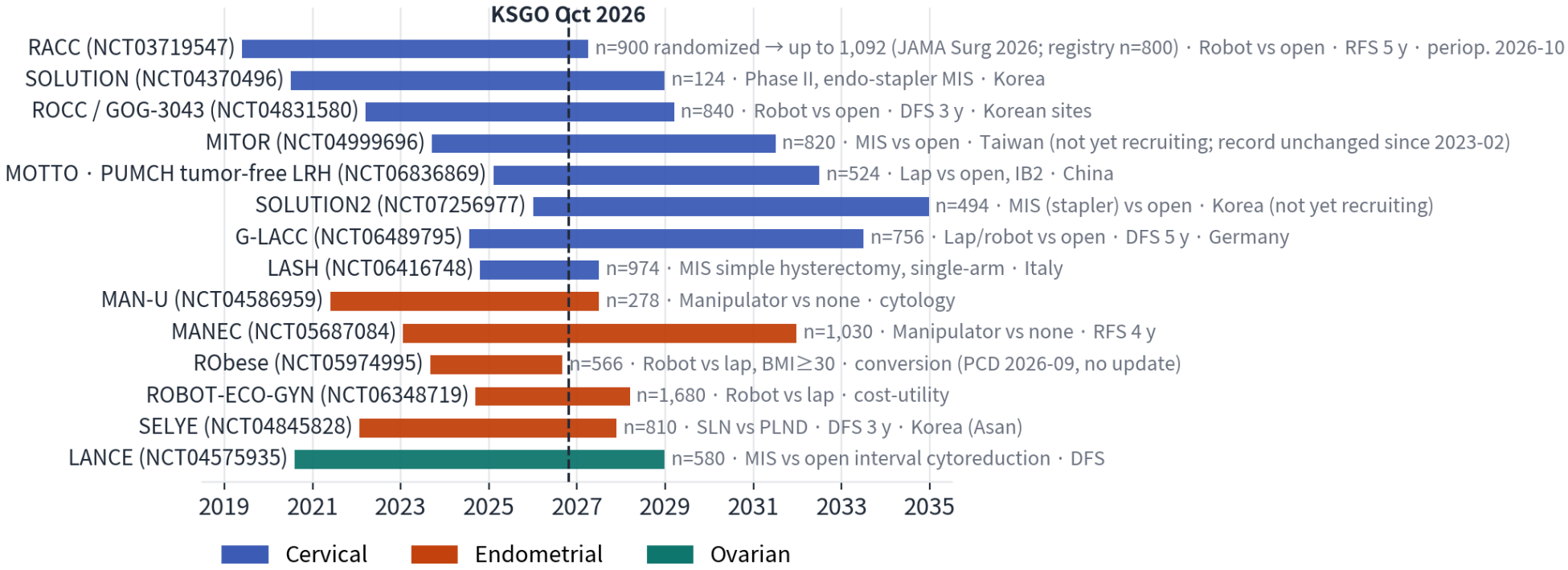
Part 5 · Synthesis

Synthesis ① The next 8 years — which trial answers what

2027 RACC·LASH·SELYE·MAN-U, 2028 LANCE·SOLUTION, 2029 ROCC, 2031–34 MANEC·MITOR (미갱신)·MOTTO·G-LACC·SOLUTION2

Ongoing trials of MIS in gynecologic cancers: start → primary completion

ClinicalTrials.gov, verified 2026-10-21. Bars end at the registered primary completion date.



ClinicalTrials.gov, 2026-10-20 검색 기준 primary completion date · 결과 발표는 통상 1차 완료 후 1–2년 · 2026-10 갱신: RACC 900 randomized → 최대 1,092 (JAMA Surg 2026; 등록상 n=800)·SOLUTION2·RObese 상태

Part 5 · Synthesis

Synthesis ② Evidence map 2026 — where MIS stands

'Standard'와 'contraindicated' 사이의 회색지대는 patient selection·protective technique·center experience·trial enrollment로 채웁니다

Cancer · setting	Current position of MIS	Level of evidence	Key conditions · open questions
Cervical · radical hysterectomy (IB1–IB2)	**Open is standard**	RCT (LACC) + meta-analyses	RACC (periop. 이득 작음, 2026)·ROCC·G-LACC·SOLUTION2 결과 전까지 MIS는 trial 내 또는 low-risk + protective technique 조건부
Cervical · low-risk (≤2 cm, SHAPE criteria)	**Simple hysterectomy; approach conditionally acceptable**	RCT exploratory + cohort	Cone margin (−), no manipulator, vaginal closure; deaths 5/524 vs 0/156 (탐색적·비무작위) 미해결 — LASH 2027; SLN-only 비열등 (PHENIX-I) · NCCN 2027 SLN preferred
Cervical · radical trachelectomy	**MIS acceptable (selected)**	Multicenter cohorts (KGOG 1048 etc.)	Tumor <2 cm; 술기 원칙 동일
Endometrial · early-stage, low-risk	**MIS is standard**	RCTs (LAP2, LACE)	SLN (ICG) 병행이 사실상 package; spillage·morcellation 금지
Endometrial · high-risk histology / high-risk group	**MIS preferred (ESGO 2025, I A)**	Meta-analyses · registries	자궁 밖 전이 (LN 제외)는 relative contraindication (ESGO III, B); high-grade + manipulator 조합 회피
Endometrial · uterine manipulator	**Controversial — avoid or minimize**	Cohort harm signal vs RCT null	MANEC (2031, RFS)·MAN-U (2027, 복강세포진 endpoint) 대기; 사용 시 기록·audit
Ovarian · apparent early-stage staging	**Expert center, conditional**	Meta-analysis (retrospective)	Spillage OR 2.15 · rupture → OS aHR 1.52 (NCDB 2026) · endobag, no fragmentation, complete staging
Ovarian · interval cytoreduction after NACT	**Trial or strict selection**	Cohorts · meta-analysis	LANCE (2028) 대기; CA-125 normalization·no upper abdominal disease
Ovarian · primary cytoreduction (advanced)	**Not recommended**	No evidence	Diagnostic laparoscopy (predictive score)는 별개 역할

Synthesis of the primary literature and guidelines cited in this lecture (NCCN, ESGO/ESTRO/ESP 2023·2025) · gray = conditional/controversial, blue = supports MIS, orange = open standard or not recommended

Part 5 · Synthesis

Synthesis ③ Research agenda 2026–2035 — beyond 'MIS vs open'

질문이 '접근법'에서 '누구에게 · 어떤 술기로 · 어떤 플랫폼으로'로 이동 — 6개 연구 축과 각 축의 진행 중 근거

① Tumor containment as a testable intervention

- G-LACC (LEEP/cone 또는 vaginal closure 필수), SOLUTION2 (endoscopic stapler), PUMCH tumor-free technique — containment 자체가 시험 변수
- 다음 단계: 술기 QA (credentialing · video audit)로 'containment MIS'를 정의하고 준수율을 보고

② De-escalation package: simple hysterectomy + SLN

- PHENIX-I (NEJM 2025, n=838): SLN-only 비열등 (3-y DFS 96.9 vs 94.6%) · SENTICOL III (n=989, 2027) · LASH (MIS simple hyst., n=974, 2027) · SELYE · ENDO-3 · NCCN v1.2027 SLN preferred
- 저위험군에서 '덜 절제 + 덜 침습'의 안전성이 확정되면 개복 논쟁의 대상 자체가 축소

③ Precision selection: molecular · imaging · ctDNA

- non-hypermutated EC (p53abn 포함) open vs lap RCT (NCT05894915, 상태 불명) · MRI deep learning의 parametrial invasion 예측, external AUC 0.91 (n=63, Cui 2025)
- HPV cfDNA clearance가 RFS 예측 (Seo 2025; chemoRT n=66) → 수술 환자 MRD 감시로 외삽은 검증 필요

④ Platforms: single-port · new robots · cost

- da Vinci SP·Hugo 등 13개 플랫폼 92개 연구, 대부분 후향적 (Bruno 2026); 신규 플랫폼 수술비용 45–60% ↓ (Pal 2024; 3개 연구, 비뇨기·외과 위주)
- 국산 Revo-i (혁신제품 지정·해외 10개국 허가) 등 신규 플랫폼의 부인암 oncologic data 부재 → 전향적·경제성 연구가 도입 조건

⑤ Advanced ovary: MIS as access, not only approach

- LANCE (2028)가 MIS-ICS의 위치를 결정; diagnostic laparoscopy 기반 환자 선택은 이미 표준
- PIPAC — SNUH PIPAC-OVPAC phase 1/2a (NCT07273396, 등록상 not yet recruiting, 2026-10): MIS가 약물전달 플랫폼으로 확장

⑥ Real-world evidence: registry · target-trial emulation

- 전향적 registry(KGOG)에 접근법·조작기·질 폐쇄·종양 크기 기록 — 청구자료(HIRA)의 교란 보완
- Target-trial emulation(프랑스 SNDS 난소암, n=2,772): 플랫폼·조작기 등 RCT 밖 질문
- 국내: 접근법별 전국자료 보고 없음 → 술기 변수 registry가 첫 단계

ClinicalTrials.gov NCT06489795 · NCT06416748 · NCT03386734 · NCT05894915 · NCT07273396 · NCT04831580 · NCT04845828 · NCT07256977 (2026-10-21) · Cui Y, Magn Reson Imaging 2025;125:110542 · Seo A, Clin Cancer Res 2025;31:697 · Bruno M, J Robot Surg 2026;20 · Pal A, J Robot Surg 2024;18:386 · Tu H, NEJM 2025;393:1463 (PHENIX-I) · Matsuo K, IJGC 2026;104890 (editorial) · Jochum F, AJOG 2025;232:194.e1 · Kim JH, Cancer Res Treat 2019;51:788

Part 5 · Synthesis

Synthesis ④ Future value — what MIS must deliver by 2030

'가능 (feasible)'을 '가치 (value)'로 바꾸는 조건 — 환자 · 종양학 · 시스템 세 축과 연도별 판정 시점

Patient value — QoL · recovery · function

- Now: LAP2/LACE에서 **합병증 ↓·QoL ↑**; SHAPE simple hysterectomy는 urinary (Plante, NEJM 2024)·sexual function (Ferguson, JCO 2025) 우위
- Needed: approach별 PRO(patient reported outcome)를 co-primary endpoint로 (SENTICOL III의 DFS+QoL 모델), 장기 성기능·림프부종 자료

Oncologic value — non-inferiority with containment

- Now: LACC·NCDB 열등, SUCCOR 10-y (전체 cohort)·SHAPE 탐색·Ontario 저위험군 '무해 신호' · RACC 2026: perioperative 이득 작음
- Needed: **ROCC·RACC·G-LACC·SOLUTION2의 비열등성과 술기 준수율 보고; LANCE로 MIS-ICS 판정**

System value — cost · access · training

- Now: 로봇 비용이 주요 장벽; 신규 플랫폼 45–60% 저비용 (Pal 2024; 3개 연구), ROBOT-ECO-GYN cost-utility (2028)
- Needed: 국내 수가·비용-효과 자료, 학습곡선 (≥60례)을 반영한 training·credentialing 체계

Year	Trial	If the result is …	Then practice …
2027	RACC (n=900) · LASH · SENTICOL III	robotic RH 비열등 / MIS simple hysterectomy 안전 / SLN-only 비열등	저위험·containment 조건부 MIS 재개 논의, simple hysterectomy + SLN-only package
2028	LANCE · SOLUTION	MIS-ICS DFS 비열등 / stapler MIS 4.5-y DFS 양호 (single-arm phase II)	NACT 반응군에서 MIS-ICS option; SOLUTION2 RCT 근거로 연결
2029	ROCC (GOG-3043)	비열등 → / 열등 →	guideline 개정 논의 (containment robotic RH) / open 표준 유지, MIS는 simple hysterectomy에 한정
2031	MANEC	manipulator RFS 비열등 / 열등	자궁내막암 manipulator 허용 조건 명시 / 고위험군 금지
2033–34	G-LACC · SOLUTION2	유럽·국내 non-inferiority	KSGO 가이드라인의 국내 근거; 술기 표준 (LEEP·closure·stapler) 확정

Ferguson SE, J Clin Oncol 2025;43:167 (SHAPE QoL) · Pal A, J Robot Surg 2024;18:386 · ClinicalTrials.gov (2026-10-20) — 연도는 등록된 primary completion 기준, 결과 발표는 통상 1–2년 후

Part 5 · Synthesis

Take-home messages

LACC 이후 8년의 교훈은 'approach'보다 'tumor exposure를 막는 원칙'과 'patient selection'이 결과를 결정한다는 것입니다

1	**Open radical hysterectomy remains the standard in cervical cancer**	LACC final analysis (DFS HR 3.91, OS HR 2.71)와 meta-analyses가 근거. SUCCOR 10-year·low-risk cohort의 '차이 없음'은 hypothesis-generating 수준. RACC (2026)는 perioperative 결과만 — oncologic 판정은 2027.
2	**Exceptions exist only as a combination of conditions**	**≤2 cm · cone margin negative · no manipulator · vaginal closure before colpotomy · skilled surgeon · documented counseling** — 이 중 containment 요소 (no transcervical manipulator · vaginal closure/LEEP · stapler)가 ROCC·G-LACC·SOLUTION2 protocol에 내장 (세 시험 모두 <4 cm; SOLUTION2는 ≥2 cm).
3	**Endometrial cancer: MIS preferred up to high-risk (ESGO 2025, I A)**	남은 논란은 **uterine manipulator** — high-grade·large tumor에서는 회피, low-grade stage I에서는 무해 신호 (cohort). MANEC (2031)이 답.
4	**Ovarian cancer: separate 'feasible' from 'standard'**	Early-stage staging은 expert center 조건부 (spillage OR 2.15; rupture 시 OS aHR 1.52 — NCDB 2026); NACT 후 ICS는 LANCE (2028) 결과 전까지 strict selection 또는 clinical trial.
5	**Until the trials report (2027–2034): practice and record**	가이드라인 범위 안에서 approach 선택 · 술기 원칙 (no transcervical manipulator · vaginal closure · endobag) 표준화 · approach·manipulator·tumor size 기록 — RACC (2027)·ROCC (2029)·SOLUTION2 (2034) 결과에 따라 재평가.



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