

Robotic vs Laparoscopic Pancreaticoduodenectomy

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ABSTRACT

Background: The comparative effectiveness of robotic vs laparoscopic pancreaticoduodenectomy (RPD vs LPD) for **malignant** disease is uncertain.
Methods: PRISMA-guided systematic review and random-effects meta-analysis (PROSPERO CRD42025634636) of primary studies comparing RPD and LPD for pancreatic/periampullary cancers (search to Aug 1, 2024). Outcomes: operative metrics, oncologic proxies, complications, and 90-day mortality; ROBINS-I bias assessment; sensitivity and pancreatic-cancer subgroup analyses.
Results: 8 studies; 6,648 patients (1,964 RPD; 4,684 LPD). RPD reduced **length of stay** (MD -0.94 days; p=0.005) and **conversion** (OR 0.20; p<0.00001) and increased **lymph-node yield** (MD +1.02; p=0.01). **Overall morbidity** was lower (OR 0.50; p=0.05) but lost significance in some sensitivity analyses and in the pancreatic-cancer subgroup. No differences in blood loss, operative time, transfusion, R0, major complications, pancreatic fistula, delayed gastric emptying, reoperation, or 90-day mortality.
Conclusions: RPD offers perioperative advantages with similar safety and oncologic surrogates to LPD; however, heterogeneity and retrospective evidence temper certainty. Further high-quality, cancer-specific trials are needed.

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INTRODUCTION

Pancreaticoduodenectomy (PD) is pivotal for pancreatic and periampullary cancers but remains complex. With minimally invasive approaches expanding, the relative performance of **robotic PD (RPD)** vs **laparoscopic PD (LPD)** for malignant disease alone is unclear.

METHODS AND MATERIALS

PRISMA-2020/Cochrane-guided systematic review and meta-analysis (PROSPERO CRD42025634636). PubMed, Scopus, Cochrane to **Aug 1, 2024**. Primary studies comparing **RPD vs LPD** for malignant pancreatic/periampullary tumors. Random-effects models; MD/OR with 95% CIs; I² for heterogeneity. ROBINS-I for bias. Sensitivity (“leave-one-out”) and a **pancreatic-cancer-only** subgroup.

RESULTS

- 8 studies; n=6,648 (RPD 1,964; LPD 4,684).
- Length of stay:** ↓ with RPD (MD **-0.94 days**, p=0.005; I²=56%).
- Conversion:** ↓ with RPD (OR **0.20**, p<0.00001; I²=0%).
- Lymph nodes:** ↑ with RPD (MD **+1.02**, p=0.01; I²=32%).
- Overall morbidity:** ↓ with RPD (OR **0.50**, p=0.05; I²=57%); became non-significant in some sensitivity runs.
- No differences:** EBL (p=0.72), operative time (p=0.28), transfusion (p=0.12), **R0** (p=0.60), major complications (p=0.54), pancreatic fistula (p=0.06), delayed gastric emptying (p=0.58), reoperation (p=0.20), 90-day mortality (p=0.97).
- Pancreatic-cancer subgroup:** results consistent except **overall morbidity** → non-significant.

DISCUSSION

For malignant PD, **RPD** shows pragmatic advantages—**shorter hospitalization, fewer conversions, and slightly higher nodal yield**—with broadly **comparable safety and oncologic proxies** to LPD. Morbidity benefits are sensitive to study inclusion and attenuate in pancreatic-cancer-only analyses, suggesting possible case-mix effects (periampullary disease). Evidence is limited by retrospective designs and heterogeneity.

CONCLUSIONS

Conclusion: RPD is a reasonable minimally invasive option with certain perioperative advantages, but definitive superiority over LPD is unproven. Well-designed, cancer-specific multicenter studies (ideally RCTs) should test long-term oncologic outcomes, stratify by pathology and center volume, and standardize reporting.

