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**MINIMALLY INVASIVE APPROACH TO PANCREATODUODENECTOMY:
A LITERATURE REVIEW**

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Open pancreatoduodenectomy (OPD) has long been viewed as the benchmark for one of the surgery's toughest procedures. Over the past decade, laparoscopic (LPD) and robotic (RPD) versions have entered the scene, challenging that long-held standard. Here is the problem: pancreatic ductal adenocarcinoma (PDAC) is on track to become the second deadliest cancer by 2030. This means we cannot wait another ten years to figure out whether minimally invasive pancreatoduodenectomy (MIPD) truly holds up - on safety, on getting clean margins, and on results that hospitals across the board can reproduce.

This review compared minimally invasive pancreatoduodenectomy (both laparoscopic and robotic) to the open procedure using data from randomized controlled trials only. The primary endpoints were 90-day mortality, major postoperative morbidity (Clavien-Dindo grade III or higher), and R0 resection rates. Operative time and the impact of the learning curve were examined as secondary outcomes.

A search of large-scale meta-analyses of randomized trials over the past five years was conducted in three databases: PubMed, Cochrane, and Scopus. Key outcomes monitored were major complications (Clavien-Dindo grade \geq III), 90-day mortality, and R0 resection rate. Operative time, pancreatic fistula rate, and length of hospital stay were secondary outcomes.

Seven randomized trials, including 1,428 patients, formed the evidence base. Ninety-day mortality was 2.9% for MIPD versus 2.6% for open—essentially identical. Major complications (Clavien-Dindo \geq III) occurred in 29.4% of MIPD patients and 25.6% of open patients; the difference is not statistically significant. Positive margins (R1) were 6.2% for MIPD versus 7.0% for open. Operative time was 51 minutes longer for MIPD. One large robotic study of 635 operations found proficiency required roughly 60 cases and mastery nearly 85; centers doing fewer than 20 per year had worse outcomes. The LEOPARD-2 trial was terminated early after the laparoscopic arm showed 6% mortality versus 1% in the open arm.

Three conclusions emerge from this synthesis. One: MIPD is non-inferior to open surgery on mortality, major morbidity, and R0 resection, but this holds true only in high-volume centers where surgeons have passed the learning curve. Two: the evidence base leans heavily on mixed periampullary tumors; PDAC-specific data remains too thin for firm recommendations. Three: publication bias exaggerates the benefits of MIPD because negative results from low-volume centers rarely see print.

Minimally invasive pancreatoduodenectomy is non-inferior to open surgery in expert hands. In inexperienced hands, it is dangerous. Structured training pathways are urgently needed. Until PDAC-specific randomized trials are completed, open surgery should remain the gold standard for pancreatic cancer patients. The future of MIPD depends not on better technology, but on better training and better trials.