



# Clinical evidence in minimal invasive pancreatic surgery

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Minimally invasive surgical techniques have become essential in the treatment of colorectal, bariatric, and upper gastrointestinal diseases. These minimally invasive techniques offer significant advantages over open surgery, such as reduced postoperative pain and faster recovery. However, due to the unique characteristics of the pancreas and the associated high postoperative morbidity, the adoption of minimally invasive pancreatic surgery (MIPS) has been gradual. As a novel approach, MIPS should meet or exceed the standards established by open surgery, which include a mortality rate of less than 2% for pancreatoduodenectomy (PD) and less than 1% for distal pancreatectomy (DP), with overall morbidity rates of less than 53% for PD and 59% for DP. Several randomized controlled trials have assessed the role of minimally invasive pancreatic surgery (MIPS). In a study by Palanivelu, laparoscopic pancreaticoduodenectomy (LPD) was compared to open pancreaticoduodenectomy (OPD). The findings indicated that LPD was associated with a shorter hospitalization period (7 vs. 13 days,  $P=0.001$ ) and reduced intraoperative blood loss (401 vs. 250 mL,  $P<0.001$ ), although it was characterized by a longer operative time (359 vs. 320 minutes,  $P=0.041$ ). The morbidity, mortality, R0 resection rate, and mean number of lymph nodes retrieved were comparable between the two groups. The PADULAP trial produced outcomes comparable to those reported by Palanivelu, demon-

strating a significantly reduced incidence of Clavien-Dindo grade  $\geq 3$  complications in the LPD group (5 vs. 11 patients,  $P=0.04$ ). Nevertheless, pancreas-specific complications were analogous between the LPD and OPD groups. Furthermore, the margin status, the number of lymph nodes retrieved, and the 90-day mortality rates were similar across the two cohorts. In 2019, the LEOPARD-2 trial was terminated early due to an unexpectedly high mortality rate in the LPD group (10%) compared to the OPD group (2%). A recently published randomized controlled trial by Wang *et al.* corroborates the findings of previous studies. There was no significant difference in 90-day mortality, serious postoperative complications, or comprehensive complication index scores. These trials demonstrated that LPD is safe and feasible in the hands of experienced surgeons. The application of minimally invasive pancreatic surgery (MIPS) in left-sided pancreatic disease was evaluated in the LEOPARD trial, which compared outcomes following minimally invasive surgery (MIS) or open distal pancreatectomy (DP) in patients with benign or malignant lesions. MIPS resulted in a shorter functional recovery time compared to the open approach, with reduced intraoperative blood loss, less delayed gastric emptying, and improved quality of life during the first month post-surgery. A Swedish single-center, open-label randomized controlled trial (RCT) also compared outcomes following open or

laparoscopic distal pancreatectomy (LDP) in patients with benign and malignant lesions. LDP was associated with reduced intraoperative blood loss, shorter functional recovery time, and decreased hospital length of stay (LOS) compared to the open approach. Both surgical methods were comparable in terms of operative time and postoperative complications. The DIOPLOMA trial conducted a comparative analysis of minimally invasive pancreatic surgery (MIPS) and open distal pancreatectomy (ODP) in the context of left-sided pancreatic adenocarcinoma. The trial provided evidence supporting the non-inferiority of MIPS compared to ODP with respect to radical resection rates in patients with resectable pancreatic cancer. The meta-analysis of randomized controlled trials conducted by Pfister *et al.* provides Level 1 evidence indicating that minimally invasive pancreatic surgery is associated with a reduced length of hospital stay and decreased intraoperative blood loss compared to open pancreatic surgery. Furthermore, the morbidity and mortality rates were found to be comparable between the two surgical approaches. The introduction of robotic platforms, which offer advantages over conventional laparoscopic surgery such as enhanced instrument dexterity, three-dimensional visualization, and improved ergonomics, establishes an optimal framework for minimally invasive pancreatic surgery (MIPS). Zureikat *et al.* reported the outcomes of 500 consecutive robotic-assisted pancreatoduodenectomies. The results are significant, with major complications occurring in less than 24% of cases, a clinically relevant postoperative pancreatic fistula rate of 7.8%, and 30- and 90-day mortality rates of 1.4% and 3.1%, respectively. The median length of hospital stay was 8 days. The authors concluded that the robotic platform is both safe and feasible when implemented through a structured approach. The recently published EUROPA trial involved a randomization of participants to either the RPD group (n = 41) or the OPD group (n = 40). The incidence of grade B/C pancreas-specific complications was higher in the RPD group compared to the OPD group, with 17 cases (58.6%) versus 11 cases (33.3%),

respectively (p = 0.046). Additionally, RPD was associated with a higher incidence of clinically relevant delayed gastric emptying, as well as increased procedure-related and overall hospital costs. The duration of surgery was also longer in the RPD group compared to the OPD group. The overall 90-day mortality rate was 4.8%, with no significant differences observed between the RPD and OPD groups. The authors concluded that, within the context of a high-volume center, both RPD and OPD can be considered safe techniques. A meta-analysis conducted by Kamarajah *et al.* examined twenty non-randomized studies encompassing 3,112 patients, comparing 793 robotic distal pancreatectomies (RDP) with 2,319 laparoscopic distal pancreatectomies (LDP). The findings indicated that LDP was associated with a shorter operative time (mean: 28, p < 0.001), although there was no significant difference in blood loss (mean: 52 mL, p = 0.07) when compared to RDP. RDP was associated with significantly lower conversion rates than LDP (OR 0.48, p < 0.001), yet there was no difference in spleen preservation rate and R0 resection. Additionally, no differences were observed in overall and major complications, as well as overall and clinically relevant pancreatic fistula. The authors concluded that RDP offers certain advantages over LDP, although both techniques appear to be equivalent. In conclusion, minimally invasive procedures (MIPS) can yield outcomes comparable to those of open surgery. However, the selection of the appropriate treatment modality should be guided by the experience of the surgical team and the capabilities of the medical center. Additionally, patient and disease characteristics must be integrated into the decision-making process to ensure the optimal surgical approach is chosen.

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