Editorial

Which is the optimal minimally invasive approach for distal pancreatectomy—robotic assisted or conventional laparoscopy?

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We read with interest the study by Guerrini *et al.* (1), entitled "Robotic versus laparoscopic distal pancreatectomy: an up-to-date meta-analysis", published recently in BMC Surgery. The authors initially planned to perform a systematic review and meta-analysis of randomized controlled trials (RCTs), comparing robotic *vs.* laparoscopic distal pancreatectomy. However, in their systematic review, they could not identify any RCTs on published on the subject and hence a meta-analysis of observational studies was performed instead.

In their study, the methodological quality of the studies analyzed was measured using the Newcastle-Ottawa scale (2) and only studies that reached seven points were considered qualitatively eligible for the meta-analysis. The authors finally included 10 articles (3-12) (267 robotic and 546 laparoscopic cases) out of 34 full text articles which met their inclusion criteria. Of note, 3 previous meta-analyses have been conducted recently on the same topic, all of which were published in 2016 (*Table 1*). The study by Huang *et al.* (13) included 9 articles, of which 2 studies by Ito *et al.* (14) and Adam *et al.* (15); were not included in the present meta-analysis. In the meta-analysis by Zhou *et al.* (16), 7 studies were analyzed of which all 7 were included in the present study (1,3-5,7-10). Gavriilidis *et al.* (17) analyzed 9 articles, of which 8 were included in the present study (3-5,7-11). The study by Ryan *et al.* published in 2015 in JSLS (15) in that study was not included in the present analysis. All, three previous meta-analyses concluded that both techniques, robotic distal pancreatectomy (RDP) *vs.* laparoscopic distal pancreatectomy (LDP), were associated with no significant difference with most perioperative outcomes including postoperative morbidity and open conversion rate. In the study by Gavriilidis (17), RDP was associated with a significantly shorter length of stay but increased readmission rate whereas Zhou *et al.* (16) found RDP to be associated with a lower blood loss, higher SP rate, shorter hospital-stay but longer operation time compared to LDP. In the study by Huang *et al.* (13), there was no significant difference in any of the outcomes between RDP and LDP.

In the present meta-analysis, both the RDP and LDP arms were comparable with respect to demographics (age, body mass index and gender), comorbidities (American Society of Anaesthesiologist score) and pathological characteristics. The key significant finding in this study, were that RDP was associated with a lower conversion rate 8.2% (19/230) *vs.* 21.6% (109/503) (OR =0.33; 95% CI, 0.12–0.92, P=0.03), higher spleen preservation (SP) rate 48.9% (106/198) *vs.* 27%% (76/281) (OR= 2.89; 95% CI, 1.78–4.71, P<0.001), shorter length of stay (7.18 *vs.* 9.08 days mean difference = −0.71%; 95% CI, −1.3– −0.15; P=0.01) but higher costs (mean difference =5.24, 95% CI, 3.52– −6.95, P<0.00001) compared to LDP. However, when considering these results, the high risk of bias inherent with the retrospective comparative studies included in this meta-analysis must be taken into account.

For example, the superior results observed with RDP with respect to conversion rate could be partly explained by surgeons having previously overcame part of the learning

Table 1 Summary of previous meta-analyses comparing RDP

Author	Year	Country	Studies included	Study design	RDP/LDP(n)	Significant findings
Huang	2016	China	(3-10)	Retrospective (3-8)	238/29	Conversion similar
				Prospective (9,10)		SP similar
			Ito 2013	Retrospective	4/10	Operative time similar
			Adam 2015	Retrospective	61/474	Morbidity similar
						Hospital stay similar
Zhou	2016	China	(3-5,7-10)	Retrospective (3-5,7,8)	211/357	Conversion similar
				Prospective (9,10)		Mayor SP RDP
						Minor blood loss RDP
						Mayor operative time RDP
						Morbidity similar
						Minor hospital-stay RDP
						Mayor cost RDP
Gavriilidis	2016	France	(3-5,7-11)	Retrospective (3-5,7,8,11)	246/391	Conversion similar minor blood loss RDP
				Prospective (9,10)		Operative time similar
			Ryan 2015	Retrospective	18/16	Morbidity similar
						Minor hospital-stay RDP
						Mayor readmission RDP
Present Study	2017	Italy	(3,12)	Retrospective (3-5,7,8,11,12)	267/546	Minor conversion RDP
				Prospective (9,10)		Mayor SP RDP
						Blood loss similar
						Operative time similar
						Morbidity similar
						Minor hospital-stay RDP
						Mayor cost RDP

RDP, robotic distal pancreatectomy.

curve with minimally invasive pancreatectomy, rather than the technical superiority of the robotic platform (12,18). This is because although it is commonly postulated that the learning curve for robotic surgery is shorter and less steep compared to conventional laparoscopy for surgeons transitioning from open surgery, there is little evidence to support this. In most studies, surgeons would have acquired prior experience with conventional laparoscopy before embarking on robotic surgery rather than transitioning directly from open surgery to robotic surgery (5).

Presently, splenic preservation (SP), is preferred when distal pancreatectomy (DP), is performed for benign and premalignant pancreatic conditions due to the important immunological function of the spleen despite its technical difficulties compared to distal pancreatosplenectomy (19). However, SPDP is a technically-demanding procedure especially when performed via the Kimura technique (vessel preserving) (19). It is important to note that in addition to technical factors, the rate of SP may also depend on the indication of pancreatectomy as SP is usually not considered for malignancies (15). Hence, the difference in SP rate observed between RDP and LDP could also be explained

by selection bias as surgeons could preferentially select cases requiring SPDP for robotic surgery (4,9,12). Nonetheless, it is important to note add that circumstantial evidence from non-comparative studies also seem to support the superiority of SP in RDP compared to LDP. For example, 2 recent large series from highly experienced surgeons reported that the rate of SP for LDP was only 58-80% of which only 50-75% were successfully performed using the Kimura technique (20,21). On the other hand, SP rate for RDP have reported to be over 90% even from small series (10,22).

In this study, RDP was associated with shorter length of stay compared to LDP. This meta-analysis showed a statistically significant reduction in the hospital stay by 1.9 days (RDP *vs.* LDP 7.18 *vs.* 9.08 days mean difference = −0.71%, 95% CI, −1.3 to −0.15; P=0.01). This was concordant with the findings of several authors including the 2 previous meta-analyses by Gavriilidis (17) and Zhou *et al.* (16) which also demonstrated that RDP was associated with a shorter length of hospital stay compared with LDP (3-5,7-11,17,23). It is difficult to postulate the reason behind this finding as there was no significant difference in postoperative morbidity between both groups. Nonetheless, the lower conversion rate observed with RDP could account for this. Similarly, it is essential to add that biases arising from surgeons and even patients' attitudes and practices in favour of RDP could account for this finding. It is also important to add that readmission rates were not analyzed in the present review and imperative to highlight that the previous study by Gavriilidis (17) demonstrated that although RDP was associated with a shorter hospital stay, it was also associated with a higher readmission rate.

Presently, despite advances in pancreatic surgery, postoperative pancreatic fistula remains a major complication after pancreas surgery and remains the most common cause of post-operative morbidity (24). To date, there is no strong evidence that the type of surgical approach (RDP *vs.* LDP *vs.* open), parenchymal transection or closure technique determines the pancreatic fistula rate (8). The results of the present study are concordant with these findings. There was no significant difference in the rate of pancreatic or major postoperative morbidity between both groups (Clavien-Dindo > III): RDP *vs.* LDP: 30.3% (75/247) *vs.* 33.5% (175/521) (OR =0.97; 95% CI, 0.66–1.39, P=0.84) and 16% (3/246) *vs.* 17% (67/391) (OR =1.19; 95% CI, 0.73–1.91, P=0.52) respectively.

Concerns have also been raised on the oncological safety of RDP and LDP with some clinicians questioning the feasibility of performing a R0 resection and adequate lymphadenectomy. Of note, all the RDP performed in this series were R0 resections and only 1% of LDP had a positive resection margin (R1 resection). The number of resected lymph nodes was similar in both groups. Six of the ten studies reported data on the surgical margin (R0/R1 resection) (3,5,7-10) and seven reported data on the number of harvested lymph nodes (3,5,7-11). Most of the studies in this meta-analysis reported a higher number of harvested lymph nodes for the RDP. Only Waters *et al.* showed a lower number of harvested lymph nodes in the RDP *vs.* LDP (5 *vs.* 11). To date, strong evidence reporting on the long-term outcomes such as disease-free survival and overall survival after RDP or LDP for pancreatic malignancies remains limited. The recent multicenter DIPLOMA study (25), which performed a match comparison between 340 minimally invasive DP with 340 open DP showed no significant differences in overall survival for LDP versus open distal pancreatectomy for pancreatic cancer.

In the present study, not surprisingly RDP was found to be more costly than LDP. Only three studies in this meta-analysis (3,4,9) analyzed cost and it was found that RDP was more expensive than LDP (standard mean difference =5.24, 95% CI, 3.52– −6.95, P<0.00001). Two of the studies found that the cost of RDP was more than twice that of LDP: RDP *vs.* LDP 8,304 *vs.* 3,861$ (4) and 2,700–3,190 *vs.* 1,434–1,674 € (9). However, although it is well-established that robotic surgery increases operative costs, comparison of total hospital costs between RDP and LDP has not been well investigated. For example, if length of hospital stay was taken into account in calculating the total hospital costs, it was found that RDP was associated with a similar cost compared to LDP: 10,588 *vs.* 12,986 $ (3) and 9,198 *vs.* 9,399 € (23).

Hence, based on current evidence it is not possible to determine the optimal minimally-invasive approach for DP. Ideally, surgeons should select the minimally-invasive approach which they are most comfortable with which allows them to perform DP safely with the highest chance of success (lowest open conversion rate) and lowest cost. Individual surgeon ability is an important confounder which is impossible to analyze in these studies. In our opinion, the role of RDP is complementary and not a replacement for LDP. In general, surgeons may elect to use RDP for more complicated procedures such as SP DP and extended DP with adjacent organ resection whereas LDP may be used for straightforward distal pancreatosplenectomies.

In conclusion, the present study suggests that both

techniques, RDP and LDP, can be performed safely and effectively even for malignant lesions. RDP seems to be superior to LDP with respect to a higher SP rate, lower open conversion rate and shorter hospital stay at the expense of higher costs. However, the current evidence evaluating both procedures remains limited to low level retrospective comparative studies with a high risk of bias. Hence, a large prospective RCT comparing the two approaches is needed to determine any significant difference between these two surgical approaches. Further studies are also needed to address the long-term oncological outcomes after RDP or LDP to confirm the oncological safety of both procedures.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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