Editorial Commentary

Robotic *vs.* laparoscopic distal pancreatectomy—equipoise in current clinical practice?

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Since the first reports of minimally invasive distal pancreatectomy 25 years ago (1), widespread adoption into routine clinical practice has been slow (2), largely due to limited formal training opportunities, concerns surrounding oncological safety and the lack of randomised controlled trial data (3). The recent pan-European Minimally Invasive versus Open Distal Pancreatectomy for Ductal Adenocarcinoma (DIPLOMA) study incorporated 1,212 patients from 34 centres with a propensity-matched study design to demonstrate comparable survival and post-operative complication rates between the minimally-invasive *vs.* open groups (4). However, oncological outcome parameters were contradictory (with a minimally-invasive approach associated with higher R0 resection rates, but lower Gerota's fascia resection and lymph node yields), strengthening the case for high quality randomised controlled trials in this setting (5). Further, of the 356 minimally invasive distal pancreatectomies included in the DIPLOMA study, only 16 (4%) were performed robotically. Robust evidence to support the theoretical benefits of robotic assistance in facilitating a safe and effective minimally invasive approach to distal pancreatectomy is currently lacking.

In an article recently published in Surgical Endoscopy, '*Robotic-assisted versus laparoscopic left pancreatectomy at a high-volume, minimally invasive center*' (6), Lyman and colleagues present their experience of 247 consecutive minimally-invasive distal pancreatectomies at the Carolinas Medical Center, USA. Over a study period of 9 years [2008–2017], four attending surgeons adopted a minimally-invasive approach for over 70% of all distal pancreatectomies performed, with two surgeons favouring a robotic-assisted technique and two continuing to choose a laparoscopic approach. The considerable experience of this centre is reflected in the case mix: 34% of minimally invasive resections were performed for pancreatitis and the mean patient BMI was 29.2 kg/m^2.

As a retrospective cohort study, the authors acknowledge some inherent limitations. In particular, despite prospective data collection, unfortunately some key nuggets of information were neither recorded nor discernible from retrospective review of case notes. The potential merits of a robotic approach in facilitating splenic preservation with distal pancreatectomy have been published elsewhere (7) and a significantly greater rate of splenic preservation is reported in this study with a robotic compared to laparoscopic technique (31.5% *vs.* 8.6%, P<0.001). However, as the operating surgeons' intention for splenic preservation is not known in this series, the reported difference could simply be a reflection of the surgeons' experience and operative strategy, rather than a limitation of the laparoscopic technique *per se*. It is foreseeable that an individual surgeon might routinely prospectively abandon the objective of splenic preservation when adopting a laparoscopic approach, or specifically select a robotic approach for patients in whom splenic preservation is particularly desirable. Indeed, a recent meta-analysis of 16 cohort studies incorporating 1,888 patients found

no significant difference in rates of splenic preservation between robotic and laparoscopic distal pancreatectomy (8).

Lyman *et al.* report a marginal increase in the direct case supply cost (cost of supplies with the addition of direct labour costs) of $206.67 per case for robotic distal pancreatectomy. Clearly, this does not take account of the leasing and servicing cost of the robotic system itself. Even without this consideration, the analysis here contrasts starkly with those of other recently published cohort studies, such as Butturini *et al.*, who reported an average additional case supply cost of €1,500 for robotic distal pancreatectomy, largely due to the additional expense of robotic instruments (9). Whilst some authors contest that the additional operative costs can be offset by a shorter length of hospital stay (10), no significant difference was found in the current study (median of 5 days for both groups, P>0.9).

Outcomes from long-term follow-up of patients undergoing minimally invasive distal pancreatectomy have been consistently lacking from studies published to date (5). Lyman *et al.* present Kaplan-Meier survival analysis after 2 years of follow-up and report no significant difference between the laparoscopic and robotic groups. Whilst the survival difference is not statistically significant (P=0.49), the Kaplan-Meier analysis is graphically and numerically striking, with comparable survival between the laparoscopic and robotic cohorts at 1 year (74.3% *vs.* 72.7% respectively) and the survival curve for the laparoscopic cohort then plunging, giving a survival at 2 years of 30.6% compared to 61.5% in the robotic cohort. There was no significant difference between groups with adenocarcinoma as the indication for resection, tumour size, R0 resection or number of lymph nodes retrieved. Survival in pancreatic cancer is multi-factorial, and it is possible that the chemotherapy given to the more recent robotic cases may be vastly different to the early days of laparoscopic surgery. Clearly, survival outcomes from longer follow-up and prospective randomised studies are keenly awaited to clarify this anomaly.

In common with any single-centre cohort study performed over a long period, the effect of learning curve on outcomes is apparent—47.5% of laparoscopic distal pancreatectomies in this series were performed with hand assistance, which might suggest an earlier stage on the learning curve (unfortunately distinction between planned *vs*. unplanned hand-assistance was not recorded) and present a relative confounding factor when considering other outcomes, such as splenic preservation. Similarly, conversions from the robotic surgical approach tended to happen earlier in the study period. The overall rate of clinically significant pancreatic fistulae was 19.8%—higher than the average of 8% (for laparoscopic and robotic approaches) derived from meta-analysis of the 13 published studies that have reported this outcome (8). Subgroup analysis of distal pancreatectomy performed for resection of adenocarcinoma reports an exceptionally high rate of pancreatic fistula in robotic group (43.5% *vs.* 14.3%). This was attributed to a type II error due to the small sample size (23 robotic and 35 laparoscopic resections); no significant difference was seen in the overall analysis, but 10 clinically significant pancreatic fistulae out of 23 robotic resections for adenocarcinoma is concerning nonetheless.

Following publication of the multicentre '*Laparoscopic versus open pancreatoduodenectomy for pancreatic or periampullary tumours*' (LEOPARD-2) randomised controlled trial (11), some assumptions around the safety and benefits of laparoscopic pancreatic resection have been challenged. Participation in this trial was restricted to surgeons who had completed a standardised training programme, performed more than 20 laparoscopic pancreaticoduodenectomies and continued to operate in high-volume centres. Despite this, after randomisation of 105 patients, the trial was terminated prematurely due to a difference in the 90-day complication-related mortality between the laparoscopic and open groups (10% *vs.* 2% respectively). Whilst pancreaticoduodenectomy adds a level of complexity to distal pancreatectomy and robotic assistance could foreseeably mitigate against some of the limitations of a laparoscopic approach, the outcome of LEOPARD-2 trial certainly highlights the need for high-quality evidence from randomised trials to support future developments in this field.

In conclusion this report presents an important insight into what can be achieved in the real world setting of a high-volume centre. Even when incorporating the early phase of the learning curve, overall clinical outcomes for laparoscopic and robotic distal pancreatectomy are excellent and essentially equivalent, at present. Whilst ongoing technological developments in the robotic field may sway the balance towards a more discernable benefit and cost analyses remain in a state of flux, both minimally invasive approaches remain appropriate in current clinical practice. Randomised clinical trial data will be needed to confirm the purported benefits of enhanced splenic preservation and lower rates of open conversion, and to allay persisting concerns regarding oncological safety.

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