Laparoscopic pancreatic surgery: a review of present results and future prospects

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Abstract
Pancreatic surgery is still associated with a relatively high morbidity and mortality compared with other specialties. This is a result of the complex nature of the organ, the difficult access as a result of the retroperitoneal position and the number of technically challenging anastomoses required. Nevertheless, the past two decades have witnessed a steady improvement in morbidity and a decrease in mortality achieved through alterations of technique (particularly relating to the pancreatic anastomoses) together with hormonal manipulation to decrease pancreatic secretions.

Recently minimally invasive pancreatic surgery has been attempted by several centres around the world which has stimulated considerable interest in this approach. The majority of the cases attempted have been distal pancreatectomies, because of the more straightforward nature of the resection and the lack of a pancreatic ductal anastomosis, but more recently reports of laparoscopic pancreaticoduodenectomy have started to appear. The reports of the series to date have been difficult to interpret and although the results are claimed to be equivalent or better than those associated with a traditional approach a careful examination of the literature and comparison with the best results previously reported does not presently support this. In the present review we examined all the reports of pancreatic procedures performed laparoscopically and compared the results with those previously achieved at open surgery.

Keywords
laparoscopic pancreatectomy, minimal access pancreatectomy, distal pancreatectomy

Introduction
Over the past 20 years minimally invasive (laparoscopic) surgery has evolved to such an extent that in suitably qualified hands the majority of general surgical procedures can be safely carried out laparoscopically. This development has been facilitated by advances in technology and the tenacity of surgeons throughout the world who have invested considerable time and expertise developing their laparoscopic skills. Despite these advances, however, the development of laparoscopic pancreatic surgery has been slow and in relative terms appears to lag behind developments in other organs. A number of factors are thought to contribute to this apparent delay and these include the technically demanding nature of pancreatic surgery, the difficulty in obtaining an adequate and appropriate operative field for this retroperitoneal structure and finally but not least anxiety concerning the potentially devastating nature of complications relating to this unforgiving organ. Nevertheless with the success of laparoscopic surgery in general there is a natural drive to continue to investigate laparoscopic pancreatic surgery with the aim of identifying and expanding the indications and defining limitations. This review focuses on the current evidence base for increasing the use of laparoscopic pancreatic resection but highlights aspects that must be considered before promoting this emerging technique.

The laparoscopic era
Since minimal access surgery was introduced in 1910, laparoscopy has been embraced and adopted by every surgical specialty. It presented surgeons, particularly in the early phases of development, with many technical challenges but at the same time promised enhanced recovery for patients. This enhanced recovery was
Role of laparoscopy in pancreatic surgery

The first open pancreatic papilllectomy was performed by Halstead in 1898 and the same year Codivilla performed a one-stage pancreatico-duodenectomy. A two-stage pancreatico-duodenectomy was first described 14 years later by Kausch. In the 1930s and early 1940s pancreatic surgery made significant strides and Taylor performed a body and tail resection in 1934. In 1935 the father of pancreatic surgery Whipple presented a case series of 80 pancreatic ampullary tumours, which included 2 two-stage pancreatico-duodenectomies. He then described the one stage procedure in 1941, which was subsequently described as ‘Whipple’s Procedure’ by Hunt and later in the 1940s Preistley performed a total pancreatetectomy for pancreatic cancer. Since the 1940s although developments in operative techniques have evolved relatively slowly, pancreatic resections are now routine in specialist units albeit remaining a skilled procedure.

Laparoscopy was first introduced into pancreatic surgery in the early 1990s, and to date it has mainly been used as a diagnostic and staging tool. It gave surgeons the privilege of a window into the abdominal cavity to assess local tumour extension and the presence or absence of peritoneal and serosal disease before potentially embarking on an extensive curative resection. When combined with steerable and sensitive ultrasound probes, the laparoscope has proved to be invaluable in assessing masses in the pancreas, involvement of local lymph nodes, extension of the tumour to surrounding organs and invasion of vascular structures. It is particularly valuable for the assessment of cystic lesions at showing internal septae, mural nodules and solid areas within cystic pancreatic tumours. Assessment of suspicious lesions in the liver prior to surgery may also be undertaken using laparoscopic ultrasound and any abnormalities can be biopsied at the same time.

Laparoscopic surgery has also been used for palliative bypass operations in patients with inoperable pancreatic cancer and in benign disease it is used to drain pancreatic pseudocysts.

The complexity of pancreatic surgery has meant that the development of more invasive laparoscopic techniques and particularly formal resections has been relatively slow compared with procedures in many other surgical specialties. Consequently its incorporation into regular clinical practice is recent and indications remain unclear as a result of the lack of a large series (particularly prospective studies) and long-term results. A number of factors are responsible for these delays and have conspired against the development of an accepted laparoscopic approach and clear guidelines in pancreatic surgery:

- It is a technically demanding surgery involving long operating times, indirect access to retroperitoneal structures, dissection around major blood vessels and the construction of complex anastomoses. These factors together with the friable nature of the pancreas are responsible for the high morbidity and frequent long hospital stays associated with pancreatic procedures particularly if associated with any complications.
- Localizing the tumour in the pancreas usually requires tactile feedback to assess the site and size of the tumour. This is largely lost in laparoscopic surgery, and for this reason people have used laparoscopic ultrasound or resorted to hand-assisted techniques to examine the gland.
- The learning curve is lengthy and these types of procedures require extensive experience in open pancreatic surgery combined with a high level of laparoscopic skill. Considering that pancreatic carcinoma, suitable at presentation for a potentially curative procedure is relatively uncommon (as little as 10% of patients are suitable for resection), a very slow progression along an already demanding learning curve is to be expected.

Despite these limitations there remains a drive towards the development of complex procedures in laparoscopic pancreatic surgery and the main and clear motivation is the wish to reproduce the benefits from laparoscopic surgery that are achieved by other specialties, such as colorectal surgery, where laparoscopic techniques have reduced hospital stays, improved recovery and attained the same oncological results as open surgery.

The theoretical advantages of laparoscopic pancreatic surgery include pain reduction and improved post-operative recovery although there are clearly also commercial pressures, particularly to reduce hospital stays. These factors combined with increased public healthcare expectations, frequently fuelled by the internet,
also play a role in driving this field forward. In addition technological developments that have facilitated the performance of advanced procedures in other fields are often directly applicable to pancreatic surgery. These have included in particular improved camera systems and the availability of instruments to perform delicate anastomoses. To date the areas that have attracted the most interest are enucleation of presumed benign or low grade neuroendocrine lesions and distal resections although a small number of formal pancreaticoduodenectomies have been performed.

**Distal pancreatectomy**

The majority of the reported series of formal laparoscopic pancreatic resections have focused on distal pancreatectomy. This is mainly because distal pancreatectomy, requiring no formal anastomosis of the pancreatic duct, is technically less demanding compared with right-sided resections and has the lowest reported mortality and morbidity. Access to the distal pancreas or areas to the left of the portal vein is not only less complex than the body or head but the fact that unlike pancreaticoduodenectomy no formal anastomosis is required to the pancreatic duct, essentially overcomes one of the main obstacles in performing this procedures. Another reason for the higher rate of distal pancreatic resections in the majority of series relates to the pathology which because of its benign or low grade nature decreases concerns about resection margins and lymph node involvement.

Most of the reported case series contain relatively low numbers with the most recent and largest series in the literature from Kooby et al. reporting on 159 resections from 2002 to 2006. Previous substantial series from Mabrut et al. (1995–2002: 82 patients) and Fernandez-Cruz et al. (1998–2007: 82 patients) both had less than 100 cases. While the authors of these series agree on the feasibility and safety of performing laparoscopic distal pancreatectomy, the morbidity, mortality and length of hospital stay are similar to those published for open surgery.

In the largest series from Kooby et al. an attempt was made to produce matching groups by extracting appropriate patients from the open series (200 out of 508). This is a retrospective approach and comparison was made of a selected group of patients from the open group. Nevertheless in these groups there was no significant difference in major complications, fistula rates, the incidence of re-operation or need for intensive care unit admission. This probably supports the belief that morbidity in pancreas surgery results from the surgery itself (particularly the retroperitoneal dissection and length of the procedure) rather than the incision.

In addition many of the ‘laparoscopic’ procedures were hand assisted which produces a further convergence of the operative techniques, but this is not quantified.

It also appears that indications for surgery in the published laparoscopic series are not equivalent to those historically thought to require open resection. An increased number of cystic lesions in the laparoscopic group were resected compared with their open counterpart.

Operative time is longer in the published laparoscopic series, although this does seem to decrease with experience in the larger series. Blood loss appears to be reduced in laparoscopic resections but an unmatched comparison makes this difficult to quantify.

Portal hypertension is a challenge for laparoscopic surgery, as dissecting the splenic vessels becomes an extremely difficult procedure, which will almost inevitably result in conversion to open surgery.

No deaths were reported in the majority of the series including the large ones. Morbidity was quite variable with a relatively big range in the series reported to date (0–56%). Pancreatic fistula remains the main complication after laparoscopic distal pancreatectomy (0–20%), while in the largest open resection series open fistula rate was reported as 5–18%.

Post-operative hospital stay is one of the main putative advantages for laparoscopic surgery, but a reported mean stay of 7.5 days is comparable and often longer than that of open resection.

Kooby et al. reported a shorter hospital stay of 5.9 ± 3.7 days compared with their open matched series of 9.0 ± 6.2 days.

**Enucleation**

Enucleation of pancreatic lesions is usually performed for neuroendocrine tumours or benign cystic tumours assuming they do not communicate with the pancreatic duct. Bleeding tends to be minimal, there is no reconstruction required and enucleation is associated with a low mortality rate.

One area which remains difficult when contemplating a laparoscopic enucleation is the precise localization of the tumour (or tumours). Pre-operative assessment using all available modalities (CT, MRI, EUS, PET and selective venous sampling) are generally able to accurately locate single lesions but this must be confirmed intra-operatively. If laparoscopic ultrasound is unable to locate the lesion then conversion to an open procedure is usually required.

Laparoscopic enucleation has been attempted by a number of laparoscopic surgeons with varying degrees of success. The majority of published series report no mortality, which is comparable to that of open procedures and the accepted standard for enucleation. Morbidity, however, showed an alarming increase to 66.6% and 77.8% in two published series by Berends and Lihara, respectively. Fistula remains the main complication after laparoscopic enucleation at a rate of around 29% compared with 16–23% in the best open series.

**Pancreatoco-duodenectomy**

Laparoscopic pancreatoco-duodenectomy remains the biggest challenge for pancreatic surgeons and entails not only extensive dissection around major blood vessels but also the formation of complex and multiple anastomoses. Even when comparing open pancreatoco-duodenectomy with open distal pancreatectomy and enucleation the mortality and morbidity rates are significantly higher.
Considering the technical difficulties and the significant attendant morbidity and mortality with previously reported open series it is not surprising that techniques have been developed to attempt to limit the potential complications. One of these is the performance of a mini-laparotomy after laparoscopic dissection to fashion the reconstruction.\(^{16,44-46}\) A hand port is employed during this phase and can be placed at the beginning of the operation to aid dissection and help control any troublesome bleeding.\(^{47}\)

Despite these advances and the reports of early series with the complexity of the surgery the majority of pancreatic surgeons are not yet convinced of the benefits. This is reflected in the literature as only four of the series reviewed had five or more cases.\(^{22}\) In these series there was no improvement in hospital stay (8–28 days) and the associated morbidity is a concern, being reported as ‘high’ by Gagner et al. and 60% by Lu et al.\(^{18,49}\) These two series also have remarkably long operating times in excess of 510 min. The results from Palanivelu et al. who reported a series of 45 patients are more encouraging with a morbidity rate of 26.7%, a mean operative time of 370 min and a mean hospital stay of 10 days.\(^{30}\) However, even these data must be treated with caution as the majority of patients were ASA (American Society of Anaesthesiologist physical status classification) I or II and thus not comparable to the general population undergoing open pancreatic-duodenectomy.

### Discussion

Laparoscopic surgery is evolving rapidly within general surgery, but laparoscopic pancreatic surgery is progressing at a measured pace. Retrospective data are emerging from around the world reporting varying degrees of success but at present there are no prospective randomized control trials.

Initial data on laparoscopic distal pancreatectomy suggest that it may confer an advantage but true comparison to open surgery is difficult because of the lack of matched controls. Morbidity, particularly fistula rate, in open distal pancreatic resection appears to have a direct relationship to increasing body mass index (BMI) and ASA grade. In the laparoscopic series reviewed, groups appear matched for body mass index (BMI) and ASA but there is minimal data presented on people with a high BMI or ASA grade to directly compare these morbidity data to the general population.

If studies show that laparoscopic enucleation can at least match the results of open surgery this remains a promising development as it will avoid large incisions (which have additional long-term complications as a result of adhesions and the formation of incisional hernias) for what are often benign tumours. Unfortunately at present fistula rates remain high and caution is required.

Laparoscopic pancreatic-duodenectomy is a developing technique. If the results of Palanivelu et al. can be replicated in matched individuals then further prospective studies could be justified although the fact that that this procedure is mainly performed for malignant rather than benign disease produces additional problems. Clear resection margins are mandatory and appropriate lymph node sampling and resection margin frozen sections to ensure adequate and complete clearance are mandatory. In addition the low percentage of operable cases at the time of initial diagnosis, often poor prognosis despite a technically satisfactory procedure and the extensive learning curve required to develop adequate laparoscopic skills makes the decision to incorporate laparoscopic pancreaticoduodenectomy into clinical practice difficult.

There will clearly be further developments in laparoscopic surgery in general and the data from these other areas together with accumulating data from laparoscopic pancreas surgery is likely to continue to clarify the indications and potential advantages. Inevitably the development in procedures performed for malignant conditions will be less rapid and data more difficult to come by as a result of the smaller numbers. In these patients multi-centre collaboration is likely to be required particularly to identify clear indications and confirm advantages.

Hopefully these studies will encourage a responsible approach to these complex and difficult patients although it is interesting to note that while laparoscopic pancreatic surgery is still in its early stages with many unanswered questions, reports are already appearing where it is combined with a natural orifice transluminal endoscopic (NOTES) approach.\(^{31}\)

### References


