Recent Advances in Minimally Invasive Pancreatic Surgery

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For curative resection of pancreatic endocrine tumours, minimally invasive methods of pancreatic surgery, such as laparoscopy, should be indicated only for benign tumours. Among these uncommon tumours, pancreatic insulinomas are mostly benign and solitary. Successful management of patients with insulinomas relies on accurate localization of the tumour and the use of appropriate surgical techniques. Because of the small size of these tumours, conventional intraoperative ultrasonography combined with palpation has been widely regarded as the best localization procedure. Because contact ultrasonography, a new technique for localization of pancreatic lesions, can be used laparoscopically, several surgeons have used laparoscopy not only for localization, but also for resection of insulinomas. In the era of minimally invasive surgery for benign pancreatic lesions, we attempted laparoscopic-focused exploration of the pancreas for resecting insulinomas based on preoperative localization. We describe the use of this technique for the detection and resection of insulinomas and the results obtained, with a review of previous reports. [*Asian J Surg* 2003;26(2):86–91]

Introduction

Among pancreatic endocrine tumours, gastrinomas and insulinomas are the most common, and are clinically characterized by characteristic symptoms. Gastrinomas may occur in not only the pancreas but also the duodenal wall, and can be multiple and small. Duodenotomy and intraluminal examination are essential for curative resection of gastrinomas, but their intraoperative localization is occasionally difficult, even by open exploratory surgery. In addition to their poor accessibility, gastrinomas are potentially malignant. Previous reports have described an incidence of malignancy, as defined by regional lymph node involvement, ranging from 30% to 100%.[1–4] Therefore, minimally invasive pancreatic surgery, such as laparoscopic pancreatectomy, is not considered advisable for resection of gastrinomas.

On the other hand, most insulinomas, excluding patients with multiple endocrine neoplasia type 1, are solitary and benign. As it is sometimes difficult to localize an insulinoma preoperatively because of its small size, intraoperative ultrasonography (IOUS) combined with palpation has been widely used as the best localization tool.[5–9] However, advances in techniques and equipment in the late 1990s have allowed surgeons to approach the pancreas laparoscopically, not only for intraoperative localization, but also for resection or enucleation of benign lesions.[10–14] Thus, once accurate localization is obtained by laparoscopic inspection, insulinomas may be laparoscopically resectable. In this article, we describe our experience with this minimally invasive surgical procedure for detection and resection of insulinomas, with a review of the literature.

Preoperative localization of insulinomas

Insulinomas are usually small lesions that can occur at any site in the pancreas. Accurate localization is considered essential for the successful management of patients with insulinoma. In the past, various imaging studies, including computed tomography (CT), magnetic resonance imaging (MRI), angiography and endoscopic ultrasonography (EUS), have been utilized for preoperative localization of insulinomas. However, none of these methods has achieved satisfactory detection rates.

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Therefore, it has frequently been emphasized that careful palpation of the pancreas during surgery and IOUS are the most sensitive aids for the localization and resection of insulinomas.[6–9,15,16] Although the success rate of IOUS combined with palpation of the pancreas is undoubtedly superior for detecting insulinomas, it requires full exploration of the pancreas through a large bilateral subcostal incision or an upper median incision in order to be performed properly. If the precise location of an insulinoma is known preoperatively, surgery can be done considerably more easily and less invasively. Despite the fact that various imaging methods may not be sufficiently effective when used alone, many insulinomas can be localized preoperatively by combining some of these methods. Thus, the conventional open procedure to perform IOUS is not necessary for resecting preoperatively localized insulinomas. With accurate preoperative localization, focused surgical exploration of the pancreas can be performed laparoscopically.

Although it is a non-visual test, transhepatic portal venous sampling (PVS) was previously regarded as the ultimate preoperative localization study for insulinomas, regionalizing the source of insulin production with a reported accuracy of 75% to 100%.[6,17,18] Since its introduction in 1991, arterial stimulation venous sampling (ASVS) has replaced PVS for preoperative regionalization of insulinomas in the pancreas, and is effective in 90% of patients.[19,20]

A cost-effective strategy for the use of preoperative localization studies remains a matter of debate.[7,8] In our opinion, non-invasive studies, such as CT or MRI, should be chosen initially. Then, if a lesion is localized in the pancreas, no further studies are needed. If these non-invasive tests fail to demonstrate a pancreatic tumour, ASVS combined with selective angiography seems justified. With proper preoperative localization of an insulinoma, laparoscopic resection can be performed as a minimally invasive, advanced surgical procedure. However, laparoscopic procedures may not be suitable for resecting occult insulinomas that are not revealed by preoperative imaging studies, because it is still difficult to detect such insulinomas by laparoscopy alone.

Laparoscopic approach to the pancreas

In the field of pancreatic surgery, several authors have devised original methods for approaching the pancreas laparoscopically to treat benign lesions.[10–14,21] In 1996, Gagner et al first described the feasibility of a laparoscopic procedure for resecting pancreatic islet cell tumours.[11] They reported a surgical technique with a laparoscopic approach for examination of the entire pancreas, from the uncinate process to the tail. Following this report, several authors described their experiences with laparoscopic resection of insulinomas. Regardless of the tumour location, most of these authors used a four- or five-trocar procedure with the patient supine in order to examine the entire pancreas during the operation. Nonetheless, we consider that focused exploration of the pancreas should be done laparoscopically for resection of insulinomas that have been localized precisely by preoperative imaging studies. Therefore, patient position depends on the location of the insulinoma. Patients with an insulinoma located in the head of the pancreas are placed in the supine position (Figure 1A). On the other hand, patients with an insulinoma located in the left side of the pancreas are placed in the right half-decubitus position (Figure 1B). In either case, a subcostal three-trocar procedure with a 30°-angled 10-mm laparoscope is used to approach the pancreas.

The first step is to create a window in the gastrocolic ligament. Ultrasonic scissors are useful for dividing the numerous vessels in the gastrocolic ligament, requiring no clips. The region of the pancreas where the tumour has been localized preoperatively is exposed anteriorly through this window by lifting the greater curvature of the stomach, and then dissection of the pre-pancreatic tissue is started. As the tissue overlying the anterior aspect of the pancreas is dissected, the tumour, if it is located on the anterior surface of the pancreas, can easily be detected by laparoscopic inspection.

Laparoscopic ultrasonography

In 1993, Pietrabissa et al first reported an initial experience with localization of an insulinoma by laparoscopic infragastric inspection of the pancreas and contact ultrasonography.[10] Recently, several investigators have analyzed the usefulness of laparoscopic ultrasonography for intraoperative localization of insulinomas.[11,21–23] Reported insulinoma detection rates for laparoscopic ultrasonography varied from 60% to 100%. According to these reports, the locations of insulinomas could be confirmed precisely by laparoscopic ultrasonography in patients whose insulinomas had been localized preoperatively. However, it is noteworthy that laparoscopic ultrasonography failed to demonstrate occult insulinomas in some patients, and conversion to laparotomy was required in order to perform IOUS combined with palpation.

In practice, appropriate ultrasonographic equipment is necessary to detect insulinomas. A laparoscopic 7.5-MHz probe 10 mm in diameter with a flexible tip (Aloka, Tokyo, Japan) is

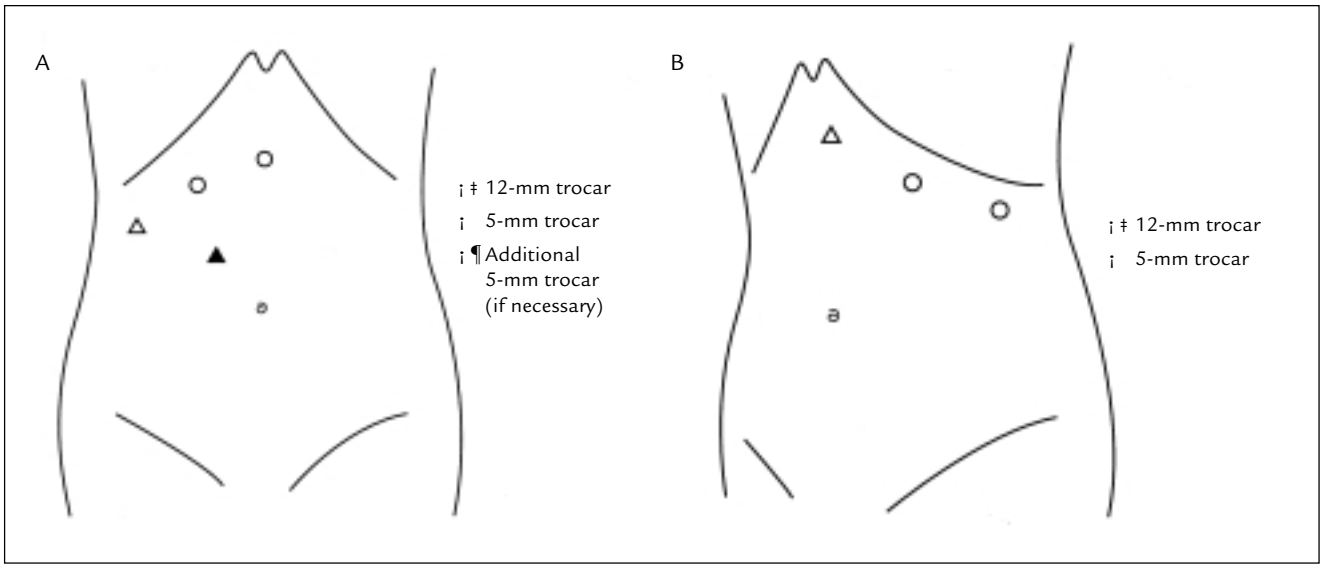

Figure 1. A) Trocar placement for laparoscopic resection of insulinomas located in the head of the pancreas. Patients are placed in the supine position. B) Trocar placement for laparoscopic resection of insulinomas located in the body or tail of the pancreas. Patients are placed in the right half-decubitus position.

used in our institution. Insulinomas are usually hypoechoic in contrast to the surrounding normal pancreatic parenchyma. Laparoscopic ultrasonography, as well as IOUS, can confirm not only the location of a pancreatic tumour but also its anatomic relationship with associated structures, such as the pancreatic duct, portal vein and splenic vessels. Doppler and colour flow monitoring, if available, are also useful for identifying these vessels.

Laparoscopic resection of insulinomas

Once a tumour in the pancreas and its anatomic relations has been confirmed, it must be decided whether laparoscopic enucleation or distal pancreatectomy is appropriate.

Laparoscopic enucleation of insulinomas

If a solitary insulinoma is separated from the pancreatic duct and adjacent vessels, enucleation can be achieved laparoscopically. This is performed using either electrocautery scissors or an ultrasonic device, dissecting the tumour from the surrounding normal pancreatic tissue. Ultrasonic dissection is superior to electrocautery because it is more reliable in coagulating the pancreatic vessels feeding the tumour. We usually use the curved ultrasonic shear for this procedure.

In patients with insulinomas in the head of the pancreas, only easily accessible tumours are considered suitable for laparoscopic enucleation. Gagner et al stated that a Kocher manoeuvre could be performed laparoscopically with an additional trocar in the right paramedian area to gain a lateral view of the second and third portion of the duodenum.[11] Using this technique, insulinomas located in the posterior aspect of the pancreatic head can be localized laparoscopically. Nonetheless, it seems hazardous to resect the tumours located in this region of the pancreas by laparoscopy alone because they are adjacent to important vessels and the major pancreatic duct.

Laparoscopic distal pancreatectomy

For an insulinoma located in the body or tail of the pancreas, laparoscopic distal pancreatectomy should be used instead of laparoscopic enucleation if the tumour is deeply seated and in close proximity to the pancreatic duct. In order to create a gastrocolic window wide enough to explore the whole anterior aspect of the body and tail of the pancreas, the inferior border of the pancreas should be dissected from the retroperitoneal fat using either an electrocautery or an ultrasonic device until the splenic vein is reached posteriorly and superiorly. The caudal pancreas can be transected with an endoscopic linear stapler, which provides adequate closure of the pancreatic duct and partial ligation of the pancreatic arterial arcades. As in open surgery, if dissection of the splenic vessels is possible, laparoscopic spleen-preserving distal pancreatectomy is preferable. In our experience, it is often difficult to dissect the splenic vessels from the pancreas with a laparoscopic procedure alone. Vezakis et al reported an alternative technique to preserve

the spleen with laparoscopic resection of the left side of the pancreas, with spleen preservation based on the vasa brevia.[14] This technique makes it unnecessary to divide the numerous small vessels that connect the splenic artery and vein to the body and the tail of the pancreas. Laparoscopic distal pancreatectomy combined with preservation of the spleen is an attractive option, but it is technically challenging.

Tokyo experience with laparoscopic resection of insulinomas

We have reported our previous experience with laparoscopic resection of insulinomas.[21] We now describe our more recent experience with this advanced surgical procedure, including the patients reported previously and one additional patient.

Patients

During a 5-year period at Tokyo Women's Medical University Hospital, we attempted ultrasonographically guided laparoscopic resection in eight patients with solitary insulinomas. The insulinomas were localized preoperatively by imaging studies in all patients. The median diameter of the insulinomas was 13 mm (range, 11–25 mm). Two of the tumours were located in the head of the pancreas, two in the body, and four in the tail.

Results of laparoscopic detection and resection of insulinomas

Two of the eight insulinomas were not localized by visual inspection because they were located deep within the pancreas. However, in all eight patients, laparoscopic ultrasonography succeeded in identifying a solitary pancreatic tumour in the same area where a tumour had been localized by preoperative imaging studies. In addition to the locations of the insulinomas, their anatomic relationships with associated structures, such as the main pancreatic duct, portal vein, and splenic vessels, were identified in all patients.

In seven of the eight patients, the insulinomas were laparoscopically resectable; five patients underwent laparoscopic enucleation, and in two patients, laparoscopic resection of the pancreatic tail was necessary (Figure 2). In one of the latter patients, the resection procedure was performed with preservation of the spleen. In the other, splenectomy was necessary because dissection of the splenic vessels was technically difficult. Conversion to open laparotomy was necessary for only one patient, whose insulinoma was located in the head of the pancreas in close proximity to the main pancreatic duct and the portal vein. In the seven patients treated laparoscopically, the mean operative time was 170 minutes (range, 140–240 minutes) and the mean estimated blood loss was 15 mL (range, 10–30 mL).

Morbidity

Three of the five patients treated with laparoscopic enucleation developed minor leakage of pancreatic juice (< 10 mL daily) that resolved with conservative management within 3 weeks after surgery. These patients required no repeat surgery. The patient treated with open enucleation of the insulinoma also developed minor pancreatic leakage, which healed 1 month after surgery. The patients who underwent laparoscopic resection of the pancreatic tail experienced no surgical complications.

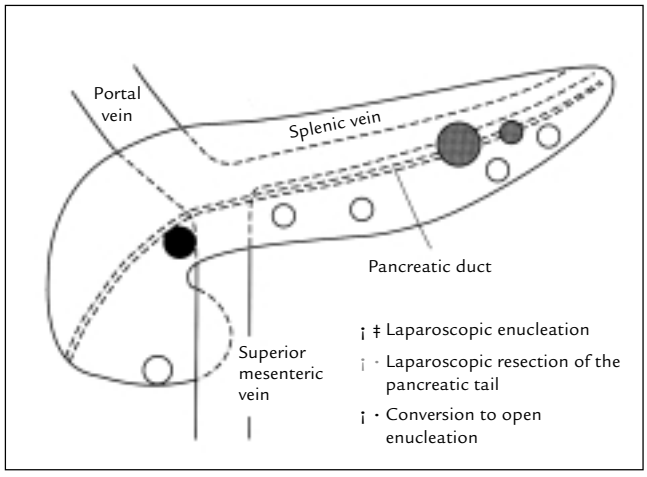

Figure 2. Schematic diagram showing insulinoma sites and appropriate surgical procedures for the eight study patients.

Discussion

Reported success rates for laparoscopic resection of insulinomas vary from 50% to 86%.[11,21–24] Surgical outcomes for laparoscopic resections of insulinomas are summarized in the Table. Gagner et al converted to laparotomy one of their five patients with insulinoma because they could not localize the tumour by laparoscopic ultrasonography.[11] In this patient, using IOUS combined with palpation, an insulinoma was identified in the retroportal neck of the pancreas. Berends et al also reported that four of their 10 patients with insulinoma required laparotomy.[22] In two of these four patients, the tumours were confirmed by laparoscopic ultrasonography to be inaccessible by laparoscopy (insulinoma located in the posterior aspect of the pancreatic head). In our present series, the laparoscopic resection success rate for insulinomas was 88%. This high success rate was probably due to easily accessible

Table. Surgical outcomes for laparoscopic resection of insulinomas

First author	Gagner[11]	Berends[22]	Iihara
No. of patients	5	10	8
Laparoscopic procedure			
Enucleation	1	5	5
Distal pancreatectomy	3	1	2
Converted	1	4	1
Success rate (%)	80	60	88
Mean operative time (min)	240	180	170
Estimated blood loss (mL)	ND	< 100	15

ND = not described.

tumour locations, as well as accurate preoperative localization. We believe that most solitary insulinomas, located in the body or tail of the pancreas, are resectable using a laparoscopic procedure. In reports of successful laparoscopic resections of insulinomas, operative times were comparable (range, 140–300 minutes), including the time needed for laparoscopic ultrasonography. Estimated blood losses were reported to be less than 100 mL. In our series of patients, the mean estimated blood loss was 15 mL. Thus, the laparoscopic procedure was superior to the open technique in terms of intraoperative blood loss.

Patients who undergo laparoscopic enucleation, as with open enucleation, are at risk for postoperative pancreatic leakage. Berends et al reported that two of five patients undergoing laparoscopic enucleation of an insulinoma developed pancreatic fistula.[22] One fistula healed with conservative treatment, the other required interventional radiological treatment. In our series of patients, three of the five patients undergoing laparoscopic enucleation developed minor pancreatic leakage; all cases healed with conservative treatment. In contrast, there was no case of pancreatic leakage among patients treated with laparoscopic distal pancreatectomy. This favourable result is likely to have been due to the reliable closure of the pancreatic duct using the endoscopic linear stapler.

Conclusions

In this article, we described the feasibility of laparoscopic focused exploration of the pancreas for detection and resection of insulinomas localized preoperatively. With accurate preoperative localization, laparoscopic ultrasonography was used to confirm the location of insulinomas during surgery. Despite recent advances in techniques and equipment, laparoscopic enucleation is still not feasible for many insulinomas located in the head of the pancreas. However, laparoscopy is feasible and safe for resection of insulinomas located in the body or tail of the pancreas. We believe that laparoscopic focused exploration is a useful minimally invasive surgical procedure for the management of insulinomas that have been localized preoperatively.

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