Hypothesis: Laparoscopic enucleation of insulinomas is safe and effective and is associated with a short hospital stay.

Design: Case series identified through retrospective review of medical records.

Setting: University of California, San Francisco Medical Center, a tertiary care referral hospital.

Patients: Nine patients with insulinomas that were thought to be suitable for laparoscopic enucleation.

Intervention: Laparoscopic enucleation of solitary insulinomas of the pancreas.

Main Outcome Measures: Successful enucleation, conversion to open operation, postoperative complications, and duration of hospitalization.

Results: Seven of 9 patients had curative laparoscopic enucleations of insulinomas. In the 2 other patients, the laparoscopic approach was converted to an open operation to perform a distal pancreatectomy. All patients were cured. Computed tomography (CT) localized the tumor in 5 of 9 patients; laparoscopic enucleation was successful in all 5. Endoscopic ultrasonography correctly identified the lesions in 2 of 3 patients with nondiagnostic CT scans. Both lesions were successfully enucleated laparoscopically. Postoperative pancreatic fistulas occurred in 7 of 9 patients, but they caused little morbidity. No patient required another operation. Five of 7 patients treated laparoscopically were discharged to home on the first postoperative day.

Conclusions: Laparoscopic enucleation was safe and effective. If the lesion was seen on CT, it could be removed laparoscopically. Endoscopic ultrasonography was useful for identifying lesions in patients whose CT scans were nondiagnostic. Pancreatic fistulas were common, but they resolved spontaneously and produced little morbidity. Laparoscopic enucleation resulted in a short hospitalization and rapid recovery for most patients.

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Insulinoma is the most common pancreatic endocrine neoplasm, occurring in 1 per 1 million persons each year. They are typically well encapsulated and less than 2 cm in diameter. Ninety percent are solitary and benign, and the remaining 10% are malignant. Multifocal insulinomas are more common in patients with multiple endocrine neoplasia type 1. The diagnosis of insulinoma is established by measuring insulin and C-peptide levels during a 72-hour fast and by calculating the ratio of insulin-to-glucose in the presence of hypoglycemia. The presence of sulfonylureas must be excluded by blood testing. Treatment is by excision. In the prelaparoscopic era, enucleation was performed via a laparotomy. Since then, surgeons have described their experience with laparoscopic enucleation and distal pancreatectomy. \textsuperscript{1-3} When enucleation is technically feasible, pancreatectomy provides no oncologic advantage, and it often requires an otherwise unnecessary splenectomy. However, few cases of successful laparoscopic enucleation have been reported,\textsuperscript{1,2,3} and its efficacy has not been established, to our knowledge.

METHODS

We attempted laparoscopic enucleations in 9 consecutive patients with insulinomas localized before surgery at the University of Cali-
Patients had CT scans negative for pancreatic mass. Four patients had CT scans positive for pancreatic mass. Five patients had CT scans positive for pancreatic mass. The second patient was a 56-year-old woman who had undergone a previous laparoscopic enucleation. The abdomen was opened, and the pancreas was examined. No abnormality was evident, so a distal pancreatectomy was performed. The specimen contained a 1.4-cm insulinoma. Had it been attempted, the distal pancreatectomy could probably have been performed laparoscopically.

Two operations were converted from laparoscopic to open procedures. The first patient was a 47-year-old man with nondiagnostic preoperative imaging studies (CT, magnetic resonance imaging, and OctreoScan [Mallinckrodt Medical, St Louis, Missouri]) and positive calcium-stimulated venous sampling in the splenic artery distribution. Endoscopic ultrasonography was not performed. The pancreas was mobilized, but no lesion could be found. A hand-assisted laparoscopic device (HandPort; Smith Nephew Surgical, Andover, Massachusetts) was placed so the pancreas could be felt, and intraoperative ultrasonography was performed. The lesion was found deep in the midbody of the gland, where it was not amenable to enucleation. The abdomen was opened, and a distal pancreatectomy was performed. The specimen contained a 1.4-cm insulinoma. Had it been attempted, the distal pancreatectomy could probably have been performed laparoscopically.

The second patient was a 56-year-old woman who had undergone a previous laparoscopic enucleation. Computed tomography showed no mass in the pancreas, and EUS was interpreted as showing a focal lesion in the pancreatic body. At laparoscopy, we were unable to identify a lesion visually or with laparoscopic ultrasonography. The abdomen was opened, and the pancreas was examined. No abnormality was evident, so a distal pancreatectomy was performed. The pathology diagnosis was diffuse hypertrophy of the islets.5 Her glucose level returned to normal after surgery and has remained so for the past year.

Figure. Diagnostic imaging and outcomes. CT indicates computed tomography; EUS, endoscopic ultrasonography.
These findings show that laparoscopic enucleation of insulinomas is safe and effective. Pancreatic fistulas were common, but they caused little morbidity. Our 29% (2 of 7 patients) incidence of complications from the fistulas following laparoscopic enucleation was consistent with other published series. The reported rate of fistula formation or peripancreatic fluid collection ranges from 18% to 33%. Despite this, hospitalization was brief (only 1 day in 5 of 7 patients who had enucleation). Most patients tolerated closed-suction drainage as an outpatient without difficulty.

The principal reason for laparotomy (22% [2 of 9]) was an inability to identify the lesion that had been seen on preoperative imaging. In the first of 2 cases that were converted to an open operation, laparoscopic distal pancreatectomy may have been possible. Such an operation is preferred when it can be performed safely.

The appropriate number of preoperative imaging studies to localize an insulinoma has been the subject of debate. Contrary to previous reports, we found that CT based on a pancreatic protocol was the study that best predicted success of laparoscopic enucleation. While only 5 of 9 scans were diagnostic, pancreatic protocol CT rendered EUS unnecessary in 4 of 7 successful laparoscopic enucleations. Furthermore, both open operations were required in patients with nondiagnostic CT scans. Endoscopic ultrasonography identified 2 lesions not visible on CT, both of which were removed laparoscopically. Although these tumors can be localized laparoscopically, patients with equivocal preoperative imaging studies are more likely to require conversion to an open operation in our experience.

All patients who underwent attempted laparoscopic enucleation had at least 1 positive preoperative localization study finding. Preoperative localization is important in planning port placement and in guiding laparoscopic ultrasonography and dissection. Additional imaging tests are usually unnecessary. Spiral CT based on a pancreatic protocol should be sufficient for most cases. Endoscopic ultrasonography may be used to confirm the CT findings in patients with equivocal or nondiagnostic CT scans. For patients with equivocal or negative findings, calcium-stimulated venous sampling can be used to confirm the diagnosis and to direct the intraoperative search for a tumor. If no tumor is found, calcium-stimulated venous sampling may help guide a blind pancreatic resection.

Our preoperative evaluation consists of spiral CT. If the scan is nondiagnostic, the patient is referred for EUS. Calcium-stimulated venous sampling is reserved for patients with equivocal EUS findings. We counsel patients that the closed-suction drains will remain for several weeks following the operation and that they should plan to return home on the first or second postoperative day.

These findings suggest that most insulinomas can be successfully treated by laparoscopic enucleation. An occasional patient may be best managed by laparoscopic distal pancreatectomy. A few patients will require enucleation or partial pancreatectomy via a laparotomy. Therefore, the surgeon or group of surgeons managing a patient with an insulinoma should optimally be capable of performing each of these procedures.

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REFERENCES