Use of Ultrasonically Activated Shears Improves the Safety of Pancreaticojejunostomy After Pancreaticoduodenectomy

Tsuneo Tanaka, MD; Yasuhiro Matsugu, MD; Yasuhiko Fukuda, MD

Objective: To study whether the use of ultrasonically activated shears (UAS) would improve the safety of pancreaticojejunostomy after pancreaticoduodenectomy.

Design: Retrospective analysis.

Setting: University teaching hospital.


Main Outcome Measures: Leakage of pancreaticojejunal anastomosis as judged from the contents of the drain within 7 days after operation, and defined as a high amylase level of discharge that was 3 times higher than that of serum.

Results: Leakage of pancreaticojejunal anastomosis was observed in 1 (1.4%) of the 70 cases. Other complications were stomal ulcer, bile leakage, renal failure, and intra-abdominal abscess in one case each.

Conclusions: Use of UAS to perform pancreatectomy eliminates bleeding and pancreatic juice leakage from the branches of the pancreatic duct. Therefore, the cut surface of the pancreas is kept dry, simplifying anastomosis. Use of UAS improves the safety of pancreaticojejunal anastomosis after pancreaticoduodenectomy.

Arch Surg. 2002;137:1258-1261

It is difficult to completely prevent hemorrhage of the cut surface when conventional pancreatectomy is performed with an ordinary or an electric scalpel. In addition, the branched pancreatic ducts are cut several times, leaving the problem of pancreatic juice leakage. These 2 factors may be suggested to be the cause of leakage from the pancreatic anastomosis. Ultrasonically activated shears (UAS; Ethicon Inc, Somerville, NJ) are a new hemostatic device that use ultrasonic energy, whereby the vibrations of the ultrasound are transmitted to a uniquely designed blade, creating the coagulation effect of protein denaturation. Tissue injury is small with the UAS compared with the electric scalpel, and the hemostasis effect is superior. Moreover, the UAS occludes the small pancreatic ducts. The authors used UAS, performing a full-potential pancreatectomy to improve the safety of pancreaticojejunal anastomosis after pancreaticoduodenectomy.

METHODS

PATIENTS

The subjects were 70 patients with cases of pancreaticoduodenectomy treated in our department from April 1997 to May 2001. Mean age was 65.4 years (range, 33-87 years). A total of 43 cases were male patients, and 27 were female. With respect to the type of disease, there were 30 cases of pancreatic head cancer, 24 cases of bile duct cancer, 6 cases of cystic tumor of the pancreas, 4 cases of chronic pancreatitis, 4 cases of gastric cancer, and 2 cases of duodenal cancer. Twenty-two of the cases presented a normal soft pancreas without dilatation of the main pancreatic duct. Combined resection of the portal vein was performed in 14 cases (20%), and pylorus-preserving pancreaticoduodenectomy (PPPD) was performed in 21 cases (30%).

SURGICAL PROCEDURE

The pancreas was divided with the UAS after determination of the dissection line. There was no bleeding observed from the end of the pancreas, and suturing hemostasis, which is necessary in surgery involving an electric coagulator, was not required. The main pancreatic duct was examined, and polyvinyl chloride tubes (Sumitomo Bakelite, Tokyo, Japan) with 5F, 6F, or 7F segments were inserted according to the diameter of the duct. Tubes were guided externally through the jejunal loop. An elliptical incision was made in the serosa of the jejunum approximately 5 cm from the jejunal stump. The posterior wall of
the anastomosis was stitched 7 to 9 times using a 3-0 polypropylene (Prolene; Ethicon Inc) suture, from the seromuscular layer to the pancreas, and tied after the application of fibrin glue (Beriplast; Behring Inst GmbH, Marburg, Germany) to the sutured surface (Figure 1 and Figure 2). In the anterior wall, a continuous running suture was performed using a 3-0 polypropylene suture. Drains were placed routinely on the anterior and posterior surfaces of the pancreatojejunal anastomosis. A long-acting synthetic somatostatin analogue (eg, octreotide acetate) was not used in this study. Diet was commenced on postoperative day 7. The external pancreatic tube was removed 3 weeks after surgery.

DEFINITION OF PANCREATIC LEAKAGE

Leakage of pancreatojejunal anastomosis was judged from the contents of the drain within 7 days after surgery, and was defined as a high-amylase level of discharge that was 3 times higher than that of serum.

RESULTS

Operative death occurred in 3 cases (mortality rate was 4.2%), 1 of which was caused by pulmonary thrombosis, and 2 with combined resection of portal vein that were caused by hepatorenal failure. Leakage of a pancreatojejunal anastomosis was observed in 1 (1.4%) of the 70 cases. Other complications were stomal ulcer, bile leakage, renal failure, and intra-abdominal abscess in 1 case each.

The pancreatic juice output steadily increased as long as 5 days after surgery. The mean±SD daily pancreatic juice output before oral intake was 118±106 mL per day, and after oral intake, 194±137 mL per day (P<.01).

On histological analysis, eosinophilic tissue degeneration and edema were observed at the end of the pancreas. Apart from this area, no damage was observed, and the branches of the pancreatic duct were closed. Ten of 18 autopsied patients who died of local recurrence and/or distant metastasis more than 1 year after surgery were able to be given a histological examination of pancreatojejunal anastomosis.

COMMENTS

PANCREATIC JUICE AND SMALL DUCTS

The big difference between pancreatic anastomosis and other digestive tract anastomoses is that autodigestion incorporating pancreatic juice occurs in the anastomosis. Although the pancreatic juice in the pancreatic duct is not activated, pancreatic juice in the anastomosis is activated by digestive juices, and this increases the risk of suture failure. If the pancreatic juice in the zone of anastomosis is removed completely, the security of the pancreatic anastomosis will most likely be increased.3 Thus, by inserting a tube in the main pancreatic duct, we have been able to drain the pancreatic juice from the body. However, in pancreatectomy methods to date, the branches of the pancreatic duct at the cut surface have been exposed, and the resulting pancreatic juice leakage is not completely prevented.

TRANSECTION METHODS

There are many methods of pancreas transection, such as use of the surgical knife, electocautery, ultrasonic dissector,5 and UAS. By using UAS, the pancreas is able to be isolated while preventing leakage of pancreatic juice from the branches of the pancreatic duct, and the cut surface of the pancreas is kept completely dry. To our knowledge, this is the first report in which using UAS for pancreatectomy decreased the occurrence of pancreatic fistula in pancreatojejunostomy after pancreatectoduodenectomy.

After we divided the pancreas with UAS, the extracted pancreas was transected again 2 cm from the UAS surface by an electric coagulator. Histologically, the small ducts were not occluded completely by the electric co-
agulator on the cut surface. Sugiyama et al\textsuperscript{5} reported the usefulness of the ultrasonic dissector in pancreatectomy; however, transection time was relatively prolonged (mean time, 31 minutes).

## PANCREATIC BLOOD FLOW

In any anastomosis, blood flow in the tissue should be well retained. In conventional methods of pancreatectomy, there is considerable and unsatisfactory hemorrhage from the cut surface, and measures for hemostasis, such as suturing hemostasis as blood and pancreatic juice accumulates on the anastomotic surface, often fail. Conversely, in pancreatectomy using UAS instead of the conventional electric scalpel, there is no increase in tissue temperature (approximately 80°C), and tissue injury is minor. Thus, UAS is presently the most ideal tool for pancreatectomy. In fact, histological examination during autopsy has shown that this method maintains the anastomosis of the pancreas well, without fibrosis, inflammatory cell infiltration, or fat replacement.

### ANASTOMOTIC TECHNIQUE AND LEAKAGE

In earlier studies\textsuperscript{3,6-12}, factors such as age older than 65 years, preoperative jaundice, ampullary or duodenal disease, small pancreatic duct, soft pancreas, large intraoperative blood loss, and lower surgical volume have been associated with an increased risk of pancreatic fistula. In addition, factors proposed to decrease complications related to pancreatic anastomosis include (1) the mucosa-to-mucosa technique, (2) external drainage of the pancreatic duct, and (3) use of octreotide.

To date, various methods have been used for pancreateojunal anastomosis. In 8 large studies\textsuperscript{3,6-12} during the past 7 years (Table), the incidence of anastomotic fistula averaged 8.6% (range, 3.1%-17.6%). The incidence of mucosa-to-mucosa anastomosis was 5.6%, and of end-to-side anastomosis, 11.5%.

Although there is no consensus among surgeons as to technique in pancreateojunal anastomosis, many surgeons believe that mucosa-to-mucosa anastomosis is safer than other anastomotic techniques. Marcus et al.\textsuperscript{13} however, evaluated methods of operative management of the pancreatic remnant, and concluded that end-to-side pancreateojjunostomy appeared safe in low-risk patients with dilated pancreatic ducts or firm fibrotic pancreata. Our procedure is a simple end-to-side pancreateojjunostomy in a 1-layer suture, and the incidence of pancreatic fistula is lower than in mucosa-to-mucosa anastomosis.

### SIMPLE METHOD

Recently, many surgeons have asserted the benefits of mucosa-to-mucosa anastomosis\textsuperscript{3,7,8,10,12}; however, for patients whose main pancreatic duct is not dilated (ie, smaller than 3 mm), performing mucosa-to-mucosa anastomosis requires much skill. No matter how well an anastomosis is performed, pancreatic juice is activated in the anastomosis, leaving the risk of suture failure. In contrast, pancreatectomy with UAS requires no special skills. There is absolutely no hemorrhage from the cut surface of the pancreas, or leakage of pancreatic juice. Until the anastomosis is completed, the cut surface is kept completely dry, and completion requires only a short time (15-20 minutes). Consequently, pancreatic anastomosis is simple and can be performed even by resident physicians.

### OCTREOTIDE

The perioperative administration of octreotide, which has been tested for the purpose of decreasing the volume, amylase content, and bicarbonate content of pancreatic juice, can reduce the rate of complications.\textsuperscript{14,16} However, Lowy et al\textsuperscript{8} reported that their prospective, randomized trial demonstrated no effect of octreotide on the incidence of pancreatic anastomotic leak, concluding that the routine use of octreotide

<table>
<thead>
<tr>
<th>Study, Year</th>
<th>No. of PDs</th>
<th>Anastomotic Technique</th>
<th>Stent</th>
<th>Received Octreotide</th>
<th>Anatomic Fistula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yeo et al.\textsuperscript{6} 1995</td>
<td>72</td>
<td>End-to-side (2 layers)</td>
<td>No</td>
<td>No</td>
<td>8/72 11.1</td>
</tr>
<tr>
<td>Howard\textsuperscript{7} 1997</td>
<td>152</td>
<td>Mucosa-to-mucosa</td>
<td>Yes</td>
<td>No</td>
<td>5/152 3.3</td>
</tr>
<tr>
<td>Lowry et al.\textsuperscript{4} 1997</td>
<td>110</td>
<td>Mucosa-to-mucosa (n = 82)</td>
<td>Yes</td>
<td>Yes (n = 57)</td>
<td>10/110 9.1</td>
</tr>
<tr>
<td>van Berge-Henegouwen et al.\textsuperscript{6} 1997</td>
<td>296</td>
<td>Invagination (n = 28)</td>
<td>No</td>
<td>No</td>
<td>29/269 10.8</td>
</tr>
<tr>
<td>Tsuji et al.\textsuperscript{10} 1998</td>
<td>300</td>
<td>Mucosa-to-mucosa (n = 213)</td>
<td>Yes (n = 152)</td>
<td>Yes (n = 55)</td>
<td>31/300 10.3</td>
</tr>
<tr>
<td>Roder et al.\textsuperscript{3} 1999</td>
<td>85</td>
<td>Mucosa-to-mucosa (n = 21)</td>
<td>No</td>
<td>No</td>
<td>15/85 17.6</td>
</tr>
<tr>
<td>Okamoto and Tsuruta\textsuperscript{11} 2000</td>
<td>162</td>
<td>Fistulation method (sutureless)</td>
<td>Yes</td>
<td>No</td>
<td>5/162 3.1</td>
</tr>
<tr>
<td>Ohwada et al.\textsuperscript{12} 2001</td>
<td>100</td>
<td>Mucosa-to-mucosa</td>
<td>No</td>
<td>No</td>
<td>4/100 4.0</td>
</tr>
<tr>
<td>Present study, 2002</td>
<td>70</td>
<td>End-to-side (1 layer)</td>
<td>Yes</td>
<td>No</td>
<td>1/70 1.4</td>
</tr>
</tbody>
</table>

*PDs indicates pancreaticoduodenectomies.
after pancreaticoduodenectomy for tumor cannot be recommended. By instituting a fast until postoperative day 7, the period when suture failure often occurs, the authors reduced the amount of pancreatic juice, and, as the juice is being drained externally, the administration of octreotide is no longer considered essential.

Use of UAS to perform pancreatectomy eliminates pancreatic juice leakage from the branches of the pancreatic duct, and assists in the secure suture of the pancreatic anastomosis. In addition, the cut surface of the pancreas is kept dry, thus simplifying anastomosis.

Accepted for publication May 18, 2002.

Corresponding author and reprints: Tsuneo Tanaka, MD, Department of Surgery, Hiroshima Prefectural Hospital, 1-5-54 Ujinakanda, Minamiku, Hiroshima 734-8530, Japan (e-mail: juntan@ipc.hiroshima-u.ac.jp).

REFERENCES