Pancreaticojejunostomy using duct-to-mucosa anastomosis without a stenting tube

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Abstract

Background Purpose. There is a high risk of anastomotic leakage after pancreaticojejunostomy following pancreatoduodenectomy in patients with a normal soft pancreas because of the high degree of exocrine function. Therefore, pancreaticojejunostomy is generally performed using a stenting tube (stented method). However, pancreaticojejunalostomy with a certain duct-to-mucosa anastomosis does not always require a stenting tube, even in patients with a normal soft pancreas. Recently, we have performed pancreaticojejunostomy with duct-to-mucosa anastomosis without a stenting tube (nonstented method) and obtained good results.

Methods. The point of this technique is to maintain adequate patency of the anastomosis using a fine atraumatic needle and monofilament thread. The results of end-to-side pancreaticojejunostomy of the normal soft pancreas using the nonstented method (n = 123) were compared with those using the stented method (n = 45).

Results. There were no differences in background characteristics between the groups, including age, gender, and disease. The mean times to complete pancreaticojejunostomy were around 30 min in the two groups and the rates of morbidity and leakage of pancreaticojejunostomy were 26.8% and 5.7% in the nonstented group and 22.2% and 6.7% in the stented group, respectively. These differences were not statistically significant. One patient in the stented group died of sepsis following leakage of pancreaticojejunostomy. There were also no significant differences in the mean time to initiation of solid food intake or postoperative hospital stay.

Conclusions. In conclusion, complete pancreaticojejunostomy using duct-to-mucosa anastomosis for a normal soft pancreas does not require a stenting tube. This nonstented method can be considered one of the basic procedures for pancreaticojejunostomy because of its safety and certainty.

Key words Duct-to-mucosa pancreaticojejunostomy · Non-stented pancreaticojejunostomy · Pancreatectoduodenectomy · Reconstruction of the normal soft pancreas

Introduction

Pancreatectoduodenectomy was introduced by Kausch1 in 1912 and by Whipple et al.2 in 1935. In recent years, marked progress in imaging modalities has lead to early diagnosis of many pancreatobiliary diseases and pancreatectoduodenectomy, including pylorus-preserving pancreatectoduodenectomy (PPPD), has been performed increasingly as a standard operation for patients with periampullary lesions. The operative techniques have also become safer, and postoperative morbidity and mortality have been reduced markedly in many large specialized centers.3-9 However, the postoperative complication rates in patients with a normal soft pancreas are still high because a soft normal pancreas has a nondilated pancreatic duct and a high degree of exocrine function. In particular, anastomotic leakage of the pancreaticojejunostomy, which is the most serious early complication after pancreatectoduodenectomy, induces severe complications, such as intra-abdominal abscess or subsequent hemorrhage from the pseudoaneurysm of the artery. Therefore, pancreaticojejunostomy is generally carried out using a stenting tube for the normal soft pancreas.5,10,11 However, no consensus has been obtained on which pancreaticojejunostomy procedure is the safest,12,13 and there are some problems with stenting tubes such as twisting, bending, and occlusion of the tube. We have seen several complications associated with the stenting tube: acute pancreatitis resulting from subsequent occlusion or bending of the stenting tube or late anastomotic stenosis following iatrogenic injury sustained when withdrawing the external stenting tube. Since 1992, we have, therefore, performed pancreati-
cojejunostomy by duct-to-mucosa anastomosis without a stenting tube using thin monofilament stitches even in patients with a normal soft pancreas. The aim of this study was to evaluate the usefulness of nonstented duct-to-mucosa anastomosis in pancreaticojejunostomy for a normal soft pancreas with a nondilated pancreatic duct compared with stented duct-to-mucosa anastomosis.

**Patients and methods**

A consecutive series of 168 patients who underwent pancretoduodenectomy and pancreaticojejunostomy with duct-to-mucosa anastomosis for a normal soft pancreas with a nondilated pancreatic duct between September 1992 and March 2003 at Tokyo Women’s Medical University Hospital was included in the study. Of these, 123 patients underwent pancreaticojejunostomy without stenting tube [nonstented group: pancreatic head cancer, 44; cancer of the papilla of Vater, 22; bile duct cancer, 16; intraductal papillary-mucinous neoplasm (IPMN), 11; endocrine tumor, 5; gastric cancer, 4; duodenal cancer, 4; serous cystadenoma, 3; others, 14] and the remaining 45 patients underwent pancreaticojejunostomy with an internal or external stenting tube (stented group: pancreatic head cancer, 12; cancer of the papilla of Vater, 7; bile duct cancer, 11; IPMN, 1; endocrine tumor, 1; gastric cancer, 5; duodenal cancer, 0; serous cystadenoma, 0; others, 8). Among the 123 patients in the nonstented group, 106 patients underwent PPPD and 17 patients underwent pancretoduodenectomy with distal gastrectomy (PD). Among the 45 patients in the stented group, 31 patients underwent PPPD and 14 patients underwent PD. The choice of anastomosis with or without a stenting tube was the surgeon’s decision. The only difference between the two groups was whether a stenting tube was used, and pancreaticojejunostomy by duct-to-mucosa and end-to-side anastomosis was performed using the same methods described below in both groups.

The normal soft pancreas with a nondilated pancreatic duct was defined as follows: the results of the pre-operative pancreatic function test was within normal limits, intraoperative assessment showed a soft pancreatic parenchyma without fibrosis, and the diameter of the main pancreatic duct measured after pancreatic resection was less than 3mm. The operative results including operating time, time to complete pancreaticojejunostomy, intraoperative blood loss, morbidity rate, mortality rate, time to initiation of solid food intake, and postoperative hospital stay were compared between the two groups. Statistical evaluation between the two groups was carried out using Student’s $t$ test and the $\chi^2$ test. Significance was defined as a $P$ value of less than or equal to 0.05. Numeric data are expressed as the means ± SD.

**Operative techniques**

The operative techniques of the nonstented method are illustrated in Figs. 1–6. The pancreas, including the pancreatic duct, is sharply transected with a scalpel. Leaving only the pancreatic duct should be avoided at this time. Any arterial bleeding points on the pancreatic cut end are repaired with 4-0 or 5-0 nonabsorbable sutures and any oozing points are coagulated by electrocautery. No other treatment of the stump such as mattress or fish-mouth suturing is performed. A small hole compatible with the caliber of the pancreatic duct is made in the jejunal wall using electrocautery. No other treatment such as excision or scarification of the jejunal wall is
done. The end-to-side anastomosis between the pancreas and jejunum consists of two layers of sutures. The outer layer encompasses the capsular parenchyma of the pancreas and the jejunal seromuscularis, and the inner layer encompasses the pancreatic duct with a little pancreatic parenchyma and the whole jejunal wall. A posterior row of interrupted sutures and an anterior row of continuous suture are placed in the outer layer using 4-0 or 5-0 nonabsorbable sutures. In contrast, interrupted sutures are placed in the inner layer using 6-0 absorbable sutures. The important aim of this technique is to preserve adequate patency of the anastomosis between the pancreatic duct and jejunum. Therefore, fineatraumatic needles and monofilament sutures should be used, carefully picking up the pancreatic duct wall to avoid injury of the pancreatic tissues or constriction of the anastomosis. Placing a fine stay suture in the middle of the anterior wall of the pancreatic duct is very useful when the inner-layer anastomosis is started because pulling it to the left or upward expands the pancreatic duct enough to allow easy needle suturing. Usually four or five stitches can be placed in the posterior wall and two or three stitches in the anterior wall. Although this technique without a stenting tube can preserve adequate patency of the anastomosis, one should not persist with the nonstented method if any injury of the pancreatic tissues occurs during the inner layer of suturing. In this series, the decision on whether to use a stenting tube was left to the staff surgeon’s discretion.

Results

Patient backgrounds

There were no significant differences in patient backgrounds, including age, sex, or disease distribution between the two groups. However, about one-third of patients in the stented group underwent PD and there was a significant difference in the operative procedure between the two groups (Table 1).

Operative results

There were no significant differences in the mean operating time, mean time to complete pancreaticojejunostomy, or mean intraoperative blood loss between the two groups. The overall morbidity rates were 26.8% in the nonstented group and 22.2% in the stented group. Major leakage of the pancreaticojejunostomy occurred in 7 of 123 patients (5.7%) with the nonstented method and in 3 of 45 patients (6.7%) with the stented method. There were no significant differences between the two
Fig. 3a–d. Anastomosis of the outer layer (posterior row) to make a small hole on the jejunal wall. a View after finishing anastomosis of the outer layer (posterior row). b–d Making a small hole in the jejunal wall. A fine stay suture in the middle of the anterior wall of the pancreatic duct has already been placed.

Table 1. Background characteristics and operative procedure of patients with a normal soft pancreas undergoing pancreaticojejunostomy (September 1992 to March 2003)

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Nonstented $(n = 123)$</th>
<th>Stented $(n = 45)$</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male/female</td>
<td>74/49</td>
<td>27/18</td>
<td>N.S.</td>
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<tr>
<td>Disease</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pancreatic head cancer</td>
<td>44</td>
<td>12</td>
<td>N.S.</td>
</tr>
<tr>
<td>Cancer of the papilla of Vater</td>
<td>22</td>
<td>7</td>
<td>N.S.</td>
</tr>
<tr>
<td>Bile duct cancer</td>
<td>16</td>
<td>11</td>
<td>N.S.</td>
</tr>
<tr>
<td>Intraductal papillary-mucinous neoplasm</td>
<td>11</td>
<td>1</td>
<td>N.S.</td>
</tr>
<tr>
<td>Endocrine tumor</td>
<td>5</td>
<td>1</td>
<td>N.S.</td>
</tr>
<tr>
<td>Gastric cancer</td>
<td>4</td>
<td>5</td>
<td>N.S.</td>
</tr>
<tr>
<td>Duodenal cancer</td>
<td>4</td>
<td>0</td>
<td>N.S.</td>
</tr>
<tr>
<td>Serous cystadenoma</td>
<td>3</td>
<td>0</td>
<td>N.S.</td>
</tr>
<tr>
<td>Others</td>
<td>14</td>
<td>8</td>
<td>N.S.</td>
</tr>
</tbody>
</table>

Operative procedure

| PPPD | 106 | 31 | $P < 0.05$ |
| PD   | 17  | 14 |           |

PPPD, pylorus-preserving pancreaticoduodenectomy; PD, pancreaticoduodenectomy with distal gastrectomy; N.S., not significant.
Fig. 4a–d. Duct-to-mucosa anastomosis of the pancreaticojejunostomy. a A fine stay suture in the middle of the anterior wall of the pancreatic duct can expand the pancreatic duct by pulling it to the left or upward. b–d Interrupted sutures in the inner layer between the pancreatic duct, including the pancreatic parenchyma, and the whole wall of the jejunum. Usually four or five stitches can be placed in the posterior wall and two or three stitches in the anterior wall at an equal distance using 6-0 absorbable sutures.

Fig. 5a–c. Anastomosis of the outer layer (anterior row) and scheme of a cross section of the pancreaticojejunostomy. a,b A continuous suture is placed in the outer layer (anterior row) using 4-0 or 5-0 nonabsorbable sutures. c The outer layer of anastomosis consists of the capsular parenchyma of the pancreas and the seromuscular layer of the jejunum. The inner layer, a duct-to-mucosa anastomosis, consists of the pancreatic duct (including the pancreatic parenchyma) and the whole jejunal wall. Two-layer anastomosis is completed without stenting.
groups. The mortality rates were 0% in the nonstented group and 2.2% in the stented group. One patient in the stented group died of sepsis as a result of leakage of the pancreaticojejunostomy. There were no significant differences in the mean time to initiation of food intake and mean postoperative hospital stay between the two groups (Table 2).

**Discussion**

Pancreatoduodenectomy is one of the most complicated operations in abdominal surgery and includes various surgical procedures such as dissection and reconstruction of the pancreatic duct, bile duct, portal vein, and digestive tract. Since pancreatoduodenectomy was established by Whipple², various innovations have been made and the procedure has been improved by many modifications. These improvements have made pancreatoduodenectomy a widely used low-risk operation for diseases of the pancreatic head region. However, it is still a fact that there are some serious complications such as intra-abdominal hemorrhage or abscesses associated with anastomotic leakage of the pancreaticojejunostomy. If such complications occur after pancreatoduodenectomy, they directly affect the patient’s life. In general, the morbidity rate as a result of complications after pancreatoduodenectomy ranges from 18% to 52%. A pancreatic fistula has been reported in 8%–19% of patients and the associated
mortality rate after pancreatoduodenectomy is high once a pancreatic fistula occurs.\textsuperscript{3–9,14,15} Therefore, safe and certain pancreaticojejunostomy is required after pancreatoduodenectomy. In particular, since the normal soft pancreas is very vulnerable to ischemia and actively produces exocrine secretions, serious complications such as pancreatic fistula occur more easily in a normal soft pancreas than in a hard pancreas after pancreatoduodenectomy.\textsuperscript{16} Various ideas on how to avoid pancreatic fistula and improve safety have been reported, such as abandoning one-step reconstruction involving pancreaticojejunostomy,\textsuperscript{17} preventing exocrine function by means of ligation plugging of the pancreatic duct\textsuperscript{18} or by total pancreatectomy. However, while these methods may actually avoid leakage of the pancreaticojejunostomy, they may not successfully maintain the pancreatic function after surgery. Besides the prevention of pancreatic fistula, it is very important to preserve pancreatic function by ensuring long-term patency of the anastomosis of the pancreaticojejunostomy. Stenting tubes are generally utilized when performing pancreaticojejunostomy with a normal soft pancreas.\textsuperscript{9,10,11} However, we have encountered several complications associated with stenting tubes. Acute pancreatitis when withdrawing the external stenting tube occurred in two patients because of injury of the wall of the pancreatic duct. A number of patients also suffered from pancreatic leakage or pancreatitis caused by bending or stenosis of the external stenting tube at the point fixed to the skin. Moreover, even in patients with an internal stenting tube, we have encountered late pancreatic insufficiency as a result of subsequent obstruction of the tube or long-term placement of the tube. It has been reported that stenting tubes are harmful for some patients undergoing a duct-to-mucosa anastomosis during pancreaticojejunostomy, especially when the pancreatic duct is less than 3 mm in diameter.\textsuperscript{19}

Based on our experience with postoperative complications associated with stenting tubes, it was considered that no stenting tube is necessary if duct-to-mucosa anastomosis is performed completely and the patency of the anastomosis is preserved adequately.

On the other hand, it has been reported that a stenting tube can reduce the leakage of the pancreaticojejunostomy.\textsuperscript{12} However, more than half of those patients who underwent the nonstented method and in whom leakage of the pancreaticojejunostomy occurred had undergone the invagination technique in this study. The invagination technique without a stenting tube tends to lead to leakage or stenosis of the anastomosis in pancreaticojejunostomy. Moreover, if pancreaticojejunostomy is performed using a stenting tube, duct-to-mucosa anastomosis can be used to prevent leakage of the anastomosis and to maintain the pancreatic function.\textsuperscript{16} To evaluate the usefulness of the stenting tube in pancreaticojejunostomy, the method of anastomosis and the degree of pancreatic fibrosis should be standardized. Our study was limited to patients with a normal soft pancreas with a nondilated pancreatic duct and the procedure of pancreaticojejunostomy was limited to duct-to-mucosa anastomosis.

In this study, the rates of overall morbidity and leakage of the pancreaticojejunostomy in the nonstented group were 26.8% and 5.7%, respectively. There were no patient deaths as a result of the operation in the nonstented group and no significant differences in the operative results were seen between the two groups. Although this procedure requires a fine technique to prevent injury of the pancreatic duct, no stenting tube is needed to maintain the patency of the anastomosis when pancreaticojejunostomy has been achieved completely. Therefore, a fineatraumatic needle and monofilament thread (6-0 or 5-0) should be used in this procedure, and if any injury of the pancreatic duct is suspected through the duct-to-mucosa anastomosis, one should not persist in the nonstented method.

In conclusion, complete pancreaticojejunostomy using duct-to-mucosa anastomosis for a normal soft pancreas does not require a stenting tube. Although these

<table>
<thead>
<tr>
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<th>Nonstented (n = 123)</th>
<th>Stented (n = 45)</th>
<th>P value</th>
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<tbody>
<tr>
<td>Mean operating time (min)</td>
<td>311 ± 79</td>
<td>347 ± 96</td>
<td>N.S.</td>
</tr>
<tr>
<td>Mean time to complete</td>
<td>31 ± 12</td>
<td>32 ± 14</td>
<td>N.S.</td>
</tr>
<tr>
<td>Mean intraoperative blood loss (g)</td>
<td>1219 ± 1437</td>
<td>1315 ± 1225</td>
<td>N.S.</td>
</tr>
<tr>
<td>Morbidity rate (%)</td>
<td>26.8</td>
<td>22.2</td>
<td>N.S.</td>
</tr>
<tr>
<td>Leakeage of pancreaticojejunostomy (%)</td>
<td>5.7</td>
<td>6.7</td>
<td>N.S.</td>
</tr>
<tr>
<td>Mortality rate (%)</td>
<td>0</td>
<td>2.2</td>
<td>N.S.</td>
</tr>
<tr>
<td>Mean time to initiate food intake (days)</td>
<td>14 ± 8</td>
<td>16 ± 9</td>
<td>N.S.</td>
</tr>
<tr>
<td>Mean postoperative hospital stay (days)</td>
<td>31 ± 17</td>
<td>34 ± 21</td>
<td>N.S.</td>
</tr>
</tbody>
</table>
results need confirmation by further studies, this nonstented method can be considered one of the basic procedures for pancreaticojejunostomy because of its safety and certainty.

References
