A new attempt to use staples for gastrojejunostomy and Braun anastomosis in modified Child method of pancreaticoduodenectomy.


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Summary
Recent developments in laparoscopic gastrectomy have led to the introduction of various methods of stapled anastomosis. We have also introduced stapled anastomosis to reconstruction of the digestive tract with the aim of performing safe and quick anastomosis and enabling an early return to oral feeding. Reconstruction of the digestive tract following pancreaticoduodenectomy in our institution is performed using the modified Child method. In this procedure, stapled anastomosis is used for gastrojejunostomy and Braun anastomosis, reducing the time required to approximately half the time previously required for hand-sewn anastomosis. Stapled anastomosis did allow a faster return to oral feeding post-operatively, with reduced frequency of delay in gastric emptying compared with hand-sewn anastomosis, but delay in gastric emptying was not completely avoided. This report summarises the procedures and key points raised following the introduction of stapled anastomosis for gastrojejunostomy using the modified Child method and for Braun anastomosis during pancreaticoduodenectomy. While the results of these procedures were satisfactory, many challenges remain and further innovation is required.

Key words: pancreaticoduodenectomy, stapled anastomosis, gastrojejunostomy, Braun anastomosis, modified Child method

Introduction
Pancreaticoduodenectomy is a surgical procedure with high degree of difficulty and mortality rate of approximately 2-3%. While there have been advances in laparoscopic pancreaticoduodenectomy, the technique has not yet become widely adopted because of anatomical complexity. Furthermore, the ability to dissect the nerve plexus with a secure field of vision is an important requirement.

Reconstruction following pancreaticoduodenectomy is associated with the issue of occurrence of pancreatic fistula, the frequency of which is particularly high in patients with soft pancreas. Under these circumstances, we have used Billroth II gastrojejunostomy in addition to reconstruction via the modified Child method and Braun anastomosis (Figure 1). Furthermore, we avoid procedures that tend to cause post-operative gastric retention, such as pylorus-preserving pancreaticoduodenectomy and subtotal stomach-preserving pancreaticoduodenectomy. Instead, we use a method in which one-third of the stomach is excised, aiming for early post-operative commencement of oral feeding and an improvement in nutrition and general condition. Based on this approach, all 220 patients who have undergone pancreaticoduodenectomy in our institution to date
have been discharged from hospital without the need for assistance. That is to say, in addition to the 136 patients described previously\textsuperscript{11}, a further 220 consecutive patients have undergone surgery and reconstruction using the same method and have been ambulatory on discharge. In almost all cases, the surgeon was Professor Kimura\textsuperscript{10}.

Albert-Lembert anastomosis was the previous method used for gastrojejunalostomy, but complications, including anastomotic stricture were not uncommon, and these complications hindered the achievement of early oral feeding and a rapid return to health as described above. It is duty of surgeon to limit the stress caused by exposure of intraperitoneal organs to room air during operation and to minimize post-operative complications. Therefore, gastrojejunalostomy and Braun anastomosis must be performed efficiently and effectively.

The use of stapled anastomosis for surgery of the gastrointestinal tract was first investigated in the 1980s, for oesophagojejunal anastomosis following total gastrectomy\textsuperscript{3,4}. Several new methods of stapled anastomosis have recently been introduced following recent developments in laparoscopic gastrectomy. We have adopted these techniques for gastrojejunalostomy and Braun anastomosis during pancreaticoduodenectomy. This report summarizes the anastomosis procedure and our refinements to the methodology.

**Objectives**

At our institution, we perform reconstruction after pancreaticoduodenectomy using Billroth II gastrojejunalostomy and the modified Child method to which Braun anastomosis is added (Fig. 1). We have introduced stapled anastomosis for gastrojejunalostomy and Braun anastomosis, with the aim of performing safe and quick anastomosis and enabling an early return to oral feeding.

**Subjects**

We performed pancreaticoduodenectomy for 27 cases during September 2012 and July 2013. One case was excluded because remnant stomach was too small for stapled anastomosis. This case had been previously undergone distal gastrectomy. Twenty-six patients in whom the modified Child method ‘s was used to perform pancreaticoduodenectomy with gastrojejunostomy and Braun anastomosis employing stapled anastomosis between September 2012 and July 2013 were selected for the study.

There were 17 males and 9 females, and mean age was 68.2 years (range 48 to 79). Diseases of 26 cases were composed of 13 pancreatic cancers, 4 bile duct cancers, 2 neuroendocrine tumor, 2 gastric cancers with pancreatic invasion, 1 carcinoma of the papilla of Vater and 1 duodenal gastrointestinal tumor, respectively.

The first author, Associate Professor Fujimoto, positively conducted these parts of operation of the study.

**Methods**

Following pancreaticoduodenectomy, the modified Child method was used to perform pancreaticojejunostomy and biliojejunostomy, after which gastrointestinal anastomosis was performed. Stomach resection was performed using Linear Cutter 100\textsuperscript{®} (Ethicon) (Fig. 2), and 4-0 PDS\textsuperscript{®} II (Ethicon) was used to close the resection margins with knotted sutures. Reconstruction was performed as posterior (retrocolic).
gastrojejunostomy using the Billroth II method, approximately 60 cm distal to biliojejunoanastomosis. Braun anastomosis was performed on the jejunum approximately 20 cm from gastrojejunostomy. The procedures involved and key points relating to the use of stapled anastomosis for gastrojejunostomy and Braun anastomosis are summarized below.

**Gastrojejunostomy: procedures and key points**

1. Staples are removed from the remnant gastric stump on the greater curvature to form a stoma.
   - **Staples are removed from an area of approximately 7-8 mm.**
   - Using the cut function of the electrosurgical scalpel helps avoiding trauma to the wound margin.
   - **The stapled section is not cut with the electrosurgical scalpel but with scissors capable of cutting through the staples.**
   - The stoma is widened using mosquito forceps, and gastric contents are aspirated. A suction tube is inserted, and the direction and spacing of the automated stapler is confirmed.

2. A stoma is formed contralateral to the jejunal mesenteric side of the planned anastomotic site.
   - **A 60-mm automatic anastomosis stapler is used; therefore, the stoma is formed approximately 2-3 cm towards the anal side from the centre of the planned anastomotic site.**
   - **The stoma is formed using the cut function of the electrosurgical scalpel in a piercing motion and is widened using mosquito forceps to enable insertion of the anvil fork.**

3. The Endo GIA™ Tri-staple™ 60 Purple cartridge (Covidien) is prepared, the anvil fork are inserted into the jejunum and the cartridge fork is inserted into the stomach (Fig. 3).
   - **Because there is more room and the wall is flexible for movement in the jejunum than the stomach, the anvil fork are first inserted into the jejunum before inserting the cartridge fork into the stomach.**
   - After inserting the anvil fork into the jejunum, the jejunum and the automatic anastomosis stapler are moved simultaneously, and the cartridge fork is inserted facing the gastric stoma.
   - **The cartridge fork is inserted into the stomach diagonally towards the posterior wall from the attachment of the greater omentum. The cartridge fork is placed approximately 1 cm from the attachment of the greater omentum.**
   - **The jejunum is positioned so that it will be contralateral to the mesentery.**
   - **During insertion, care must be taken to ensure that the gastric and jejunal stomas do not invert with the cartridge base.**

4. The anvil of the stapler is tentatively closed and the area is inspected.
   - **Tentative closure enables confirmation of the shape of the whole anastomosis, including checking for torsion and entanglement.**

5. The stapler is fired. With this step, gastrojejunal side-to-side anastomosis is complete.
• After firing, the area is inspected to confirm that there is no bleeding from the insertion hole.

6. The anastomosis staples are opened out to form a V shape, and the common entry hole is closed with 4-0 PDS® II continuous single-layer sutures.
• Non-removable 4-0 PDS® II sutures are used. Our institution uses SH-1 needles with 4-0 PDS® II sutures, with one of the two end needles removed.
• The anastomosis staples are opened out around the stump, forming a V-shaped anastomosis.
• Having staples on the stump does not present an issue, but care is required to ensure that the staples themselves are not arranged on top of one another.
• The sutures are placed in such a manner that the first and the last suture knots lie outside of the hole.
• The over-and-over suture method is used (Fig. 4).

7. To reinforce the section that will come in contact with the tip of the automatic suture instrument, the stomach and the jejunum are sutured with single needle 4-0 PDS® II suture.
• A 45-mm automatic anastomosis stapler is used; therefore, the tentative fixture is formed approximately 2 cm to the cranial side of the centre of the planned anastomotic site.
• A 45-mm automatic anastomosis stapler is used; therefore, the stomas are formed approximately 2 cm to the caudal side of the centre of the planned anastomotic site.
• Stomas are formed using the cut function of the electro surgical scalpel in a piercing motion and are widened using mosquito forceps to enable insertion of the automated stapler.

8. In some instances, it is acceptable to fix the afferent loop to the gastric wall and elevate it.
• This aids flow to the efferent loop.
• This step can be omitted if it could cause torsion.

Braun anastomosis: procedures and key points
1. The area contralateral to the jejunal mesenteric side of the section planned for anastomosis is sutured with 4-0 PDS® II sutures and tentatively fixed.

Figure 4.

Figure 5.
there is no bleeding from the insertion hole.
6. The common entry hole is closed with 4-0 PDS® II continuous single-layer sutures.
7. To reinforce the section that will come in contact with the tip of the automatic suture instrument, the two sections of the jejunum are sutured with single needle 4-0 PDS® II sutures.

Results
We recorded the time required for gastrojejunostomy and Braun anastomosis. For stapled anastomosis, time was measured from the opening of the stoma in the stomach to the cutting of the final suture of Braun anastomosis. For hand-sewn anastomosis, time was measured from the application of intestinal clamps during gastrojejunostomy to the cutting of the final suture of Braun anastomosis. Of the 26 cases of stapled anastomosis performed, anastomosis time could be measured in 16 cases. The average time was 26 min (range 15-35 min). The average anastomosis time for three cases of hand-sewn anastomosis performed prior to the introduction of stapled anastomosis was 65 min (range 63-68 min), indicating that the introduction of stapled anastomosis has enabled the reduction of anastomosis time (Table 1).

The first patient treated after the introduction of stapled anastomosis in our institution started oral fluid intake on the second post-operative day and consumed thin rice gruel on the third post-operative day. Contrastradiography on the fifth post-operative day showed that anastomosis was satisfactory and there was no anastomotic leakage. Thus, there were no issues from a safety perspective. The patient had soft pancreas; therefore, the indwelling drain was in place for some time, but there were no problems with oral feeding. By post-operative day 14, the patient exhibited approximately ≥80% of normal adult food intake, and recovery was uneventful.

Post-operatively, no cases of anastomotic leakage or stricture were observed. The middle-day before patients could tolerate oral ingestion of solid rice gruel was 11 days post-operatively, with a range of 6-52 days. In the patients who had difficulty tolerating solid rice gruel, delay in the evacuation of stomach contents was observed, and in many cases, the stomach tube had to be reinserted. Ultimately, all patients resumed oral feeding and were ambulatory on discharge from hospital.

Discussion
Recent developments in endoscopic surgery have resulted in a more proactive approach to gastrectomy and colectomy, whereas previously endoscopic surgery was more common for procedures not requiring anastomosis, for example, gallbladder and appendix resection. In particular, because resections of areas from the stomach to the large intestine require anastomosis, these procedures have presented many challenges in the past. However, the development of new surgical instruments and techniques has lead to these procedures more frequently being performed endoscopically.

Reconstruction by stapled anastomosis is performed for gastrojejunostomy using the Roux-en-Y method or gastroduodenostomy using the Billroth II method, and these techniques could be applicable to pancreaticoduodenectomy. Our method combines Billroth II gastrojejunostomy with Braun anastomosis, and we considered that it was possible to apply our experience gained from previous endoscopic surgeries to these procedures. Taking into account the various techniques as described in the Methods section, we decided on an adapted Delta anastomosis. We followed the same procedure for Braun anastomosis. As indicated by the results, the operating time using stapled

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Table 1. Clinical outcomes for all 26 cases.

<table>
<thead>
<tr>
<th></th>
<th>mean</th>
<th>range</th>
</tr>
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<tbody>
<tr>
<td>operating time</td>
<td>530 min</td>
<td>362–727 min</td>
</tr>
<tr>
<td>bleeding count</td>
<td>628 ml</td>
<td>189–1258 ml</td>
</tr>
<tr>
<td>anastomosis time</td>
<td>36 min</td>
<td>15–35 min</td>
</tr>
<tr>
<td>intake rice porridge after surgery</td>
<td>16 days</td>
<td>6–52 days</td>
</tr>
<tr>
<td>postoperative hospital stay</td>
<td>35 days</td>
<td>15–72 days</td>
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anastomosis was considerably shorter than that using hand-sewn anastomosis. Regarding post-operative progress, while many patients started early oral feeding and followed a satisfactory post-operative course, we did observe delayed evacuation of stomach contents, and reinsertion of the stomach tube was necessary in some cases. Delayed evacuation of stomach contents is also observed following hand-sewn anastomosis, and although the incidence of this problem has reduced since the introduction of stapled anastomosis, it has not been completely eliminated. In patients with delayed evacuation of stomach contents, post-operative transillumination showed that, in most cases, gastrojejunostomy had been pulled to the right, and the anastomotic site had been vertically displaced. While anastomotic stricture was not observed, the displacement caused delayed evacuation from the remnant stomach to the jejunum. The following factors, among others, might have caused this problem. (1) Because the pancreaticojejunostomy site and the gastroduodenal artery stump are separated during surgery at this institution, the greater omentum of the remnant stomach is wrapped around pancreaticojejunostomy. Therefore, the anastomotic site is pulled, and displacement can occur. (2) When the remnant stomach is too large, the anastomotic site is prone to move, and displacement does occur. (3) Pancreatic fistula or inflammation within the abdominal cavity can cause adhesions, leading to deformation of the anastomotic site. To reduce delays in the evacuation of stomach contents, further research is required in a range of areas including placement of the gastrectomy line, the fixed position of the stomach after reconstruction and the overall balance of the reconstructed organs.

**Conclusion**

We introduced stapled anastomosis for reconstruction by gastrojejunostomy and Braun anastomosis following pancreaticoduodenectomy using the modified Child method. Anastomosis was performed quickly and safely, with a considerable reduction in operating time compared with hand-sewn anastomosis. However, delays in the evacuation of stomach contents still occurred. In the future, we intend to actively investigate further improvements in this procedure, with regard to efficiency, efficacy and safety.

**References**