Novel Device for Pancreaticojejunostomy via a Pure Laparoscopic Approach

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Although minimally invasive surgery has rapidly evolved to include a variety of complex surgical procedures, laparoscopic pancreaticoduodenectomy (PD) has yet to be accepted as a generalized surgical method for the resection of pancreatic head lesions. The main reasons are both the difficulty and time consumption of pancreaticoenteric anastomosis,1,2 and involve not only the challenge of accurate needle handling, but also tangling of a number of sutures that have been retained without ligation after stitching. Therefore, we used a modified Kakita method,3 which is familiar to most Japanese pancreatic surgeons as a simple and safe method for open pancreaticojejunostomy (P-JS), and we created a novel device, Haenawa (Fig. 1), for this method. We herein describe our experiences of PD and middle pancreatectomy (MP). As background, in Japanese, Haenawa means a fishing trawl line consisting of a number of fishhooks.

METHODS

Patients are placed in a lithotomy position and secured firmly to the bed. A 12-mm trocar is placed at the umbilicus or a little lower than the umbilicus and pneumoperitoneum is established. Another two 12-mm trocars are placed, both lateral of the first trocar, and two 5-mm trocars are placed at the right and left infracostal arch. The positions of these 4 trocars are all on the right and left midclavicular lines. During PD, we divide the pancreas and extrahepatic bile duct with a Harmonic scalpel (Ethicon Endo-Surgery, Inc) at the final stage after dissecting the pancreas from the mesenteric vessels. In a similar manner, during MP, after division of the right side, the stump of which is usually closed using a stapler, the left side, the stump of which requires anastomosis, is divided at the final stage. After resection, the midline just above the pancreas is opened to 4 cm and the specimen is removed within the plastic bag through this incision. A wound retractor (Applied Medical) is then loaded with a 5-mm trocar connected through a latex glove at this incision. The jejunal limb is brought in a retrocolic fashion to the right of the middle colic vessels and the blind end is placed near the pancreas remnant in PD. The jejunal limb is brought in a similar manner to the left of the middle colic vessels in MP.

Before the reconstruction, Haenawa is assembled (Fig. 1) from a 10-cm 18-Fr catheter, 4 pieces of 4-0 Nespine suture with a gently curved long needle (monofilament polypropylene suture: Alfresa Pharma Corporation), which has been cut to 18 cm, and metal clips as stoppers. Haenawa and Secura (urethane sponge: Hogy Medical Co, Ltd) are inserted through the 4-cm incision. Haenawa is placed on the right side of the abdominal cavity, and Secura is placed on the remnant pancreatic body. After re-establishing the pneumoperitoneum, P-JS is performed before choledocojejunostomy, using the modified Kakita method, which is generally a double-layered end-to-side technique consisting of an outer layer approximated by 5 to 6 interrupted sutures of the seromuscular layer of the jejunum and full-thickness pancreas and an inner layer of duct-to-mucosal anastomosis.3,4 In our modified Kakita method for laparoscopic surgery (Video 1), the outer layer is approximated by 4 interrupted sutures using 4-0 Nespine sutures of Haenawa. Using these sutures, the seromuscular layer of the jejunum is first stitched in the anterior-to-posterior direction, and then the full-thickness pancreas is stitched in the posterior-to-anterior direction. The suture then penetrates a Secura placed on the remnant pancreatic body and is secured by clipping on the far side of the Secura, and then the needle is separated off (Fig. 2). These sutures are performed with a backhanded stitch technique.

Regarding the procedure for the inner layer, for the dilated main pancreatic duct (MPD), duct-to-mucosal anastomosis using continuous 5-0 Maxon sutures is performed without a stent (Video 2). For normal size MPD, a short stent tube for internal drainage is placed and fixed at the stump of the MPD with a purse-string suture of the...
pancreatic parenchyma around the MPD using a 5-0 Maxon suture (Covidien), and then is inserted into the jejunum through a small orifice without duct-to-mucosal anastomosis (internal drainage method; Video 1). After all Haenawa sutures have been placed, first the most cranial side Haenawa suture is ligated. Then, inner layer procedures are performed, and the other Haenawa sutures are ligated in sequence from the cranial to caudal side (Fig. 3). The choledocojejunostomy and duodeno- or gastro-jejunostomy are then performed. Before closing the abdomen, a closed-suction drain is placed in the pancreatic anastomosis area.

From August 2011 to November 2012, 20 patients underwent laparoscopic PD and 3 patients underwent laparoscopic MP at Tokyo Metropolitan Cancer and Infectious diseases Center Komagome Hospital. The 23 patients had a median age of 68 years (range 34 to 86 years). The male:female ratio was 14:9. Histopathologic diagnosis was intraductal papillary mucinous neoplasm in 10, papilla carcinoma in 5, pancreatic carcinoma in 3 patients, and pancreatic neuroendocrine tumor, bile duct neuroendocrine tumor, duodenal carcinoma, solid and pseudo-papillary neoplasm, and serous cystadenoma in 1 patient, respectively. In 17 of 23 patients, excluding 5 patients for whom we performed P-JS via the open approach and a patient for whom we performed P-JS via the laparoscopic approach for the first time, P-JS was performed by our standardized method using Haenawa. Of these 17, the internal drainage method was performed in 12 and duct-to-mucosal anastomosis was performed in 5 patients for the inner layer.

RESULTS
The mean overall operative time among 17 patients was 462 minutes (range 341 to 656 minutes), with mean blood loss of 126 g (range 0 to 350 g). Of 17 patients

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**Abbreviations and Acronyms**

- **MP** = middle pancreatectomy
- **MPD** = main pancreatic duct
- **PD** = pancreaticoduodenectomy
- **PJ-S** = pancreaticojejunostomy
- **POPF** = postoperative pancreatic fistula

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**Figure 1.** Haenawa created on the back table. Haenawa is assembled from a 10-cm, 18-Fr catheter, 4 pieces of 4-0 Nespliene sutures with a gently curved long needle, which has been cut to 18 cm, and metal clips as stoppers.

**Figure 2.** Well organized sutures of Haenawa after completion of stitching. They have been arranged like guitar strings. The seromuscular layer of the jejunum was stitched from the patient’s right side, and then full-thickness pancreas was stitched in the posterior-to-anterior direction. These sutures were performed with the back-handed stitch technique. A short stent tube was placed and fixed at the stump of the main pancreatic duct with a purse-string suture of the pancreatic parenchyma around the main pancreatic duct.

**Figure 3.** After completion of pancreaticojejunostomy. The white sponge on the right side of this photo is Securea.
who underwent laparoscopic P-JS using Haenawa, in 12 with the internal drainage method and 5 with duct-tomucosal anastomosis, the mean times for P-JS were 81 minutes (range 48 to 111 minutes) and 103 minutes (range 79 to 156 minutes), respectively. Postoperative complications occurred in 8 patients. Postoperative pancreatic fistula (POPF) of Grades A and B occurred in 1 and 2 patients, respectively, and peptic ulcer, portal vein thrombus, congestion of the afferent loop jejenum, abdominal abscess, and pneumonitis occurred in 1 patient, respectively. In all patients, complications were resolved with conservative measures.

DISCUSSION
Laparoscopic PD has yet to be accepted as a generalized surgical method because of both the difficulty and time consumption of pancreaticoenteric anastomosis. In our first case of totally laparoscopic P-JS, for which we did not use our current procedure, we felt marked stress, especially during P-JS. More than 1 hour on average is required for P-JS; however, we feel that our stress was reduced by eliminating the tangles of sutures retained without ligation after stitching. Therefore, we believe that totally laparoscopic P-JS is feasible using our current procedure with Haenawa. Because we have yet to experience many cases and are still on a learning curve, we believe that the time to complete P-JS can become shortened in the near future.

Our current 2 procedures for P-JS via the laparoscopic approach were almost the same as those via the open approach, except that continuous sutures were used instead of interrupted sutures in the duct-to-mucosal anastomosis. We used a modified Kakita method, which is familiar to most Japanese pancreatic surgeons as a simple and safe method for open P-JS. Although an approximation of the jejunal wall and the pancreatic stump is made using 6 to 8 nonabsorbable interrupted penetrating sutures in the original Kakita method, only 4 sutures are used in our current procedure. We performed this procedure without Haenawa for more than 100 cases via the open approach, and our results were comparable to the general results (no data shown). There is still no accepted standard approach for restoration of pancreatic drainage after PD or MP. Among the randomized controlled trials comparing pancreaticogastrostomy with P-JS, the POPF rate in pancreaticogastrostomy was lower than in P-JS, while the other results showed no difference. Using the invagination method, a randomized controlled trial showed that the POPF rate was lower than with duct-to-mucosal anastomosis; the other results showed no difference. However, anxiety remains about increasing the degree of functional deterioration of the pancreas remnant. Regarding the significance of placing a stent, although randomized controlled trials showed that the POPF rate in the group with an external stent was lower than in the group with no stent, there was no difference between the groups with no stent and with a short stent tube, and there was no difference between the groups with an external stent and with a short stent tube.

CONCLUSIONS
Whichever procedure becomes standard in the future, this device is thought to be useful for laparoscopic pancreaticoenteric anastomoses using interrupted sutures for approximating the pancreas remnant and the jejunum or stomach.

Author Contributions
Study conception and design: Honda
Acquisition of data: Kurata, Okuda, Kobayashi, Yamaguchi, Matsumoto, Nakano
Analysis and interpretation of data: Honda
Drafting of manuscript: Honda
Critical revision: Honda, Takahashi

REFERENCES


