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Hanging Maneuver in Pancreaticoduodenectomy: A safe method of Pancreatic amputation with Concomitant Pancreatitis

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Abstract

Introduction: Pancreatic transection is a crucial step in pancreaticoduodenectomy for pancreatic head cancer, which often leads to concomitant pancreatitis. The aim of pancreatic transection is to dissect only the pancreatic parenchyma without damaging the common hepatic artery (CHA), splenic artery (SpA), portal vein, or splenic vein. We demonstrate that a hanging maneuver using two cotton tapes enables the safe and uniform transection of pancreatic head cancer with concomitant pancreatitis.

Methods: This hanging maneuver has three steps. In the first step, the area around the SMA up to the celiac plexus must be dissected. In the second step, the CHA is dissected from beyond the bifurcation of the Celiac Axis to the SpA. The third step, involves passing two cotton tapes through the planned pancreatic cut line. These three steps make pancreatic transection safe and uniform. The hanging maneuver has been performed in 30 cases of pancreaticoduodenectomy for pancreatic head cancer with severe concomitant pancreatitis.

Results: No significant differences were observed in any of the items between the hanging maneuver for concomitant pancreatitis group and the conventional pancreaticoduodenectomy without concomitant pancreatitis group.

Conclusions: Pancreatic transection using the hanging maneuver is an effective and safe approach to pancreaticoduodenectomy with concomitant pancreatitis.

Introduction

Pancreatic transection is a crucial step in pancreaticoduodenectomy for pancreatic head cancer, which often leads to concomitant pancreatitis caused by tumoral obstruction of the pancreatic duct [1,2]. Furthermore, the inherent characteristics of high invasiveness and sclerosing nature of pancreatic cancer often create difficulty in dissecting the pancreas from the surrounding tissue. Specifically, the common hepatic artery (CHA) and splenic artery (SpA) are located on the patient's cranial side, and the superior mesenteric artery (SMA), portal vein (PV), and splenic vein (SV) are located on the patient's dorsal side in the pancreatic body to be amputated. These important blood vessels are often integrated with pancreatic parenchyma due to concomitant pancreatitis. During pancreaticoduodenectomy, if the pancreas cannot be resected along the planned cut line, the surgery cannot proceed any further.

Therefore, the primary aim of pancreatic transection is to dissect only

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the pancreatic parenchyma without damaging the CHA, SpA, PV, SV. Once the pancreatic parenchyma is cut, it becomes possible to directly visualize the pancreatic head plexus and celiac plexus located on the dorsal side, which is a very useful step in the progress of the surgery.

In this study, we demonstrate that a hanging maneuver using two cotton tapes enables the safe and uniform transection of pancreatic head cancer with concomitant pancreatitis. The method and the results are described subsequently.

Material and Methods

Procedure for pancreatic amputation

In most cases of pancreatic transection for pancreatic head cancer with concomitant pancreatitis, the transection site is often located on the ventral side of the superior mesenteric artery (SMA). The pancreatic body on the ventral side of the SMA includes the SV, Toldt's fascia. The CHA and SpA are located on the patient's head side. The superior mesenteric vein and PV are located on the pancreatic head side (Figure 1). Sufficient anatomical knowledge and surgical skills are required to safely dissect this area, which is surrounded by many major blood vessels. Furthermore, separating CHA and SpA from the pancreatic parenchyma affected by concomitant pancreatitis is often difficult. If pancreatic transection cannot be performed, the pancreatic amputation surgery cannot proceed to the next step, which will extend the operating time and affect the radicality of the surgery. Our established technique for pancreatic transection is a safe and innovative method for uniformly transecting only the pancreatic parenchyma regardless of the extent of inflammatory adhesion in the surrounding major blood vessels caused by concomitant pancreatitis. The method we present here consists of three steps. In the first step, which is a preliminary step to ensure a safe pancreatic transection, the area around the SMA up to the celiac plexus must be dissected. We dissected the SMA to the celiac plexus using the mesenteric approach [3,4]. The SMA is secured with a tape at the horizontal portion of the duodenum, after which the middle colic artery (MCA) is ligated and transected. The MCA is then dissected circumferentially from the root of the SMA to the celiac plexus to secure the most dorsal portion of the pancreatic body (Figure 2). In the second step, the CHA is dissected from beyond the bifurcation of the CA to the SpA and then separated from the pancreatic parenchyma. This phase of the surgery is most significantly affected by concomitant pancreatitis since in cases of severe inflammation, separating the CHA and SpA from the pancreatic parenchyma becomes difficult. In particular, the SpA often penetrates the parenchyma rather than run around it, which may create difficulty in its separation from the pancreatic parenchyma before pancreatic transection (Figure 3). The third step, the most important of the three steps, involves passing two cotton tapes through the planned pancreatic cut line. Inserting a Kelly forceps between the ventral side of the SMA and the posterior side of the Toldt's fascia, the tip of the Kelly forceps would be observable from the posterior side of the CHA or SpA to the patient's head (Figure 4a). The CHA or SpA, pancreatic parenchyma, SV, and Toldt's fascia are pulled ventrally as a unit with two cotton tapes. This traction method using cotton tape is called the hanging maneuver (Figure 4b). Traction applied by pulling the cotton tapes symmetrically around the planned pancreatic cut line facilitates the management of bleeding, even if the blood vessels embedded in the pancreatic parenchyma were damaged during pancreatic transection. The hanging maneuver is performed to separate the CHA, SpA, or SV from the pancreatic parenchyma while controlling bleeding. In cases of severe adhesion caused by concomitant pancreatitis, separating the vessels from the pancreatic parenchyma may not be possible. Three combinations of tissues are taped at the time of pancreatic transection: ① The CHA or SpA, SV, and pancreatic parenchyma are pulled together; ② only the CHA or SpA can be separated, and the pancreatic parenchyma and SV are pulled together; and ③ only the pancreatic parenchyma is pulled.

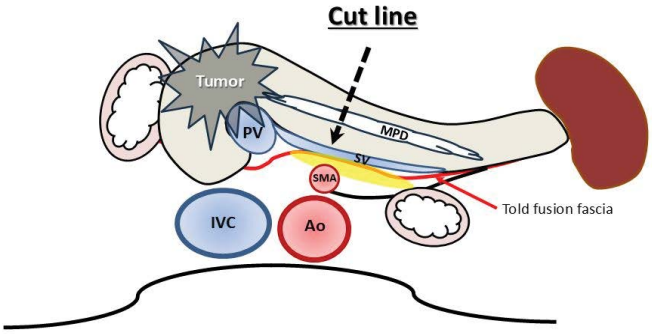

Figure 1: The pancreatic parenchyma together with splenic artery and splenic vein are pulled with cotton tape from the dorsal side of the Toldt's fascia (yellow area).

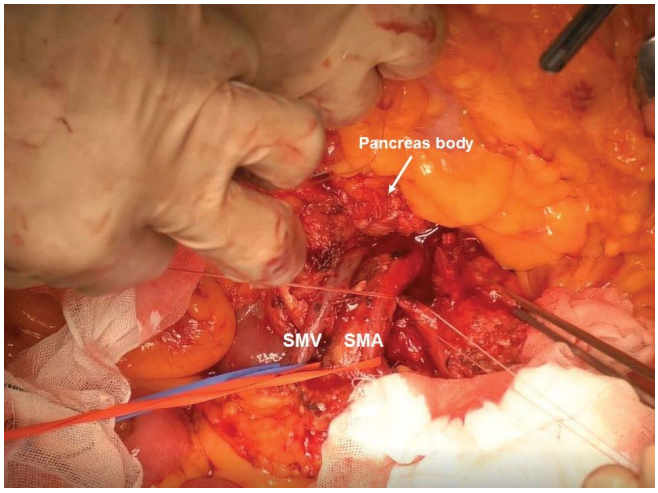

Figure 2: The pancreatic parenchyma together with splenic artery and splenic vein are pulled with cotton tape from the dorsal side of the Toldt's fascia (yellow area).

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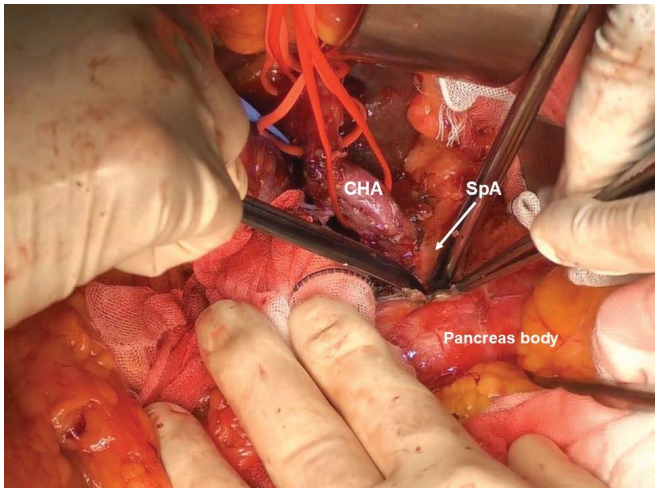

Figure 3: The dissection proceeds from the common hepatic artery toward the splenic artery (SpA). The SpA perforates the pancreatic parenchyma, making dissection difficult.

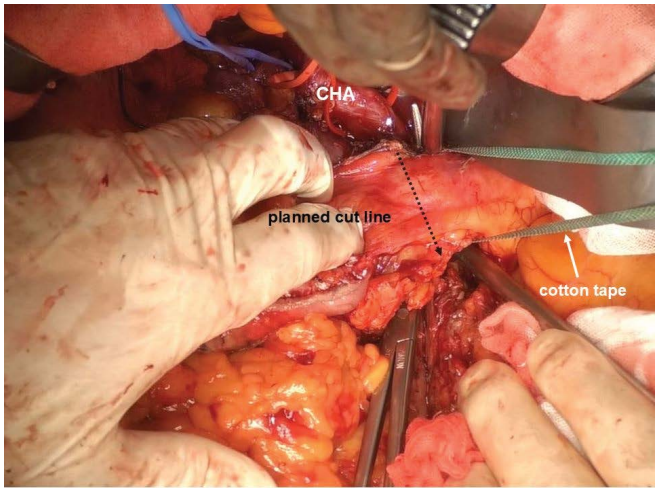

Figure 4a: A Kelly forceps is inserted dorsal to the planned pancreatic cut line, and the common hepatic artery or splenic artery and splenic vein are pulled together.

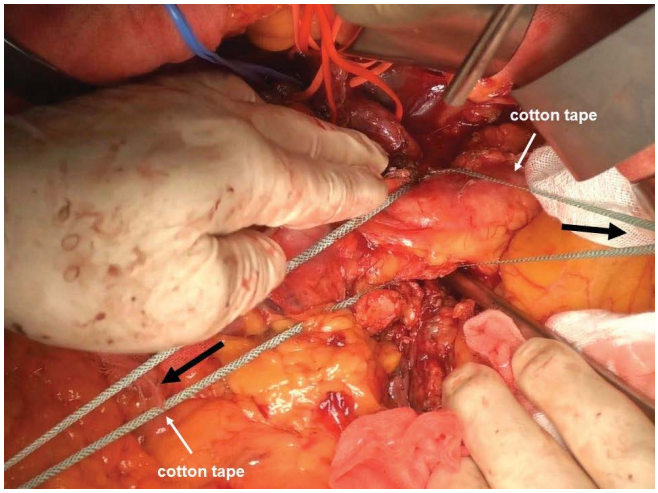

Figure 4b: The two inserted cotton tapes are pulled in the direction of the arrows to perform a hanging maneuver of the pancreas.

After a cotton tape is used to pull one side of the planned pancreatic cut line, the pancreatic parenchyma is transected with an electric scalpel and a round blade (Figure 5a). The arteries are relatively easy to identify by their nerve plexuses located around the wall. Furthermore, even if the CHA or SA is taped together with, it is often easy to separate from the other tissue during transection. After the dilated pancreatic duct is transected, the pancreatic parenchyma is carefully dissected dorsally using a Metzenbaum knife to access the SV, which is located dorsally from the pancreatic parenchyma. If the SV needs to be transected, it is ligated and transected at this site. If the SV needs to be preserved, the dissection is continued toward the PV (Figure 5b). These three steps make pancreatic transection safe and uniform (video reference).

Pancreatic resection time was defined as the time from when the planned pancreatic resection line was finally

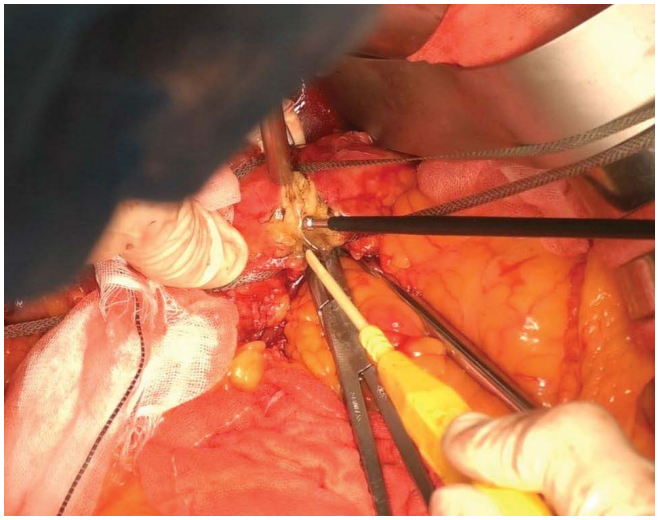

Figure 5a: The pancreatic parenchyma is cut from the ventral side.

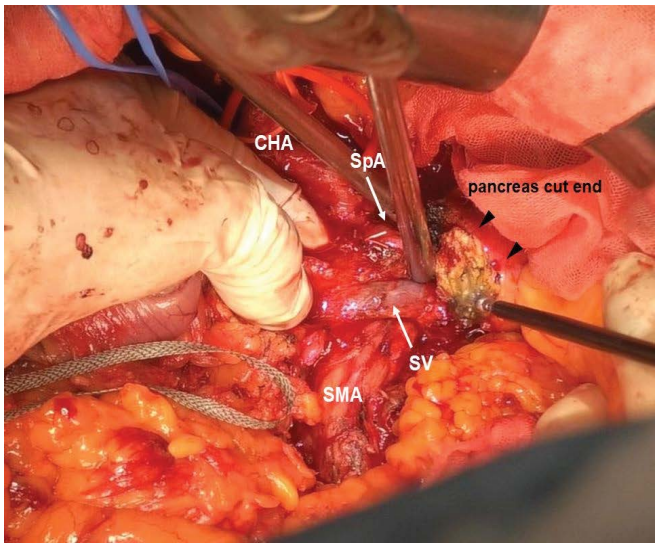

Figure 5b: Once pancreatic parenchymal amputation is complete, subsequent retroperitoneal dissection can be easily performed.

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determined by intraoperative ultrasound examination to the completion of pancreatic resection. Blood loss was defined as the total blood loss volume from the start to the end of the surgery. Histopathological cure of the pancreatic cut margin was defined as the final diagnosis based on the permanent specimen obtained.

Patients

Since 2016, the hanging maneuver method has been performed at our institution in 30 cases of pancreaticoduodenectomy for pancreatic head cancer with severe concomitant pancreatitis. The operating time, blood loss, and histopathological cure rate of the pancreatic cut margin of these 30 cases were compared with 26 cases of conventional pancreaticoduodenectomy in pancreatic head cancer without concomitant pancreatitis performed during the same period. We also compared the surgical time, blood loss, and histopathological cure rate of the pancreatic cut margin between the 30 cases and 20 cases of pancreaticoduodenectomy without the hanging maneuver for patients with pancreatic head cancer and associated concomitant pancreatitis, which were performed between 2010 and 2015.

Results

We compared the pancreatic resection time, blood loss, and histopathological cure of the pancreatic cut margin between the cases of pancreaticoduodenectomy using the hanging maneuver for concomitant pancreatitis and those of conventional pancreaticoduodenectomy without concomitant pancreatitis. No significant differences were observed in any of the items between the hanging maneuver for concomitant pancreatitis group and the conventional pancreaticoduodenectomy without concomitant pancreatitis group (Table 1). Furthermore, comparison of the two groups before and after the introduction of the hanging maneuver revealed no differences in the blood loss volume or histopathological cure rate of the pancreatic cut margin. However, the pancreatic resection time was significantly shorter with the introduction of the hanging maneuver (25 ± 7.2 minutes) than that (38 ± 9.6 minutes) in the non-hanging maneuver group (Table 1).

Discussion

Pancreaticoduodenectomy for pancreatic cancer is a surgery that requires sufficient skill and experience to successfully manage the many perioperative complications [5,6]. In general, surgery for gastrointestinal cancer is divided into resection and organ reconstruction. Although reliable organ reconstruction is needed to reduce perioperative complications, the primary surgical aim in gastrointestinal cancer is to safely and reliably remove the lesion (radical operation: R0 operation). The standard radical surgical procedure for all types of peri-ampullary cancer is pancreaticoduodenectomy; however, the difficulty of this procedure varies significantly with the type of cancer. In particular, pancreaticoduodenectomy for pancreatic head cancer accompanied by concomitant pancreatitis requires considerable skill and experience to perform en bloc tumor resection because the cancer border is typically unclear due to adhesions, adhesion caused by the concomitant pancreatitis, and scirrhous proliferation [6,7]. The typical surgical steps that determine the difficulty of pancreaticoduodenectomy are the en bloc dissection of the uncinate process dorsal to the SMA and pancreatic body amputation [8-11]. The method for safely and reliably resecting the uncinate process dorsal to the SMA is the mesenteric approach described in previous reports [3,4,12], which is already widely practiced worldwide. The surgical method described here is the second most challenging step in pancreatic amputation that facilitates the safe separation or combined resection of the pancreatic parenchyma and the surrounding blood vessels, no matter how strongly they are adhered to one another. Furthermore, if this surgical technique can be mastered, it is a fully feasible intervention for T4 pancreatic cancer invading the celiac artery, which is the most difficult surgical procedure [13]. The comparison between pancreaticoduodenectomy using a hanging maneuver for pancreatic cancer with concomitant pancreatitis and pancreaticoduodenectomy without a hanging maneuver for periampullary cancer without concomitant pancreatitis revealed no differences in resection time or blood loss, indicating that the use of the hanging maneuver facilitates for a safe and smooth operation, even with concomitant

Table 1: Results for each surgical method.

	Hanging maneuver with the CP	Traditional method without CP	Traditional method with CP
Patients	30	26	20
Operation time (min)*	25 ± 7.2†	21 ± 8.5	38 ± 9.6†
Blood loss (g)**	550	445	568
PCM(−/+)	30/0	26/0	20/0

CP: concomitant pancreatitis; PCM: pancreatic cut margin.

*Operation time is defined as the from the final intraoperative ultrasound extermination to the completion of pancreatic parenchymal amputation. operation time (mean value).

**Blood loss (median value).

†t-test: $p < 0.05$

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pancreatitis (Table 1). Furthermore, in the comparison between pancreaticoduodenectomy with and without the hanging maneuver for pancreatic cancer with concomitant pancreatitis, the operation time of pancreaticoduodenectomy using a hanging maneuver was significantly shorter, indicating that the operation is safe and smooth (Table 1). However, bias occurred due to the difference in the periods of the operations. In the present study, the lack of significant differences in blood loss between the two surgical groups may be due to variations in patient background and bleeding at many sites caused by the resection procedure [14,15].

Our study has several limitations associated with errors and biases inherent in a small study. A large number of trials are recommended to further evaluate the effectiveness of the hanging maneuver for pancreatic amputation.

Conclusion

Pancreatic transection using the hanging maneuver is an effective and safe approach to pancreaticoduodenectomy with concomitant pancreatitis.

Conflicts of interest

The authors have no financial conflicts of interest to disclose concerning the writing of the report and the decision to submit the report for publication.

Informed Consent Statement

Written informed consent to publish this paper was obtained from the patients.

Institutional Review Board Statement

This study was conducted in accordance with the Declaration of Helsinki and approved by the Nippon Medical School Musashikosugi Hospital ethics committee (Kawasaki Kanagawa Japan: No. 528-31-57. 27th April 2020).

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Author contributions

Conceptualization, S.M. and N.T.; methodology, S.M., K.N.; validation, T.A.; formal analysis, N.T.; investigation, H.F. and J.U.; data curation, J.U. and M.Y.; writing—original draft preparation, S.M.; writing—review and editing, T.A., Y.N. and H.Y.; supervision, H.Y.; project administration, Y.N. and N.T.; funding acquisition, N.T. All authors have read and agreed to the published version of the manuscript.

Data availability

Data are contained within the article.

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