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**Ischemic Gastropathy after Distal Pancreatectomy with Celiac Axis Resection**

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***Abstract***

**Purpose:** Stomach-preserving distal pancreatectomy with en bloc resection of the celiac, common hepatic, and left gastric arteries is a radical operation performed for locally advanced cancer of the pancreatic body. However, it is unknown if the collateral pathways that develop immediately from the superior mesenteric artery to the gastroduodenal and hepatic arteries provide sufficient blood flow to support the hepatobiliary system and the stomach. This article examines the ischemic gastropathy that can occur after this procedure and identifies the predisposing conditions.

**Methods:** Between 1997 and 2001, nine patients underwent stomach-preserving distal pancreatectomy with en bloc resection of the celiac, common hepatic, and left gastric arteries. Concomitant resection of the right gastric artery or gastroduodenal artery was performed in three patients due to cancer infiltration.

**Results:** Irregular, shallow and wide ulcerations thought to be ischemic in origin developed in these three patients, but all the ulcerations healed in 1 to 2 weeks with anti-ulcer medication. None of the other six patients had evidence of gastric ischemia.

**Conclusions:** Ischemic gastropathy is rare after distal pancreatectomy with celiac axis resection alone; however, division of additional arteries supplying the stomach may predispose to ischemic gastropathy.

## ***Introduction***

Radical distal pancreatectomy with en bloc resection of the celiac axis has been proposed as a treatment for locally advanced cancer of the pancreatic body involving the celiac axis or common hepatic artery. Although the overall survival rate is poor, long-term survival has been achieved in selected patients.<sup>1-3</sup> The major advantages of this procedure, in addition to the potential for cure, include that there is no need for arterial reconstruction because collateral pathways from the superior mesenteric artery via the pancreatoduodenal arcades to the gastroduodenal artery develop immediately (Fig. 1), and that complete relief of intractable cancer pain is achieved by the bilateral celiac ganglionectomies.<sup>4,5</sup> Moreover, postoperative diarrhea is mild and controllable by medication, and organ resection is limited to the distal pancreas, spleen, and left adrenal gland.

En bloc resection of the celiac axis was originally designed to enable complete nodal clearance around the artery in combination with total gastrectomy for advanced gastric cancer.<sup>6</sup> Initially, concern was expressed that postoperative ischemia-related complications would occur in the hepatobiliary system due to the insufficient development of collateral pathways from the superior mesenteric artery. However, hepatic or gallbladder necrosis has rarely been reported. When en bloc resection of the celiac axis is included in radical distal pancreatectomy for locally advanced cancer of the pancreatic body, the alimentary tract, including the entire stomach, can be preserved. Therefore, attention should be paid to postoperative ischemia-related complications not only in the hepatobiliary system,<sup>3,7</sup> but also in the stomach. To our knowledge, no previous study has addressed the ischemia-related gastric complications associated with this resection.

Thus, we report our experience of treating patients with ischemic gastropathy after radical distal pancreatectomy with en bloc resection of the celiac axis and identify the conditions predisposing to this complication.

### ***Patients and Methods***

Between 1997 and 2001, nine patients with cancer of the pancreatic body involving the common hepatic, celiac, or splenic arteries underwent stomach-preserving distal pancreatectomy with en bloc resection of these arteries and the left gastric artery (Fig. 1). The routine procedure included concomitant resection of the celiac ganglions and plexuses, the left adrenal gland, and the para-aortic lymph nodes. In seven patients, the portal vein was also resected and reconstructed, and in two patients, the lesser curvature of the stomach was dissected with preservation of the gastric wall due to cancer involvement, and division of the right gastric artery (Fig. 2). In one patient, the segment of the gastroduodenal artery between the posterior and anterior pancreaticoduodenal branches was resected due to cancer invasion (Fig. 3). The other six patients underwent preoperative coil embolization of the common hepatic artery to stimulate the development of collateral pathways from the superior mesenteric artery, and to prevent postoperative ischemia-related complications.<sup>8</sup>

### ***Results***

The two patients who underwent dissection of the lesser curvature complained of postprandial epigastralgia on postoperative days 8 and 15, respectively. Gastroscopy revealed irregular, shallow, wide ulcerations on the lesser curvature of the gastric body (Fig. 4). The patient who underwent segmental resection of the gastroduodenal artery required gastroscopy on postoperative day 2 because the drainage fluid from the nasogastric tube was black. The gastroscopy showed irregular shallow ulcerations along the greater curvature of the gastric body, but all these ulcerations healed in 1 to 2 weeks with anti-ulcer medication.

No evidence of gastric ischemia was found in the other six patients. Postoperative gastroscopy was performed in three of these patients, and no ulcerative or necrotic lesions

were identified.

### ***Discussion***

It has still not been established if the collateral pathways that develop from the superior mesenteric artery to the gastroduodenal and hepatic arteries immediately after radical distal pancreatectomy with en bloc resection of the celiac axis provide sufficient blood flow to sustain the hepatobiliary system and the entire stomach. Irregular ulcerations that were shallow and wide, unlike the typical peptic ulcers with a well-demarcated round shape, developed in three of our nine patients, and were thought to be ischemic in origin.

Preoperative coil embolization of the common hepatic artery to encourage collateral pathway development from the superior mesenteric artery<sup>8</sup> may have played a preventative role in the remaining six patients who did not have any evidence of gastric ulcerations. However, the three patients in whom ischemic gastropathy developed probably had predisposing factors, given that no report has described ischemia-related complications in the stomach after this procedure, even without preoperative embolization of the common hepatic artery. The entire stomach is supplied by the right gastric artery and the gastroduodenal-gastroepiploic artery (Fig. 1). However, in two patients, the right gastric artery was divided, and in one patient, segmental resection of the gastroduodenal artery was performed. Thus, the division of additional arteries that supply the stomach is likely to compromise gastric blood flow and result in ischemic gastropathy.

It is well established that gastric ischemia contributes to gastric ulceration.<sup>9,10</sup> There have been reports of characteristic gastric ulcers with irregular shapes, sloping edges, and whitish sclerotic bases, suggestive of chronic mesenteric vascular insufficiency, resulting from occlusion or severe stenosis of the celiac axis and superior mesenteric artery due to atherosclerosis, requiring revascularization.<sup>11,12</sup> Furthermore, gastroduodenal ulcers or

erosions occur as a complication of transcatheter arterial embolization for unresectable hepatocellular carcinoma in about 50% of patients.<sup>13</sup> The pathogenesis of this condition is thought to be mucosal ischemia caused by embolic material, the toxic effect of antineoplastic drug infusion, or stress.

Ulceration of the gastric tube for esophageal replacement has also been reported to occur as a consequence of low blood flow. Even despite the antacid effect of truncal vagotomy, gastric tube ulcers can develop within 20 cm of the esophagogastrostomy, an area that is particularly vulnerable to ischemia.<sup>14</sup> It is well known that ischemia-related ulceration and necrosis of the gastric wall can occur after selective proximal vagotomy<sup>15,16</sup> because when the lesser curvature of the stomach is dissected, the end-arteries from the left and right gastric arteries are divided along with the vagal branches. Regional ischemia due to devascularization is exaggerated by elevated intraluminal gastric pressure due to gastric stasis produced by denervation.<sup>17</sup> These conditions resemble those arising in our two patients who underwent lesser curvature dissection with preservation of the gastric wall. However, the frequency of ulceration and necrosis of the gastric wall after selective proximal vagotomy is not high. In fact, Kirk<sup>18</sup> routinely performed endoscopy 3 to 6 days after selective proximal vagotomy in 60 patients and found no evidence of mucosal vascular insufficiency in any patient.

Considering these reports and our experience, we conclude that ischemic gastropathy is rare after lesser curvature dissection with preservation of the gastric wall alone, and also after distal pancreatectomy with celiac axis division alone. On the other hand, the combination of these two procedures can cause ischemic gastropathy. Therefore, when the division of additional arteries supplying the stomach, such as the right gastric artery or the gastroduodenal artery, is performed in radical distal pancreatectomy with en bloc resection of the celiac axis, anti-ulcer treatment should be given, and routine gastroscopy performed

postoperatively. Furthermore, special attention should be paid to the risk of gastric necrosis, which can be fatal and mandates emergency gastrectomy.<sup>15</sup> Preoperative coil embolization of the common hepatic artery may prevent postoperative ischemic gastropathy by stimulating the development of collateral pathways from the superior mesenteric artery to the stomach.<sup>8</sup> Alternatively, middle colic artery-gastroepiploic artery bypass may be recommended for intraoperatively compromised arterial supply to the stomach.<sup>19</sup>



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***Figure legends***

Fig. 1. Schematic illustration showing the collateral pathways (arrows) that develop immediately from the superior mesenteric artery (SMA) to the gastroduodenal and hepatic arteries (HA) after radical distal pancreatectomy with en bloc resection of the celiac trunk (CT). Double lines indicate the sites where each artery was divided.

Fig. 2. Schematic illustration showing the distribution of the arterial supply to the stomach in the two patients in whom the lesser curvature of the stomach was dissected with preservation of the gastric wall. The right gastric artery was also divided. CT: celiac trunk; HA: proper hepatic artery; SMA: superior mesenteric artery. Double lines indicate the sites where each artery was divided.

Fig. 3. Schematic illustration showing the distribution of the arterial supply to the stomach in the patient in whom the gastroduodenal artery was resected between the posterior and anterior pancreaticoduodenal branches. CT: celiac trunk; HA: proper hepatic artery; SMA: superior mesenteric artery. Double lines indicate the sites where each artery was divided.

Fig. 4. Gastroscopic view on postoperative day 20 in the patient who underwent distal pancreatectomy with celiac artery resection and additional resection of the right gastric artery. Irregular shallow and wide ulcerations and reactive hyperemia can be seen on the lesser curvature of the gastric body.