Introduction

Pancreatoduodenectomy (PD) or Whipple’s operation is still a demanding field of modern surgery with persistently high morbidity rates even in experienced centers. While the mortality after this procedure has continuously declined in the last decades, the morbidity remains high as 25-50%. Common complications after PD are pancreatic fistula, intra-abdominal abscess, delayed gastric emptying and postoperative hemorrhage. The postoperative hemorrhage was reported in 5-16% of patients following PD and associated with high morbidity and mortality. It was shown as an early or delayed fashion. Although the causes of postoperative hemorrhage are variable, many reports said that delayed hemorrhage is largely associated with pancreatic leakage. Erosion of bare vessels and anastomosis can lead life-threatening bleeding from major arteries (esp. gastroduodenal artery) and suture lines.

Recently, the surgical margins or resection margins have been a hot issue in pancreatic head tumor. Especially, the superior mesenteric artery (SMA) margin has been paid attention to many hepatobiliary surgeons and pathologists. It is said that high R1 resection rate after PD was due to SMA margin positive.

Hemorrhage after Pancreatoduodenectomy

Bleeding after PD was manifested by extraluminal (through intra-abdominal drain, abdominal distension with decreased Hb level, etc.), intraluminal (melena, hematemesis, etc.) bleeding or both. According to occurred postoperative times, it is divided into early and delayed hemorrhage.

1. Early hemorrhage
   1) Time: Many controversies existed but it is accepted to be within postoperative 3 days.
   2) Causes: It is usually the result of technical failure of hemostasis during operation.
   3) Sites: There are many potential sites of the bleeding such as suture lines, incomplete transfixing sutures, or slippage of ligatures.
   4) Treatment: Early hemorrhage was usually managed by re-operation.

2. Delayed hemorrhage
   1) Time: It is difficult to define because of lack of consensus on the definition. But, bleeding occurring at least 7 days after surgery is reasonable.
   2) Causes: Eroded peripancreatic arteries, remnant pancreatic stump, disrupted suture lines, marginal ulcer, pseudoaneurysm of gastroduodenal artery or hepatic artery, etc.
   3) Risk factors: Most of delayed hemorrhage cases are associated with pancreatic fistula, bile fistula and intra-abdominal abscess.
   4) Sentinel hemorrhage: Initial small intermittent hemorrhage preceded massive bleeding.
   5) Treatment: In a hemodynamically stable patient, angiographic embolization is usually chosen initially. In unstable cases, re-operation is unavoidable and associated with high mortality.
   6) Prevention: There are many methods protecting stump of GDA such as leaving a stump of at least 2 cm, suture ligation with monofilament and covering the stump with omentum or other prosthetic materials. But, most important of all is to prevent pancreatic fistula or bile fistula and intra-abdominal abscess.
**Superior Mesenteric Artery Margin**

As defined by AJCC 7th edition, SMA margin is the soft tissue that often contains perineural tissue adjacent to the lateral wall of the superior mesenteric artery and also be termed the retroperitoneal, meso-pancreatic, and uncinate margin. Particular attention should be paid because most local recurrences arise in pancreatic bed along this critical margin. The SMA margin should be inked as part of the gross evaluation of the specimen; the specimen is the cut perpendicular to the inked margin for histologic analysis. Some pathologists insist on regarding entire pancreatic head surface as a surgical margin.

In conclusion, we should paid attention to surgical margins (especially, SMA margin) as well as TNM staging.

**References**