

# Modified Appleby operation for carcinoma of the pancreatic body and tail

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## Abstract

This is a case of a pancreatic tumor with invasion of the celiac stem treated using the modified Appleby operation. Preoperatively, routine B-ultrasound, computed tomography, and magnetic resonance imaging were performed. In the perioperative period, the combined gallbladder was excised; the duration of the operation was 5 h and volume of blood loss was approximately 500 ml. Postoperatively, the liver function temporarily returned and after a liver protection treatment, it returned to normal within 2 weeks. The liver had normal arterial blood supply, and the postoperative course was uneventful. It is safe and feasible to resect the whole pancreatic body and tail tumor combined with celiac stem resection. It can improve the resection rate of tumor and relieve pain.

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**Key words:** modified Appleby operation; pancreas cancer

## Clinical data

A 68-year-old patient was admitted to the hospital on February 13, 2019, owing to complaints of epigastric pain and discomfort with anorexia that started more than two months previously. On physical examination, the abdomen was flat and soft, with left epigastric tenderness, no rebound pain, and no palpable mass. On auxiliary examination, abdominal B-ultrasound showed pancreatic space-occupying lesions and multiple gallstones. Thin slice computed tomography (CT) plain scan and enhanced scan of the pancreas showed that the shape of the pancreas was irregular and an irregular soft tissue density mass was found in the body of the pancreas, measuring approximately 2.5 cm × 2.3 cm with an unclear boundary and uneven density; the enhanced scan showed an opposite low density, atrophy of the tail of the pancreas, dilatation of the pancreatic duct, and a close relationship between the lesions and splenic artery and celiac trunk. It was consistent with the characteristics of pancreatic cancer, considering the invasion of the splenic artery and celiac trunk, and that multiple gallstones were found in the gallbladder. Magnetic resonance imaging

plain scan and enhanced scan of the whole abdomen (Fig. 1) revealed that a nodular abnormal signal on both T1- and T2-weighted images could be seen in the body of the pancreas, with a high signal on DWI, measuring 19 mm × 20 mm. After enhanced scanning, the arterial phase enhancement was not evident, the volume of the tail of the pancreas was reduced, and the distal pancreatic duct was expanded; therefore, it was considered as pancreatic body cancer because the multiple gallstones were found in the gallbladder after exploring the swelling. The tumor indices were as follows: AFP 1.52 µg/mL; CEA 3.90 µg/L, CA 1993.19 µ/mL; and the modified Appleby operation was performed under general anesthesia on February 21, 2019. During the surgery, the common hepatic artery in the proximal and distal parts of the gastroduodenal artery and its origin were exposed freely, and the common hepatic artery was clamped. The pulse of the artery continued to remain palpable in the proper hepatic artery; therefore, we decided to perform the modified Appleby operation. The main hepatic artery was cut off near the origin of the gastroduodenal artery. Thereafter, the whole body and tail of the pancreas and spleen including the tumor were cut off from the neck of

the pancreas. The right omental and gastric arteries were preserved to maintain the blood supply to the stomach. The gallbladder was removed during the operation. The duration of the operation was 5 h, and the volume of blood loss was approximately 500 mL. Postoperatively, the liver function temporarily returned and after a liver protection treatment, the liver returned to normal within 2 weeks. The liver had normal arterial blood supply, and the postoperative course was uneventful. Pathological examination revealed differentiated adenocarcinoma of the pancreas with nerve invasion (Fig. 2). There was no recurrence or metastasis at 1, 3, and 6 months after the surgery.

## Discussion

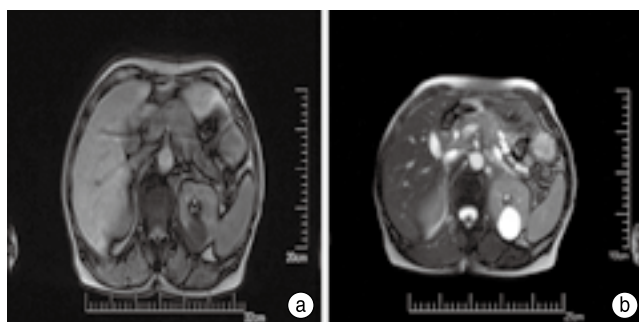
The first Appleby operation in the world was performed in 1953, which included resection of the whole stomach, body and tail of the pancreas, the spleen, and combined resection of the celiac trunk and common hepatic artery. In 1976, Nimura *et al*<sup>[1]</sup>, School of Medicine of Nagoya University, Japan, applied Appleby operation to the extended radical operation of the body and tail of the

pancreas for the first time. Owing to the removal of the abdominal trunk, the blood supply to the liver and stomach was seriously affected. In 1991, Hishinuma *et al*<sup>[2]</sup> carried out the first modified Appleby radical resection of pancreatic body and tail carcinoma with preservation of the stomach. It is suitable for patients with no tumor invasion at the root of the celiac trunk, with common hepatic artery (CHA) and bifurcation of the gastroduodenal artery (GDA), and in those in whom the tumor invades the celiac trunk but not the superior mesenteric artery (SMA) and proper hepatic artery (HA).

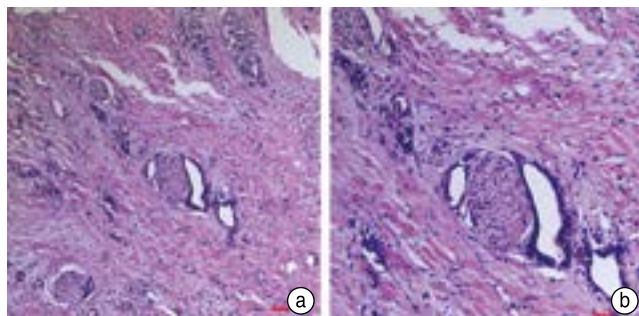
The anatomical basis of the improved Appleby operation is that the CHA sends out the proper HA and the gastroduodenal artery<sup>[3]</sup>, and the upper pancreaticoduodenal artery from the gastroduodenal artery and the lower pancreaticoduodenal artery from the SMA form the pancreaticoduodenal artery arch around the head of the pancreas; therefore, when the CHA is cut off, the arterial blood can flow from the SMA through the 12 fingers of the pancreas. The intestinal arch and gastroduodenal artery are injected into the proper HA to ensure blood supply to the liver.

The indications of the modified Appleby operation were as follows: (1) the tumor was confined to the tail of the pancreas without invasion of the head of the pancreas and without distant metastasis; (2) the tumor did not invade the proper HA and the SMA; (3) the root of the celiac trunk and the bifurcation of the common hepatic and gastroduodenal arteries were not infiltrated by the tumor, and therefore, the celiac trunk could be ligated and cut off at the root, and the bifurcation of the common hepatic and gastroduodenal arteries could also be cut off. The main HA was ligated and cut off on the central side of the liver; (4) the retroperitoneal tumor could be removed completely during the operation; and (5) the main HA could be blocked experimentally during the operation, and the pulsation of the inherent HA could be evidently noted after 1–2 minutes, implying that even if the main HA was cut off, the body could maintain sufficient blood flow to the HA<sup>[4]</sup>.

The key to improve the Appleby operation is to determine the integrity of the pancreaticoduodenal artery arch by preoperative celiac trunk and SMA angiography. In addition to routine angiography, a balloon catheter can be used to temporarily block the CHA, and then SMA angiography can be used to determine whether the artery arch is developed or if coil embolization can be used to make the pancreaticoduodenal artery arch compensatory expansion, or if 3D reconstruction technology of preoperative blood vessel CT can be used to understand the relationship between the tumor and blood vessels<sup>[5]</sup>. During the operation, the CHA can be temporarily blocked and the inherent HA can be examined for pulsation; Color Doppler ultrasound was used to evaluate



**Fig. 1** (a) Magnetic resonance imaging (MRI) cross-sectional plain scan. Nodular abnormal signal on T1 and T2-weighted images seen in the body of the pancreas. (b) On the cross-sectional enhanced MRI scan, the arterial phase enhancement is not evident, the volume of the pancreatic tail is decreased, and the distal pancreatic duct is dilated



**Fig. 2** Postoperative pathological examination reveals tumor cells to be arranged in an irregular glandular tube with infiltrating growth; the cells are atypical. (a) HE staining  $\times 50$ ; (b) HE staining  $\times 100$

the blood flow of the proper HA after the occlusion of the CHA.

Advantages of improved Appleby operation: (1) It improves the resection rate of pancreatic cancer, thereby providing patients with a longer survival period<sup>[6]</sup>. The traditional view is that the invasion of the celiac stem by pancreatic cancer is an unresectable disease; if it cannot be removed, the average survival period is 6–10 months, and the 5-year survival rate is less than 5%. The average survival period of patients after the modified Appleby operation can be increased until 21 months. The 5-year survival rate can be increased until 25%. (2) It improves the quality of life of patients after surgery, mainly alleviating intractable abdominal and back pain, which can be relieved immediately and made last for a long time.

Disadvantages of the improved Appleby operation: Although the improved Appleby operation does not need reconstruction of the blood vessels and digestive tract and the perioperative mortality is low, the postoperative complications rate is as high as 48%, including postoperative liver function abnormality, liver abscess, gallbladder necrosis, gastric mucosal ischemia, gastric ulcer formation, and diarrhea. The postoperative liver function abnormality is mostly transient, which can be reduced to normal several days after the surgery<sup>[7]</sup>. Gallbladder necrosis is a fatal complication. Some experts believe that the modified Appleby operation requires routine cholecystectomy. This patient was complicated with multiple gallbladder stones, chronic cholecystitis, and evidence of cholecystectomy. Most of gastric mucosal ischemia and ulcer formation can be alleviated by acid suppression therapy. Experts believe that embolization of the CHA before operation can promote the collateral circulation of SMA and protecting the vessels of the lesser curvature of the stomach during the operation can reduce this complication. In addition, because the celiac plexus was excised at the same time, it is easy to have persistent diarrhea. The incidence of postoperative diarrhea was 62.5%, of which 75% needed to be administered antidiarrheal drugs for a long time. There were no serious postoperative complications in this patient.

To sum up, there are only a few reports about the modified Appleby operation in the treatment of advanced pancreatic cancer, and most are case reports. Some reports also expand the scope of surgical resection. Owing to the limited number of cases, whether patients can benefit from the operation is still controversial. Although some studies have confirmed that the modified Appleby

procedure is safe, effective, and feasible in the treatment of advanced pancreatic body and tail cancer, larger cohort, multicenter case-control studies are lacking. Patients should undergo a routine multidisciplinary discussion before the operation, and it is recommended that experienced pancreatic surgeons should perform the procedure in larger pancreatic centers.

### Ethics approval and consent to participate

This report was approved by the Institutional Review Board and Human Ethics Committee of the Affiliated Huaian No. 1 People's Hospital of Nanjing Medical University (Huaian, China). The patient provided a written informed consent to participate.

### Conflicts of interest

The authors indicated no potential conflicts of interest.

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