

CASE REPORT

Title

**Dissecting aneurysm of the proper hepatic artery after laparoscopic hepatectomy
possibly related to the Pringle maneuver: A case report**

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Running Title

Dissecting aneurysm after hepatectomy

Authorship Declaration

Makoto Kurimoto wrote the draft of the manuscript. Satoru Seo, Tomoaki Yoh, and Hironori Shimizu revised the manuscript. All authors read and approved the final manuscript.

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Abstract

In hepatectomy, the Pringle maneuver is commonly used, but its association with iatrogenic injury is not yet well understood. This report presents a case of dissecting aneurysm of the proper hepatic artery (PHA) possibly associated with the Pringle maneuver during laparoscopic hepatectomy, that was successfully treated by transcatheter arterial embolization (TAE). The patient was a woman in her 70s, and repeat hepatectomy for liver metastasis of rectal neuroendocrine neoplasm was planned. She underwent hand-assisted laparoscopic hepatectomy with the Pringle maneuver. On postoperative day (POD) 7, enhanced computed tomography showed a dissecting aneurysm of the PHA. TAE of the PHA to prevent hemorrhage was performed on POD 9 with no complications. Even after TAE, intrahepatic arterial flow was provided by the peribiliary arteries. This case suggests the possibility that the Pringle maneuver can cause a dissecting aneurysm of the hepatic artery.

Keywords:

Dissecting Aneurysm, Hepatectomy, Laparoscopy

INTRODUCTION

In liver surgery, the Pringle maneuver is the accepted procedure for reducing bleeding. Recently, this approach has also been used in laparoscopic hepatectomy. The association between this approach and iatrogenic injury is still unclear.

This report presents a case of a dissecting aneurysm of the proper hepatic artery (PHA). In this case, the Pringle maneuver during laparoscopic hepatectomy was the only factor that might have caused the dissecting aneurysm. This case was successfully treated by transcatheter arterial embolization (TAE).

CASE PRESENTATION

The patient was a woman in her 70s. Five years earlier, she had undergone laparoscopic resection for rectal neuroendocrine neoplasm and laparoscopic partial hepatectomy for synchronous liver metastasis in Segment 5. Five years after these surgeries, follow-up computed tomography (CT) showed two liver tumors (Figure 1), which were suspected recurrent liver metastases. Laparoscopic partial hepatectomy was planned.

The trocar placement is shown in Figure 2. Since it was difficult to mobilize the right lobe due to adhesions, an 8-cm incision was made, and the procedure was converted to hand-assisted laparoscopic surgery. Adhesions around the hepatoduodenal ligament were easily detached by the fingers, and the ligament was taped smoothly for the Pringle maneuver. Clamping of the ligament was

performed by a tourniquet, using cotton tape and a Nelaton catheter (Figure 2). Partial hepatectomy was performed for the two lesions with the Pringle maneuver (occlusion: 3 times; 15 minutes each). The operation time was 6 hours and 8 minutes, and blood loss amounted to 77 g.

On postoperative day (POD) 7, routine contrast-enhanced CT showed a dissecting aneurysm of the hepatic artery (HA) (Figure 3a). Irregular dilation from the PHA to the left hepatic artery (LHA) was found, and flow in the right hepatic artery (RHA) was not seen. No extravasation of contrast agent was found. Coil embolization of the PHA to prevent hemorrhage was performed on POD 9. Angiography after embolization showed disappearance of flow in the PHA, while arterial flow to the right lobe could be detected via the peribiliary artery (Figure 3b). After TAE, serum liver enzymes were not elevated, and no complications occurred. CT on POD 15 showed disappearance of flow of the PHA, but intrahepatic arterial flow was maintained. The patient was discharged on POD 20.

DISCUSSION

In liver surgery, one of the most widely used methods of occluding hepatic blood flow to reduce bleeding is the Pringle maneuver, involving intermittent clamping of the hepatoduodenal ligament. The Pringle maneuver has been reported to be capable of safely reducing bleeding¹. As complications of this method, previous studies reported concerns of ischemia-reperfusion injury and the possibility of increased postoperative complications and recurrence. A few studies have reported surgical injuries, such as occlusion of the HA by extravascular coagulation² and portal vein thrombosis³, but no study has reported dissecting aneurysms.

The Pringle maneuver is also used in laparoscopic hepatectomy, and there are several variations, some using tourniquets or intestinal clips. In laparoscopic hepatectomy, bleeding is one of the serious intraoperative complications and the main reason for conversion to open surgery⁴; therefore, countermeasures against bleeding are important. In our department, preparation for the Pringle maneuver with a tourniquet was routine.

A visceral arterial aneurysm without aortic dissection is rare, with most occurring in the superior mesenteric artery and rarely occurring in the celiac artery and HA⁵. The mortality for spontaneous dissecting aneurysms of the HA was reported to be 62-85%, and 43-46% of patients died of rupture^{6,7}. Several factors, such as abdominal operation, peritonitis, hypertension and preexisting arterial disease, and iatrogenic injury were reported to be associated with HA dissection^{8,9}. In the present case, there were no risk factors for arteriosclerosis such as a history of hypertension or diabetes, and there was neither patient history nor family history of connective tissue diseases. Only the patient's previous surgery was a risk factor, but preoperative examination found no abnormalities (Figure 1) and no arterial calcifications in the aorta, coronary, or visceral arteries. Therefore, it is probable that the arterial dissection was caused by the latest surgery. Since the adhesion around the hepatoduodenal ligament could be detached smoothly, it is unlikely that detaching adhesions caused dissection. Therefore, it is highly likely that the cause was manipulation during clamping by the tourniquet. In our view, unlike in open surgery, the tourniquet passed through the abdominal wall, and there was a possibility that an unnatural force was applied to the hepatoduodenal ligament. In

addition, since clamp manipulation is indirect through trocars or small incisions in laparoscopic hepatectomy, it can be difficult to adjust the tightness of clamping. In some cases, in our department, clamping by a tourniquet is performed directly through a multichannel port device (E·Z Access/LAP-PROTECTOR Hakko Co., Ltd., Tokyo, Japan), and the tourniquet is entirely placed in the abdominal cavity. This method may prevent dissection of the HA.

For the treatment of visceral aneurysms, follow-up, drug therapy, interventional radiology (IVR), or surgery is selected. In cases of HA aneurysms, since the possibility of rupture is high, immediate interventions such as surgery or IVR must be considered. The advantage of IVR is its lower invasiveness compared to surgery. As IVR procedures for dissecting aneurysms of the PHA, coil embolization⁷ and stent insertion¹⁰ have been reported. In the present case, the dissection extended from the PHA to the LHA. The preoperative diameter of the LHA was less than 3 mm, too narrow to insert stents, and it was difficult to secure the landing zone. Furthermore, there was a risk of sacrificing flow of the gastroduodenal artery by stenting. Therefore, stenting was considered inappropriate. Meanwhile, embolization of the PHA had a risk of impairing hepatic arterial flow. A previous report⁷ of TAE for the PHA suggested that hepatic arterial flow was maintained after TAE due to the collateral circulation. In the present case, there was no development of collateral circulation, and there was a risk of hepatic infarction. However, the intrahepatic arterial flow was maintained by the supply from the peribiliary arteries after TAE. In some cases, such as the present case, the hepatic arterial flow may be maintained even if the PHA is embolized, and TAE may be an option.

CONCLUSION

A case of a dissecting aneurysm of the PHA after laparoscopic hepatectomy, which was successfully treated by TAE, was reported. The Pringle maneuver could be involved in the etiology of a dissecting aneurysm of the PHA. When performing the Pringle maneuver during laparoscopic hepatectomy, it is necessary to avoid excessive traction or clamping.

Acknowledgments and Disclosure

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Conflicts of Interests

The authors have no conflicts of interests.

Ethical Statement

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional research committee and with the Helsinki declaration (revised in Brazil 2013), and written informed consent was obtained from the patient.

Consent for Publication

Written informed consent was obtained from the patient for publication.

Data Availability Statement

Not applicable to this case report.

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Figure Legends

Figure 1

The preoperative contrast-enhanced computed tomography images show liver tumors in Segments 4 and 7, and no abnormalities of the hepatic artery.

Figure 2

Intraoperative findings. Trocar placement and Pringle maneuver by a tourniquet.

Figure 3

Images of interventional radiology and computed-tomography.

(a) Before embolization. The postoperative(POD 7) contrast-enhanced computed tomography image shows dilation of the proper hepatic artery.

(b) After embolization. The arterial flow to the liver via the peribiliary artery is seen, and the intrahepatic arterial flow is confirmed.





