



High ligation of inferior mesenteric artery in laparoscopic resection of rectal cancer: is it safe or dangerous?

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Nowadays anterior resection and abdominoperineal excision for rectal cancer have been well standardized in laparoscopic approach. But there are still arguments about the level of the ligation of the inferior mesenteric artery (IMA) (1). Some surgeons tie the IMA at its origin from the aorta (high ligation). Others tie the IMA below the origin of the left colic artery (LCA) (low ligation). It is not clear if there is different incidence rate of anastomotic leakage and survival period between these two different levels of ligation of the IMA after radical resection of rectal cancer.

As everyone knows, the colon has two main sources of blood supply: the superior mesenteric artery (SMA) and the IMA. The main branches of the SMA include the ileocolic artery (ICA), the right colic artery (RCA) and the middle colic artery (MCA), which supplies the cecum, the ascending colon, and the transverse colon. The main branches of IMA include LCA, the sigmoid artery (SA) and the superior rectal artery (SRA), which supply the descending colon, the sigmoid colon and the up-half rectum.

In laparoscopic resection of rectal cancer, high ligation of the IMA appears easier to achieve than low ligation. The other advantage of high ligation is to reduce the tension of anastomosis (2). In theory, the descending colon ischemia and necrosis will not happen after high ligation of IMA in anterior resection for rectal cancer because there are some arterial arches between the MCA from the SMA and the LCA from the IMA. But is high ligation of the IMA really safe?

It is usually considered that there are two arterial arches between the MCA and the LCA, which maximally keep the blood supply for the descending colon after high ligation of

the IMA. One is the marginal arterial arch, also known as the artery of Drummond. The other is Riolan's arch.

The artery of Drummond (*Figure 1*) is composed of arterial branches which supply the colon and runs in the mesentery close to the colon as part of the vascular arcade that connects the SMA and IMA. It is named by Hamilton Drummond [1882–1925], an English physician. But because of congenital developmental defects, the artery of Drummond is perhaps incomplete especially at the splenic flexure of colon, where is the site of watershed anastomosis of midgut and hindgut in the embryonic stage of development. This point is also called Griffiths' point (3). At the Griffiths' point, the anastomosis of the artery of Drummond may be substantial, tenuous, or absent (*Figure 2*). Angiographic studies show that anastomosis at Griffiths point is present in 48%, poor or tenuous in 9%, and absent in 43% (3). It means that the proportion of poor development of the artery of Drummond at the Griffiths' point reaches as high as 50%. This has relevance in radiology, as it explains why the splenic flexure watershed site is the most common location for ischaemic colitis.

Riolan's arch represents an important collateral circulation between the SMA and the IMA upon which the descending colon may be dependent. But the definition of Riolan's arch, which named by Jean Riolan [1580–1657], a famous 17th century French anatomist, is deliberately vague. In general, Riolan's arch refers to a distinguishing anatomical entity connecting the MCA with the LCA, additional to the artery of Drummond (*Figure 3*) (4). There are also many other interpretations and synonyms of Riolan's arch (*Table 1*). The rate of emergence of Riolan's

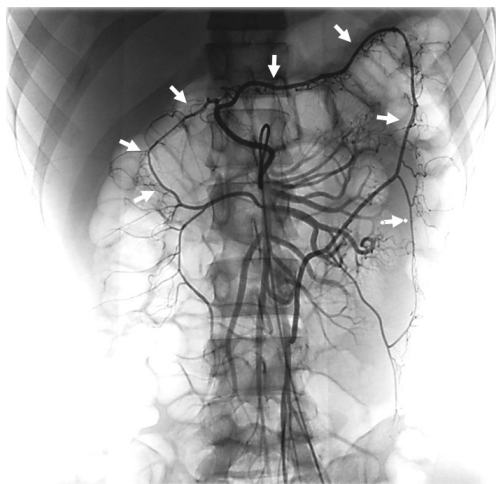


Figure 1 Digital subtraction angiography of SMA shows the artery of Drummond (white arrows). SMA, superior mesenteric artery.

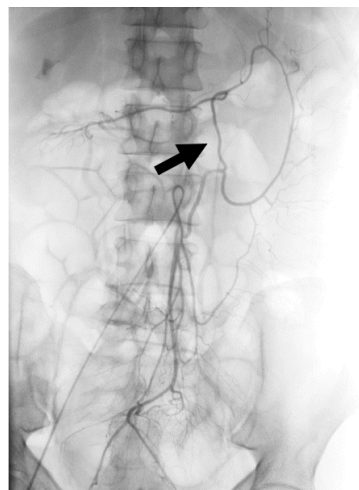


Figure 3 Digital subtraction angiography of IMA shows Riolan's arch (black arrow). IMA, inferior mesenteric artery.

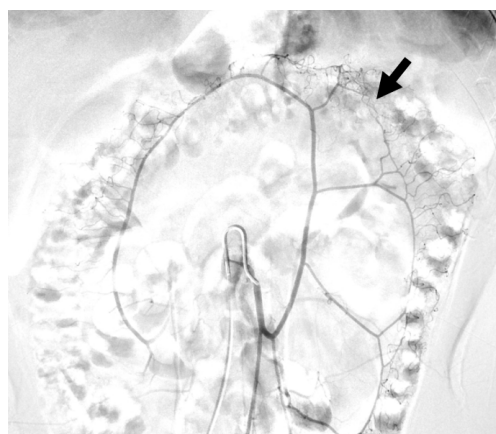


Figure 2 Digital subtraction angiography of IMA shows the absence of the artery of Drummond at Griffiths' point (black arrow). IMA, inferior mesenteric artery.

arch is very different because of the difference of definition, race, research method and sample size in different reports. A book edited by the Chinese Society for Anatomical Sciences reports that the incidence rate of Riolan's arch is $6.19\% \pm 1.13\%$ in Chinese people. It illustrates that Riolan's arch is usually in the state of no or only having a little blood flow. Some authors even think that the incidence of Riolan's arch means there is severe stenosis in the SMA or IMA.

Some reports show that the descending colon ischemia or necrosis will happen after high ligation of the IMA. Tsujinaka *et al.* (5) observed that 6 out of 302 patients (2.0%)

Table 1 Synonyms of Riolan's arch (4)

Central anastomotic artery of colon
Mesomesenteric artery
Middle-left colic collateral
Intermesenteric artery or arcade
Meandering mesenteric artery
Anastomosis (magna) of Riolan
Meandering artery of Riolan
Great colic artery of Riolan
Arch of Treves
Artery of Moskovitch
Artery of Gonzalez
Anastomosis maxima of Haller
Arcus magnus mesentericus

with high ligation of the IMA developed proximal colon necrosis, which were confirmed by secondary surgery. Of these 6 patients, 2 died from associated complications. The results, which are obtained from the univariate analysis showed that advanced age, cerebrovascular disease, and hypertension were significantly associated with colon necrosis. In another report (6), 1,201 patients with sigmoid colon or rectal cancer who underwent high ligation of IMA were analyzed. Ten patients (0.83%) diagnosed

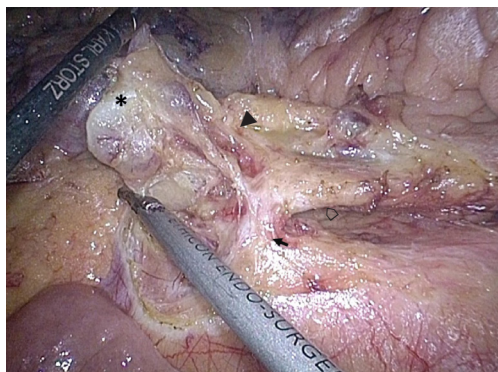


Figure 4 Low ligation of the IMA with dissection the lymph nodes at root of the IMA (→: IMA; ►: LCA; *: the lymph nodes at root of the IMA; △: low ligation point of the IMA). IMA, inferior mesenteric artery.

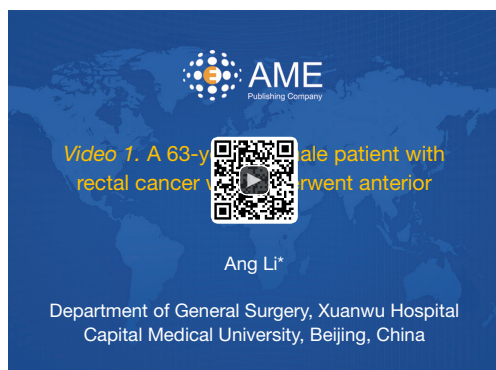


Figure 5 A 63-year-old male patient with rectal cancer who underwent anterior resection (8). The IMA was tied below the origin of the LCA with dissection the lymph nodes at the root of the IMA. IMA, inferior mesenteric artery; LCA, left colic artery.
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postoperative colonic ischemia. Mortality was 10%. The symptoms of postoperative colonic ischemia occurred on the 5th day (range, 2nd–10th day) after operation. Over all, both the artery of Drummond and Riolan's arch may not provide reliable blood supply to the descending colon after high ligation of IMA. But there were different opinions. Boström *et al.* (7) reported that symptomatic anastomotic leakage occurred in 12.3% (41/334) of patients in the high ligation group and in 10.6% (41/388) in the low ligation group. There was no statistical difference between two groups and high ligation was not independently associated with a higher risk of anastomotic leakage.

In conclusion, despite the controversy, the descending colon ischemia and necrosis after high ligation of IMA in anterior resection for rectal cancer should be pay great attention because of the existence of the Griffiths' point and the low incidence rate of Riolan's arch, especially for the patients with advanced age, cerebrovascular disease, and hypertension. Low ligation of the IMA with dissection the lymph nodes at the root of the IMA (Figures 4,5) perhaps is another choice. But that issue requires further study.

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Footnote

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