



Variant origin of the middle colic artery from the gastroduodenal artery

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Abstract

A detailed anatomical knowledge of the normal and variant blood supply of the colon remains an essential prerequisite in modern day advanced abdominal surgery viz., abdominopelvic resection, carcinoma of colon and pancreatic surgery. The colon receives its blood supply from the branches of superior and inferior mesenteric arteries. Though certain studies have been devoted to assess arterial variations, only a minority of previous studies report such incidence. The present study reports 2 cases of middle colic artery arising from the gastroduodenal artery instead of its usual origin from the superior mesenteric artery, an unusual variation encountered in literature or clinical surgery.

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Key words [middle colic artery] [gastroduodenal artery] [arterial supply of transverse colon] [colonic surgery] [coeliac trunk]

Introduction

Usually, the middle colic artery arises from the superior mesenteric artery or its major branches. However, previous cadaveric and radiological studies have observed its atypical origin and absence from the coelico-mesenteric system [1, 2]. Such anatomical knowledge of arterial disposition is especially important in present day diagnostic angiographic procedures and minimal access surgery.

Case Report

During routine educational dissections among undergraduate students, an unusual origin of the middle colic artery was recorded in two female cadavers aged 68 years and 71 years, respectively. Gradual dissection of all the branches of coeliac trunk revealed that in case No. 1 (Case 1, Figure 1, 3), the gastroduodenal artery in addition to its normal branches, provided a 17 cm long vertical branch of 4 mm caliber, which stretched downwards in front of the head of the pancreas and third part of the duodenum to supply the right and middle part of the transverse colon. In case No. 2 (Case 2, Figure 1, 2, 3), the gastroduodenal artery provided, in addition to its normal branches, a branch which was 9 cm long and of 4 mm caliber and that supplied the right colic flexure and the right part of the transverse colon. Careful dissection of all the branches from the superior mesenteric artery demonstrated

that the right colic and ileocolic arteries on the right side and the jejuno-ileal branches on the left side arose normally in both the cadavers but no middle colic artery was found taking origin directly or indirectly from superior mesenteric artery (Case 1, Figure 1, 2, 3, and Case 2, Figure 1, 2, 3). However, the origin of the middle colic artery was variable in both the cases. In both the cases, the compromised vascular pattern was supplemented by the variant middle colic artery that took origin from the gastroduodenal artery and supplied the right and the middle part of the transverse colon in case no. 1 and the right colic flexure with right part of transverse colon in case no. 2, respectively (Case 1, Figure 3, Case 2, Figure 1, 2). These apparently substituted the deficient middle colic arteries from the superior mesenteric arteries in both the cases.

Discussion

Normally, the middle colic artery leaves the anterolateral aspect of superior mesenteric artery just inferior to the uncinate process of the pancreas and in front of the third part of duodenum and descends through the transverse mesocolon to divide into a right and left anastomotic branch [3]. It may arise high from the superior mesenteric and descend with this between the duodenum and pancreas, or may pass through the gland [4]. Gastroduodenal artery arises from the common hepatic artery behind or above the first part of duodenal artery.

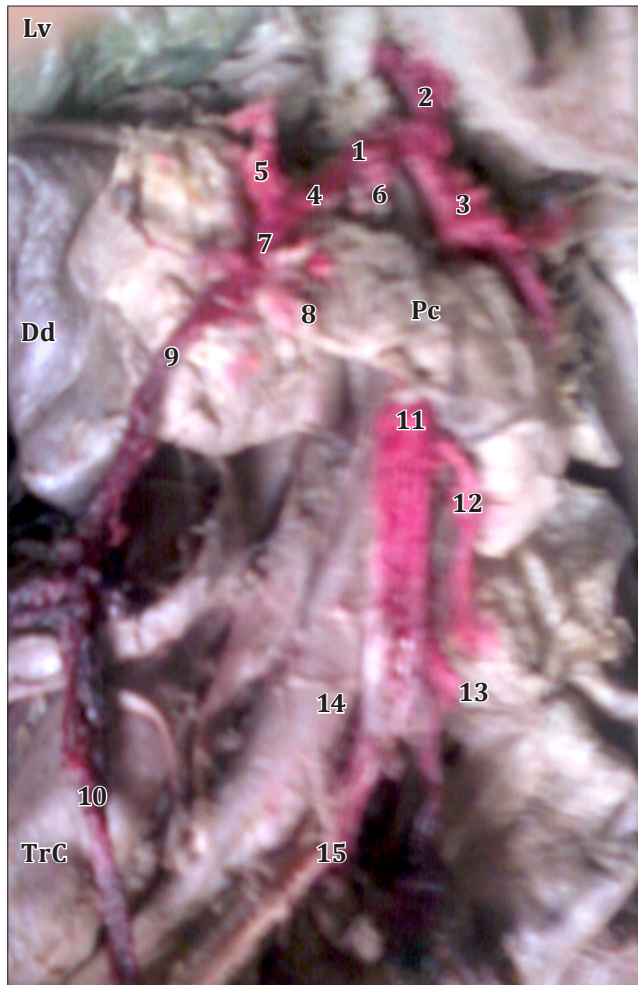


Figure 1. Photograph showing absence of middle colic artery from the superior mesenteric artery and taking origin from gastroduodenal artery. Stomach was removed. Part of the transverse colon on the left side was dissected and removed. (1: Celiac trunk; 2: left gastric artery; 3: splenic artery; 4: common hepatic artery; 5: hepatic artery proper with branches; 6: right gastric artery; 7: gastroduodenal artery; 8: superior pancreatico-duodenal artery; 9: gastroduodenal artery coming down in front of pancreas; 10: unusual long branch of gastroduodenal artery going downwards within the right border of the transverse mesocolon and supplies the right side of the transverse colon; 11: superior mesenteric artery; 12: jejunal branch; 13: ileal branches; 14: right colic artery; 15: ileocolic artery; Dd: duodenum; TrC: transverse colon; Pc: pancreas; Sp: spleen; Lv: liver)

It descends between first part of duodenum and pancreatic neck, then at the lower border of the first part of duodenum it gives right gastroepiploic and superior pancreaticoduodenal artery. Supraduodenal artery may arise from gastroduodenal artery. Gastroduodenal artery may arise from a trifurcation of right and left hepatic artery, superior mesenteric artery and left hepatic artery.

Earlier studies cite that the middle colic artery may be absent in between 3% and 5% of cases [2, 5-7] and in infrequent

instances, it may arise from the quadrifurcation and pentafurcation of the coeliac trunk or one of its branches [8].

A radioanatomical study among infants by Pereira et al. comprised of 50 cases and distinguished 5 fundamental types of vascular origin and two basic types of distribution of middle colic artery [9]. The middle colic artery originating atypically from the bed of coeliac Trunk was reported only in a single case [10]. Researchers have hitherto reported atypical origin of variant middle colic artery from the proximal segment of the splenic artery [1], splenic artery itself [11], common hepatic artery [12], hepatic artery [3, 13] inferior mesenteric artery [3, 14] inferior pancreaticoduodenal artery, [4] dorsal pancreatic artery, [3] left colic artery [3] as well as the gastroduodenal artery [4]. Garcia-Ruiz et al. [15] and Chitra have reported the presence of double middle colic arteries in their study of cadaveric dissections [8].

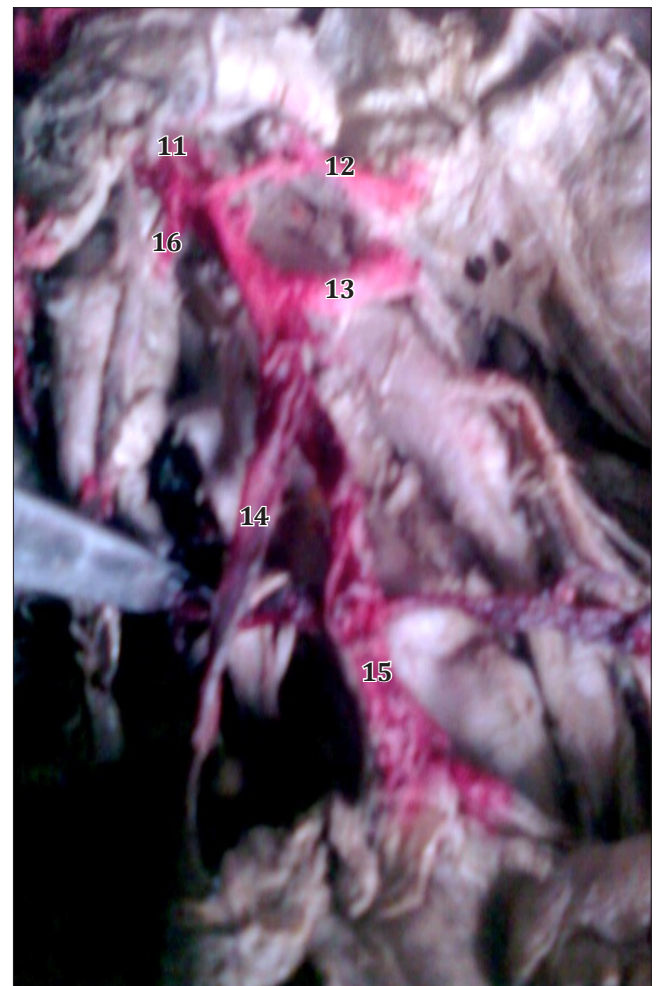


Figure 2. Photograph showing exclusively the superior mesenteric artery and its branches. It shows absence of middle colic artery from it. (11: Superior mesenteric artery; 12: jejunal branch; 13: ileal branch; 14: right colic artery; 15: ileocolic artery; 16: inferior pancreatico-duodenal artery)

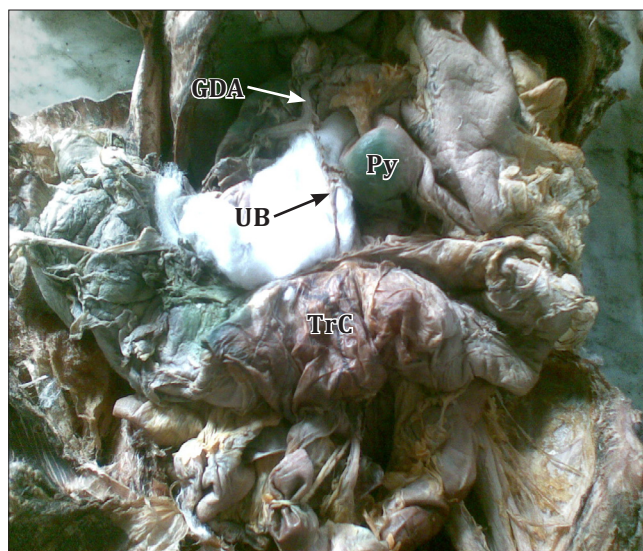


Figure 3. Photograph showing the *gastroduodenal artery (GDA)* giving out the *unusual long branch (UB)* lying over the cotton piece. This branch supplies the right part of the transverse colon. (*PY*: pylorus; *TrC*: transverse colon)

The middle colic artery may also arise as a middle mesenteric artery [16] or a third mesenteric artery [17] from the aorta between the superior and inferior mesenteric arteries.

In general, it is acknowledged that abdominal angina occurs only when there is a serious obstruction in at least 2 of the 3 splanchnic vessels, mesenteric arteries and the coeliac trunk. However, this common view does not take into account the anatomical variation of the arteries that supply blood to the intestine [18]. In higher origin of the artery its blood supply might be shut off in ligating the gastroduodenal artery, or the vessel could be directly injured, in operations on the head of the pancreas, as it passes across and behind this [4].

The arterial supply of large intestine is derived from both the superior and inferior mesenteric artery. The caecum, appendix, ascending colon, and right 2/3rd of the transverse colon (derived from the midgut) are supplied from ileocolic, right colic and middle colic branches of superior mesenteric artery. The marginal artery of Drummond of the colon is formed by the main trunks and the arcade arising from the ileocolic, right colic, middle colic and left colic artery. The anastomoses form between the main terminal branches running parallel to the colon to supply it. This marginal artery of colon may get hugely dilated, when the superior mesenteric artery is progressively occluded, to supply the majority of the midgut. In both of our cases the middle colic artery was unavailable to take part in forming such anastomosis [3].

The present study reports 2 cases of middle colic artery arising from the gastroduodenal artery instead of its usual origin from the superior mesenteric artery, an unusual variation encountered in literature or clinical surgery. It was interesting to note that both the cases were observed in

female cadavers, which leaves the window of future scrutiny on the basis of gender predilection of such variation.

Embryological Background

During fetal development, both primitive dorsal aortae provides three sets of paired segmental branches, viz., a ventral set for the gastrointestinal tube, a somatic intersegmental set to the body wall and the neural tube and a lateral splanchnic set for derivatives of the intermediate mesoderm. After fusion of the dorsal aortae cranio-caudally, the ventral branches are also fused to form a series of unpaired segmental vessels

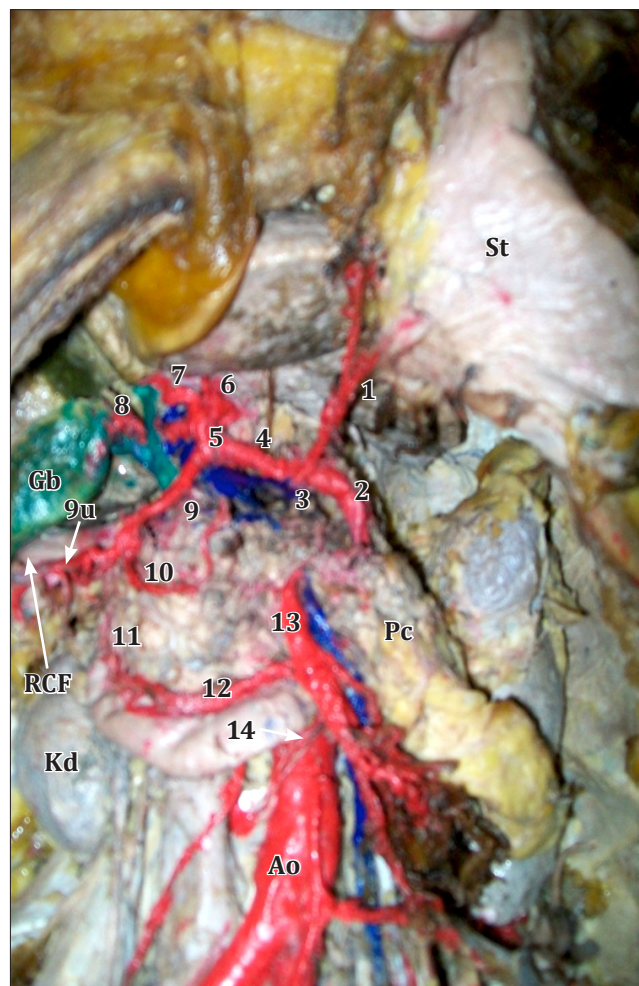


Figure 4. Photograph showing absence of middle colic artery from the superior mesenteric artery and taking origin from gastroduodenal artery. Stomach was removed. Part of the transverse colon on the left side was dissected and removed. (*1*: Left gastric artery; *2*: splenic artery; *3*: coeliac trunk; *4*: common hepatic artery; *5*: hepatic artery proper; *6*: left hepatic artery; *7*: right hepatic artery; *8*: cystic artery; *9*: gastroduodenal artery; *9u*: the unusual branch from the gastroduodenal artery supplying the right colic flexure; *10*: gastroepiploic artery; *11*: superior pancreatico-duodenal artery; *12*: inferior pancreatico-duodenal artery; *13*: superior mesenteric artery; *14*: right colic artery; *RCF*: right colic flexure; *Pc*: pancreas; *Kd*: kidney; *St*: stomach; *Ao*: aorta; *Gb*: gallbladder)

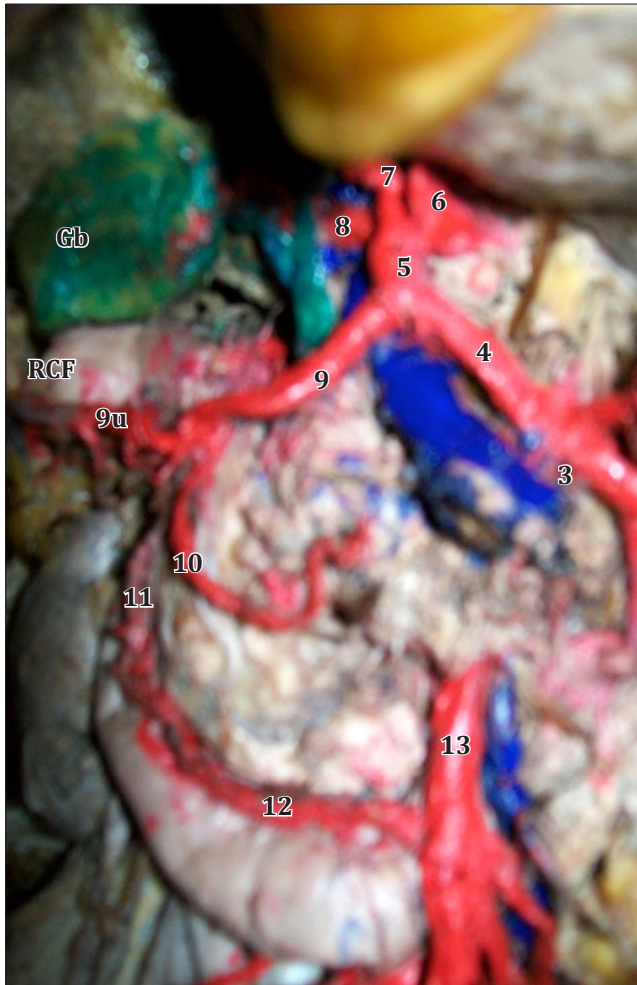


Figure 5. Photograph showing branches of the coeliac trunk and superior mesenteric artery in part, clearly showing the absence of middle colic artery and an unusual branch taking origin from gastrooduodenal artery and supplying the right colic flexure. (3: Coeliac trunk; 4: common hepatic artery; 5: hepatic artery proper; 6: left hepatic artery; 7: right hepatic artery; 8: cystic artery; 9: gastrooduodenal artery; 9u: the unusual branch from the gastrooduodenal artery supplying the right colic flexure; 10: gastroepiploic artery; 11: superior pancreatico-duodenal artery; 12: inferior pancreatico-duodenal artery; 13: superior mesenteric artery; RCF: right colic flexure; Gb: gallbladder)

which divide into ascending and descending rami along the dorsal aspect of the developing gastrointestinal tube and eventually forms a dorsal and ventral anastomosis along the gut. Due to such extensive anastomosis, the need of numerous ventral splanchnic branches reduces and ultimately only three trunks persist, namely the coeliac trunk for the foregut, superior and inferior mesenteric artery for the midgut and hindgut, respectively.

Some of the ventral and dorsal anastomotic branches lose their connection and develop as branches of the three main arteries. The dorsal anastomosis persists as gastroepiploic,

inferior pancreaticoduodenal and marginal arteries of the large gut while the ventral anastomosis forms right and left gastric arteries. A middle colic artery originating from a coeliac trunk was considered as evidence for the ventral longitudinal anastomosis of the primitive vitelline arteries in the embryo [19].

Meanwhile the foregut develops into the stomach, and duodenum, the midgut loop herniates through the umbilicus and the hepatic bud and dorsal and ventral pancreatic bud develops.

During rotation and re-fixation of the foregut, the ventral pancreatic bud fuses with the dorsal one along with their arterial supply, so that the superior pancreaticoduodenal branch along with the ventral anastomosis lies behind the neck of the gastroduodenal artery. Hence in absence of the middle colic artery any branch e.g., gastroduodenal or superior pancreaticoduodenal branch of coeliac trunk may supply the right part of transverse colon (rami).

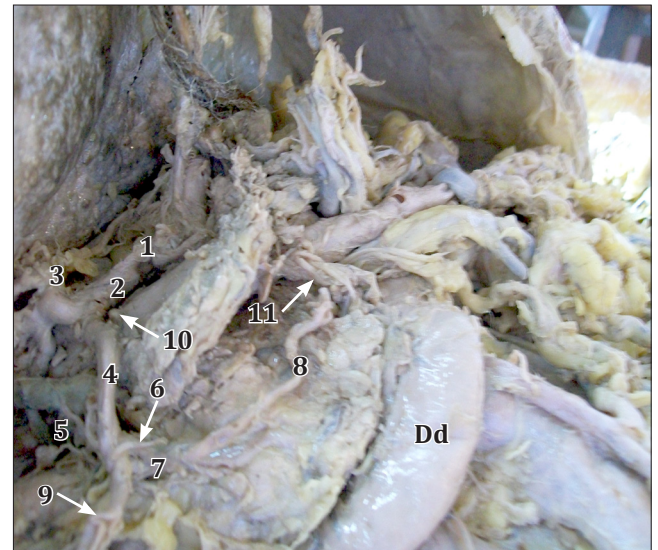


Figure 6. Photograph showing branches of the coeliac trunk and superior mesenteric artery in part, clearly showing the absence of middle colic artery and an abnormal branch taking origin from gastrooduodenal artery and supplying the right colic flexure. (1: Coeliac trunk; 2: common hepatic artery; 3: hepatic artery proper; 4: gastrooduodenal artery; 5: branches of gastrooduodenal artery supplying head of the pancreas; 6: right gastroepiploic artery; 7: superior pancreatico-duodenal artery; 8: inferior pancreatico-duodenal artery; 9: unusual branch from gastrooduodenal artery supplying the right colic flexure; 10: right gastric artery; 11: origin of superior mesenteric artery clearly giving no middle colic artery; Dd: duodenum)

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