MACROSCOPIC AND MICROSCOPIC INTERMESENTERIC COMMUNICATIONS

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The aim of this study was to describe all levels of the intermesenteric communications because of their importance in vascular diseases of the colon. The connections of superior and inferior mesenteric networks are very important in cases of acute or chronic obstruction to prevent ischemia and necrosis. Angiograms of mesenteric arteries were studied (40), cadaverous large intestine samples with mesentery and feeding vessels were dissected (36) or injected with India ink solution (24) or methylmetacrylate Mercor (41). In 7.9 % of cases an intermesenteric connection was described, named *anastomosis intermesenterica accessoria* and classified according to Pikkieff's¹ proposal. The marginal artery in the left colic flexure forms an arch called *Riolan's arcade*² or *Haller's anastomosis*³ and is present in 95 % of cases. Infrequent anastomosis between straight vessels and mighty plexuses in the intestinal wall were registered. There are no regional differences when compared to the rest of colon.

INTRODUCTION

Mutual connections between superior and inferior mesenteric arterial networks are important in both acute and chronic obstructions of the large intestine. The most afflicted spot is the cranial part of the superior mesenteric artery, caused mainly by atherosclerotic stenosis. This is demonstrated either by a clinically silent state, appears as chronic abdominal anginous pain or sudden thrombotic disorder, or as an acute embolic attack. Tumorous metastasis in lymph nodes is able to compress the vessels, too. The presence, lumen, frequency and level of anastomosis and possible growth of collaterals are the limiting factors of such afflictions. This is a reason for mapping the frequency of intermesenteric anastomosis in Czech population.

MATERIAL AND METHODS

Parts of the large intestine were dissected including its arterial supply in the extent of the whole artery from its origin to the branching in arteriolae rectae. Material was obtained from cadavers dissected at the Department of Anatomy, 3rd Medical Faculty, Charles University (36 bodies, aged 56–81). Angiograms of both mesenteric arteries, stored in the archive of the Department of Anatomy (11 samples) and lent by Radiological Department of the Faculty Hospital at Královské Vinohrady (29 samples) were examined too. In addition, 24 samples of colon tissue including feeding vessels were cut out of cadavers at Department of Pathology of the Faculty Hospital at Královské Vinohrady (aged 41–92). After rinsing and cleaning, dissecting and cannulating the feeding vessels,

the network was flushed with lukewarm saline (20 °C) and then saline was replaced with India ink solution. Ligated samples were preserved in 8 % formalin solution for 10 days and then dissected.

Another 41 samples from the pathological ward (age 30–88) were injected with commercially produced methylmetacrylate called Mercor CL-2B (Ladd Research Industries, Burlington, VA), after the same procedure as for the previous India ink injections. When injected the samples were stored in warm water (45–50 °C) for polymerization for 24 h, then put in 30 % kalium lye (50 °C). Rinsed and dried casts were deep-frozen, cut, refined and dried again, then vaporized with gold powder and scanned in electronic microscope (S 5120.1 Proxima – Aquasem). No pathological changes were found in the samples.

RESULTS

In the macroscopic part (a total of 76 samples) a mighty vessel connecting both mesenteric arteries was identified in the dissected bodies only once and in angiograms five-times (Fig. 1). As for total amount of the macroscopically examined samples it rates 7.9 %. The vessel calibre was always very large, close to main colic branches diameter. There were no principal similarities in all six cases, which is why the qualitative division made by Pikkieff¹ was applied.

Two samples corresponded to type IIa (Fig. 2a) (connection between the midpoint of middle colic artery length and the midpoint of left colic artery), other two angiograms correspond to type IIb (Fig. 2b) (connection between the midpoint of middle colic artery length and the origin of left colic artery) and one angiogram and

one sample resembled type IIc (anastomosis between the lower third of middle colic artery and upper third of left colic artery). There was no connection between either accessory middle colic artery or accessory left colic artery.

As for microcirculatory level, infrequent anastomosis between arteriolae rectae and frequent ones within subserous plexus were found on India ink injections. Mighty constant plexuses in all intestinal wall layers were to be found on methylmetacrylate casts. Especially submucous plexus forms a massive possible collateral canal. The dimensions and frequency of all plexuses don't differ from those in the rest of the colon (Fig. 3, 4, 5).

DISCUSSION

Interconnections between both mesenteric networks are divided in four levels. The first one is a large intermesenteric anastomosis, present in approximately 10 %. Firstly drawn by Mascagni⁴, mentioned by Corsy⁵, first name adopted by Villemin⁶ as „anastomose central intermésentérique“, it was widely described by Pikkieff¹ (1931) who was the only one to use the term of „anastomosis accessoria“. Later authors called it „intermesenteric arcade“, Vandamme⁷ applied the term of „arcus intermesentericus“, and some others even adopted the expression of „Riolan arc“ by Grant and Basmajian⁸. On the contrary Andrejew⁹, Huard¹⁰, Pikkieff¹ and Testut¹¹ used „Riolan arc“ as well as renowned medical dictionaries^{12,13} and even some recent authors¹⁴ apply the expression of „intermesenteric arterial arch / arcade“ in the meaning of part of the marginal artery in the area of the left colon flexure. This misunderstanding dates back to Riolan whose description of the colon is very inexact but his

Fig. 1. Angiogram of the anastomosis intermesenterica accessoria.

drawings show a vessel now called the arteria marginalis coli Drummondi¹⁵.

To differentiate between the anastomosis magna *Halleri* and the intermesenteric connection the name of „anastomosis parva“ has been suggested. Although „par-

Fig. 2a. Type IIa of anastomosis intermesenterica accessoria according to Pikkieff's division.

Fig. 2b. Type IIb of anastomosis intermesenterica accessoria according to Pikkieff's division.

Legend to figures

AMS = arteria mesenterica superior
 AMI = arteria mesenterica inferior
 ACM = arteria colica media
 ACS = arteria colica sinistra
 AIA = anastomosis intermesenterica accessoria
 AMH = anastomosis magna Halleri
 A = artery
 V = vein
 vR = vasa recta
 vM = vasa marginalia
 C = Lieberkühn's crypts
 a = artefact
 Mu = plexus mucosus
 SM = plexus submucosus

vus" could evoke a shorter vessel, its lumen is often wider and the anastomosis is absent in 90 %. On this account we strongly suggest the unambiguous expression of *anastomosis intermesenterica accessoria* or *accessory intermesenteric anastomosis* in English according to following rules (stated by Williams¹⁶ (1957)). The eponym referring to this term is Villemin⁶.

This vessel connects either superior and inferior mesenteric trunk or, more frequently, their branches in the mesentery, close to its root, never in its peripheral margin. It is not part of the marginal artery, and there are no straight arteries arising from it. It runs close to the inferior mesenteric vein and forms second, accessory arterial arch, bending along the duodenojejunal flexure and traversing the ligamentum suspensorium duodeni anteriorly.

Its frequency varies from 0 % to 18 % (García-Ruiz¹⁷ 0 %, Bamsajian⁸ 5.7 %, Hovelacque¹⁸ 5 %, Huard¹⁰ 6 %, Pikkieff¹ 9 % to 10 %, Renner¹⁴ 9.6 %, Griffiths¹⁹ 10 %, Williams¹⁶ 11 %, Vandamme^{20,21} 12 %, Villemin⁶ 18 %). The half of the anastomosis lumen samples is similar to connected arteries, the other half is narrower.

Fig. 3. Marginal and straight vessels on the India ink injected sample.

Pikkieff has proposed the type division which the authors agree to:

- I – connection between the accessory middle colic artery and the left colic artery – 5.7 %
- II – communication between the middle colic artery and the left colic artery – 3 %
- III – anastomosis between trunks of both mesenteric arteries – 0.3 %
- IV – vessel connecting superior mesenteric artery and left colic artery – 0.3 %

The term *Arcus Riolani*, *Riolan's arcade* or *arch* refers to that part of the colic marginal artery situated in the area of left colic flexure unambiguously, it is identical to the expression of *anastomosis magna Halleri*. This is the second level of intermesenteric communications as a short part of a long channel called by Drummond¹⁵ (1913), macroscopically detectable in 95 % with various calibres (Steward²² states its 100 % presence). Also secondary and tertiary arcades respectively, if present belong to this level. The most frequent ones are at main arteries branching points.

Fig. 4. Vasa recta and plexus suberosus on the Mercor corrosion cast.

Fig. 5. Submucosal and mucosal plexus on the Mercor corrosion cast.

The last, equally important but not the least level is the microcirculatory network. Except infrequent anastomosis between arteriolae rectae there are constant mighty plexuses in all colon wall layers. Sparse subserous network is derived from both long and short straight arteries. The second plexus is stretched between circular and longitudinal muscular layer, the third, a massive one, is submucous, supplying both muscular and the innermost, mucous, tiny meshwork sending capillaries around the intestinal crypts. In normal state these plexuses feature no regional differences throughout the whole length of colon.

CONCLUSION

From the morphological point of view there is a connection between both mesenteric networks, in all cases at the macroscopic level nearly and constantly at the microcirculation level. For the intermesenteric communication close to the arteries roots (present in 5–10 %) the term *anastomosis intermesenterica accessoria* is strongly suggested. The question is if the anastomosis is able to replace the source of arterial blood supply in the case of acute obstruction. Finally it is to remind that expressions *Riolan's arch* and *Haller's anastomosis* are identical and cannot be mistaken for *anastomosis intermesenterica accessoria*. The following conclusion is important for possible collateral circulation: the number and frequency of anastomosis increase with growing distance from aorta.

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