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Anatomical Variations of the Colic Arteries and its Clinical and Surgical Implications

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ABSTRACT

Introduction: anatomical variations are morphological alterations of bodily structures resulting from congenital modifications which do not impair the organism's development. In this context, variations in arterial blood vessels have an embryonic origin with highest recurrence, possibly leading to changes in the route, distribution, and nourishment. Therefore, the right, middle, and left colic arteries give rise to several branches, among which the main ones are the ileocolic, appendicular, anterior cecal, and posterior cecal arteries.

Methods: it is a descriptive observational study conducted in a physical setting at the Human Anatomy Laboratory of UFAM in June 2023. A male cadaver's abdomen was used, and exclusion criteria were applied to anatomical specimens exhibiting lacerations in the intestinal vasculature or those that had been previously dissected. The initial data collection involved dissecting cadaver abdomens to map the arteries within this anatomy.

Results: based on the analysis of the cadaver used in this study, the presence of typical arteries supplying the right colic and middle colic regions (superior mesenteric artery), as well as the left colic and sigmoid regions (inferior mesenteric artery), was observed. Thus, the research results were obtained through macroscopic analysis, revealing the presence of the Riolan's arch within the colic arteries.

Conclusion: to Conclude, it was possible to effectively describe the anatomical variations of the intestinal arteries present in the cadaver under study through photographs and dissection.

Keywords: Anatomy; Anatomic Variation; Intestine; Arteries.

Introduction

Anatomical variations are morphological alterations of bodily structures resulting from congenital modifications which do not impair the organism's development. In this context, variations in arterial blood vessels have an embryonic origin with highest recurrence, possibly leading to changes in the route, distribution, and nourishment in different kinds of tissues without resulting in any adverse harm. (Ruiz *et al*., 2017). In this context, the superior and inferior mesenteric arteries originate jejunal and ileal colic. However, while these represent the classical morphological pattern, modifications in origin and distribution have been noticed, with high clinical and surgical significance. (SILVA *et al*; 2020).

Therefore, the right, middle, and left colic arteries give rise to several branches, among which the main ones are the ileocolic, appendicular, anterior cecal, and posterior cecal arteries. According to a study by Ozkan *et al*. (2006), the classic formation of arterial anatomy appears in less than 25% of cases. Thus, given the high frequency of variations, there is a significant need for documenting these alterations to enrich the literature in clinical and surgical aspects, as well as to contribute to knowledge in the academic field during the professional training process.

In this perspective, recent advances in imaging techniques, such as Computed Tomography Angiography (CTA) and Magnetic Resonance Imaging (MRI), have allowed for a better visualization of anatomical variations in the colic arteries before clinical or surgical procedures (Shigueoka; 2016). This enables more precise planning of interventions, minimizing risks, and optimizing results.

In light of this, we emphasize the importance of interdisciplinary collaboration between surgeons and gastroenterologists for the effective management of this anatomical variation.

To the best of our knowledge, there have been numerous studies on anatomical variations of intestinal arteries. This paper contributes to the literature by exploring a rarely studied variation. In the following sections, the research describes the anatomical variation of intestinal arteries observed in a cadaver from the Universidade Federal do Amazonas (UFAM) through dissection and photographs.

Material and Methods

It is a descriptive observational study conducted in a physical setting at the Human Anatomy Laboratory of UFAM in June 2023. A male cadaver's abdomen was used, and exclusion criteria were applied to anatomical specimens exhibiting lacerations in the intestinal vasculature or those that had been previously dissected.

This study complied with Law No. 8,501 of November 30, 1992, which addresses the use of unclaimed cadavers for studies or scientific research. The authors

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state that every effort was made to follow all local and international ethical guidelines and laws that pertain to the use of human cadaveric donors in anatomical research (Iwanaga *et al*., 2022).

The initial data collection involved dissecting cadaver abdomens to map the arteries within this anatomy. Specimens were pinned and clamped to facilitate the anatomical interpretation of structures. Subsequently, the cadaver with the best-preserved vascularization was selected. The arteries were then photographed using a cell phone for macroscopic structural analysis. The origin, position, course of the arteries, and their relationships with the abdominal viscera were analyzed. The study findings were compared with those described in the literature.

Additionally, digital illustrations and information tables were included to enhance understanding of the macroscopic and anatomical correlations of the arteries in the studied specimens. This research was submitted to the Ethics and Research Committee (CEP) and approved under review number 3.352.104.

Results

Based on the analysis of the cadaver used in this study, the presence of typical arteries supplying the right colic and middle colic regions (superior mesenteric artery), as well as the left colic and sigmoid regions (inferior mesenteric artery), was observed. Additionally, more distal branches of the arteries supplying the colon and small intestine were identified. Tables 1 and 2 present the origin, course, and distribution of these arteries. Thus, the research results were obtained through macroscopic analysis, revealing the presence of the Riolan's arch within the colic arteries.

Superior mesenteric artery

In the cadaver under study, the superior mesenteric artery (SMA) was observed to provide vascularization, primarily to the right colon (Figures 1, 2, 3 and 4).

It emerged from the right anterior surface of the abdominal aorta, below the celiac trunk. It distributes

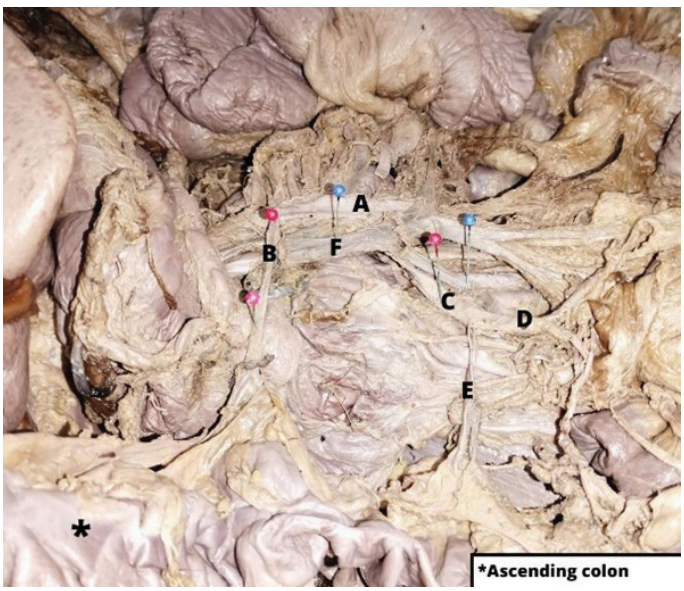

Figure 1. Arteries originating from SMA. A: superior mesenteric artery; B: right colic artery; C: ileocolic artery; D: colic branch of the ileocolic artery; E: ileal branch of the ileocolic artery; F: superior mesenteric vein

Table 1. Characteristics of SMA arterial branches presents in the cadaver under study.

Artery	Origin	Route	Distribution
Right colic	Superior mesenteric artery	Descends to the right and reaches the ascending colon	Ascending colon
Ileocolic	Terminal portion of the SMA	Descends inferiorly and bifurcates into ileal and colic branches	Ileal, ascending colic, and cecal branches.
Middle colic	Proximal portion of the SMA	Ascends superiorly to the right	Transverse colon and portions of the ascending and descending colon
Appendicular	Ileal branch of the ileocolic artery	Descends inferiorly	Vermiform appendix
Anterior cecum	Ileal branch of the ileocolic artery	Descends inferiorly to the right	Anterior portion of the cecum
Jejunal and Ileal	Left side of the SMA	runs to the left between the two layers of the mesentery.	Jejunum and Ileum

Legend: SMA: Superior mesenteric artery.

Table 2. Characteristics from IMA arterial branches.

Artery	Origin	Route	Distribution
Left Colic	Inferior mesenteric artery	Ascends superiorly to the left	Descending colon
Sigmoid	Terminal portions of the IMA	Descends inferiorly to the left	Sigmoid colon and part of the descending colon.
Superior Rectal	Ramo terminal da IMA	Descends inferiorly	Upper rectum

Legend: IMA: Inferior mesenteric artery.

inferiorly to the right, supplying the right portion of the colon and the distal portion of the small intestine through the arteries from Table 1.

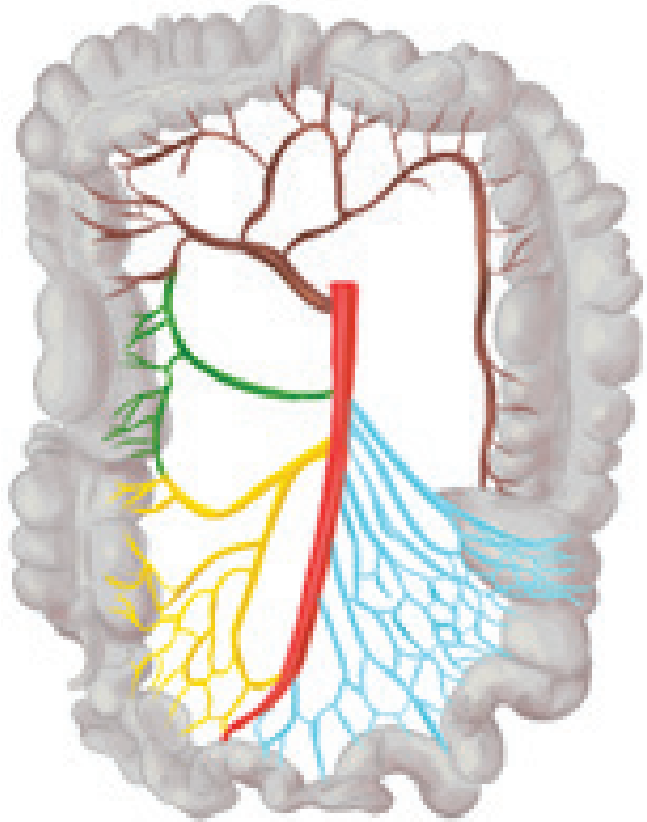

Figure 2. Schematic representation of colonic arteries. SMA (red); ileocolic artery and branches (yellow); right colic artery (green); middle colic artery (brown); jejunal and ileal arteries (blue).

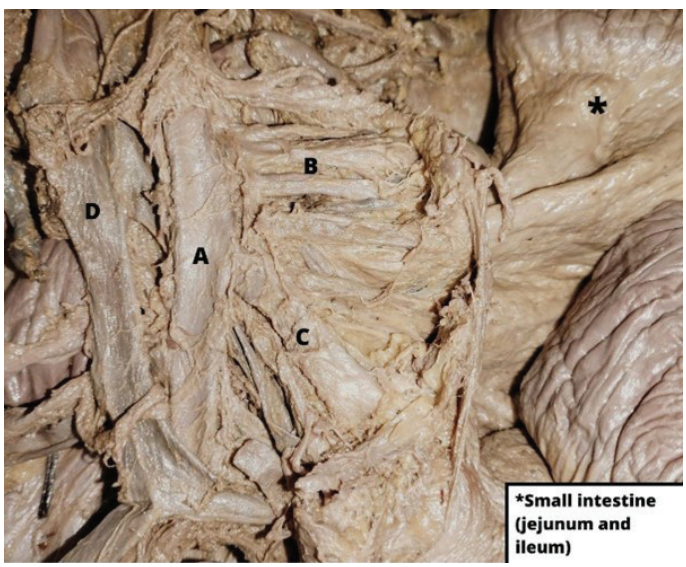

Figure 3. Arteries originating from SMA. A: superior mesenteric artery; B: jejunal arteries; C: ileal artery; D: superior mesenteric vein.

Inferior mesenteric artery

The Inferior Mesenteric Artery (IMA), was present in the cadaver under study, nourishing the left portion of the colon and the upper part of the rectum (Figures 4 and 5).

Figure 4. Arteries originating from the IMA. A: inferior mesenteric artery; B: sigmoid arteries; C: superior rectal artery; D: left colic artery.

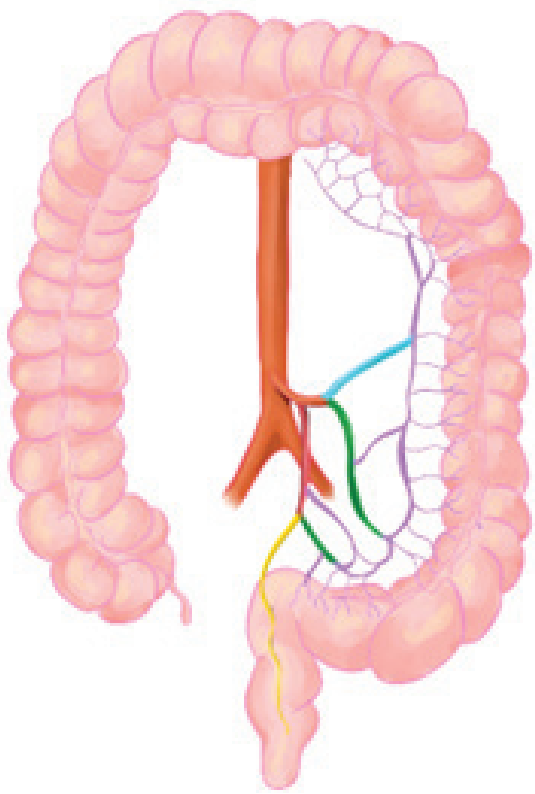

Figure 5. Schematic representation of the arteries of the left portion of the colon. IMA (red); Left Colic Artery (blue); Sigmoid arteries (green); Superior Rectal Artery (yellow); Marginal Artery of Drummond (purple).

It emerged from the left anterior side of the abdominal aorta, just below the gonadal artery. Its distribution descends to the left, vascularizing the left colon and the upper rectum via the arteries listed in Table 2.

Riolan's Arch

The anatomical variation found originates the Riolan's Arch, an artery that typically vascularizes the transverse and descending colons. Although the Riolan's Arch of the cadaver under study was sectioned, it is still possible to observe and understand its anatomical distribution (Figures 6, 7 and 8).

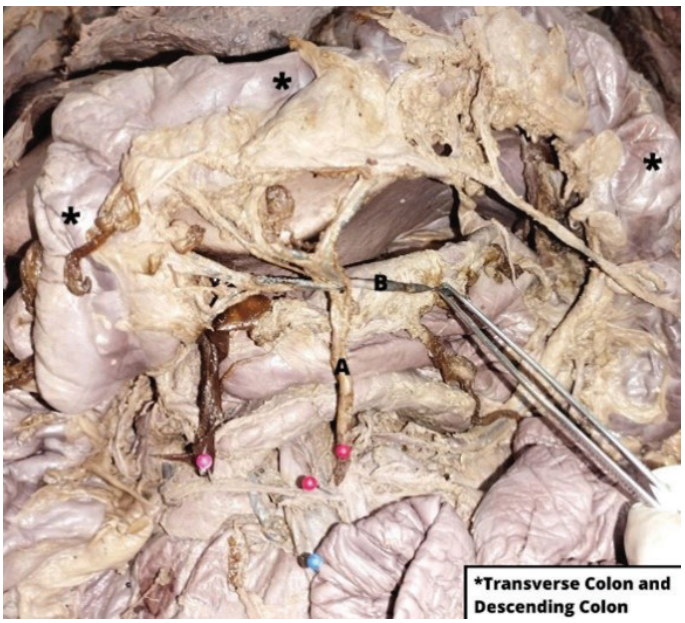

Figure 6. Left side from Riolan's Arch (red pin); A: Ascending Branch from left colic artery; B: Descending branch from left colic artery.

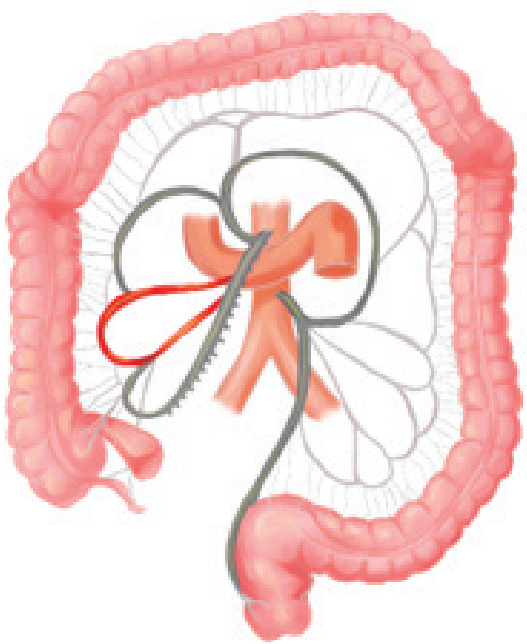

Figure 7. Schematic representation of colonic arteries. SMA (red); Ileocolic arteries and branches (yellow); right colic artery (green); middle colic artery (brown); jejunal and ileal arteries (blue).

Figure 8. Right side of Riolan's Arch (forceps; B); A: middle colic artery.

The Riolan's Arch emerges on the left side via the ascending branch of the left colic artery and communicates with the middle colic artery via the right side. Table 3 presents the main characteristics of this anatomical variation.

Discussion

This paper presents the macroscopic arrangement of intestinal arteries in a cadaver. Within it, the vascular distribution of the superior and inferior mesenteric arteries was observed, with the main finding being Riolan's arcade.

The arteries present in the large intestine exhibit a high degree of variability in their branches. Regarding the superior mesenteric artery, its right colic branch is present in 10-63% of cases reported in the literature, and the middle colic branch in 99.3% of the cases studied (ALSABILAH J *et al*; 2016). Therefore, the superior mesenteric artery is responsible for two-thirds of the vascularization of the right large intestine, encompassing the cecum, ascending colon, and part of the transverse colon (XU *et al*; 2014).

Furthermore, in relation to the inferior mesenteric artery, the left colic, sigmoid, and superior rectal branches are responsible for nourishing one-third of the transverse colon, descending colon, sigmoid colon, and rectum. The available literature at the time of the research provided limited information about the left

Table 3. Characteristics of Riolan's Arch observed in the cadaver under study.

Artery	Origin	Rout	Distribution
Riolan's Arch	Ascending branch of left colic artery	Ascends and bends to the right to anastomose with the middle colic artery	Segments of the transverse and descending colon

colic artery, specifically the accessory left colic artery (RUSU *et al*; 2008). This artery consists of an ascending branch that anastomoses with the middle colic artery and a descending branch responsible for vascularizing the lower portion of the descending colon.

According to GOLIGHER, there is a variable number of sigmoid arteries, ranging from one to five. Thus, the research aligns with the findings in the current literature. In the experimental study conducted by DEGNI, it was reported that the arteries supplying the sigmoid colon have three distinct origins. Firstly, they can originate from the inferior mesenteric artery alone (6.7%) or through a common branch (9.7%). Secondly, sigmoid arteries can originate from either the inferior mesenteric artery or the left colic artery alone (40.3%) or through a common branch (23%). In the third scenario, they originate solely from the left colic artery in 2.8% of cases.

Regarding the main finding of this research, Riolan's Arch is responsible for indirect communication between the inferior and superior mesenteric arteries. Previously, according to RIOLAN and DRUMMOND, communication between the right and left sides of the abdominal arteries occurred only via marginal arteries. However, research has shown anatomical variations that contradict the research conducted by the cited authors. In this context, the current research confirms the existing literature by reporting the discovery of Riolan's arcade. In the cadaver under study, it emerges from the ascending branch of the left colic artery and anastomoses with the middle colic artery, enabling an alternative communication between the right and left vascularization of the large intestine (KORNBLITH *et al*; 1992).

Conclusion

To Conclude, it was possible to effectively describe the anatomical variations of the intestinal arteries present in the cadaver under study through photographs and dissection. We observed that knowledge of intestinal arterial anatomy is of fundamental importance for clinical and surgical studies. In this regard, understanding the anatomical variations of these arteries assists in the diagnosis of malignant neoplasms, aneurysms, and other diseases, allowing for surgical correction based on prior theoretical knowledge. Additionally, theoretical knowledge of arterial anatomy also contributes to the maintenance of intestinal microbiota, which is important for overall body balance and patient health. Therefore, further studies on this subject are necessary to expand the literature and knowledge base.

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