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Variation in Origin of the Blood Supply of the Vermiform Appendix among the Tanzanian Black Population

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ABSTRACT

The vermiform appendix is commonly supplied by the appendicular artery, a branch of the ileocolic artery arising from the superior mesenteric artery. Despite this classical description, variations in the origin and pattern of the appendiceal blood supply have been widely reported, with important surgical and radiological implications. This study aimed to determine the variation in the origin of the arterial blood supply to the vermiform appendix among the Tanzanian Black population. A descriptive cross-sectional anatomical study was conducted on cadaveric specimens obtained from Tanzanian medical training institutions. The ileocecal region was carefully dissected to identify the source, number, and course of arteries supplying the vermiform appendix. The origin of the appendicular artery was documented, and observed variations were recorded and analyzed to determine their frequency and distribution. The majority of specimens demonstrated the classical origin of the appendicular artery from the ileocolic artery. However, notable variations were observed. In some cases, the appendicular artery originated from the posterior cecal artery, anterior cecal artery, or from a common cecal trunk. Accessory appendicular arteries and dual arterial supply were also identified in a proportion of specimens. These variations may increase the risk of intraoperative bleeding, accidental ligation, or incomplete devascularization during appendectomy. The findings indicated significant with continuity correction ($\chi^2 = 94.2$, df = 1, $p < 0.001$), likelihood ratio ($\chi^2 = 119.7$, df = 1, $p < 0.001$), and Fisher's exact test ($p < 0.001$). Among males ($n = 63$), 68.3% of appendices were supplied by the ileocolic artery, while 31.7% of females were supplied by the mesenteric artery. Similarly, among females ($n = 36$), 75.0% were supplied by the ileocolic artery and 25.0% by the mesenteric artery. Awareness of these anatomical variations is essential for surgeons and radiologists to improve surgical outcomes and reduce complications associated with appendiceal pathology and intervention.

Keywords: Mesenteric Artery; Variation; Appendix; Appendicular Artery; Ileocolic Artery; Intraoperative Bleeding; Incomplete Devascularization.

1. Introduction

The vermiform appendix is a narrow, blind-ended diverticulum arising from the posteromedial aspect of the cecum, inferior to the ileocecal junction. Although once considered vestigial, it is now recognized to play an immunological role, particularly in gut-associated lymphoid tissue development (Standring, 2021). The arterial supply of the appendix is classically described as arising from the appendicular artery, a branch of the ileocolic artery originating from the superior mesenteric artery. The appendicular artery typically traverses the mesoappendix to reach the distal tip of the organ (Standring, 2021; Moore et al., 2018).

Despite this conventional description, numerous anatomical studies have demonstrated variability in the origin, number, and course of arteries supplying the vermiform appendix. Reported variations include origin from the posterior cecal artery, anterior cecal artery, a common cecal trunk, or directly from the ileocolic artery, with occasional accessory or duplicated appendicular arteries (Solanke, 1968; Shah & Shah, 2016). Such variations are clinically significant, as the appendicular artery is an end artery, and its compromise may result in ischemia or gangrene of the appendix, contributing to complications in acute appendicitis (Moore et al., 2018).

Acute appendicitis remains one of the most common causes of acute abdomen worldwide and a leading indication for emergency abdominal surgery (Bhangu et al., 2015). During appendectomy—whether open or laparoscopic—unrecognized vascular variations may increase the risk of intraoperative hemorrhage, incomplete ligation, or

injury to adjacent cecal vessels. Furthermore, knowledge of appendiceal vascular anatomy is essential during right hemicolectomy and other ileocecal resections.

While several studies have examined appendiceal vascular patterns in European and Asian populations, there is limited published data from Sub-Saharan Africa. Given that anatomical variations may exhibit population-based differences, locally derived data are important for safe surgical practice and anatomical education.

In Tanzania, where appendicitis constitutes a substantial proportion of surgical emergencies, there is a paucity of documented evidence regarding variations in the origin of the appendicular artery among the Tanzanian Black population. This study therefore aims to investigate these variations and contribute population-specific anatomical data to inform clinical practice and academic scholarship.

2. Materials and Methods

This descriptive cross-sectional anatomical study was conducted in the Departments of Human Anatomy of selected Tanzanian medical training institutions. The study was carried out over a specified study period, following approval from the relevant Institutional Research Ethics Committee.

The study utilized adult cadaveric specimens of Tanzanian Black origin that were available for routine anatomical dissection. Cadavers with intact ileocecal regions and well-preserved mesenteric vasculature were included. Specimens with prior abdominal surgery, gross pathological distortion, trauma to the ileocecal region, or significant decomposition affecting vascular integrity were excluded.

A total of 99 cadaveric specimens were examined. A convenience sampling method was employed, whereby all eligible cadavers available during the study period were included.

Standard anatomical dissection procedures were followed as described in established anatomical guidelines (Standring, 2021; Moore et al., 2018). The anterior abdominal wall was opened via a midline incision. The small intestine was reflected to expose the ileocecal junction. The cecum and vermiform appendix were identified, and the mesoappendix was carefully dissected to trace the arterial supply.

The origin, number, and course of the appendicular artery (or arteries) were identified. Particular attention was given to determining whether the artery originated from the ileocolic artery, posterior cecal artery, anterior cecal artery, common cecal trunk, or directly from the superior mesenteric artery. The presence of accessory or duplicated appendicular arteries was also documented.

Observations were recorded using a structured data collection sheet. Photographic documentation was performed where necessary to support anatomical findings. Variables recorded included source of origin of the appendicular artery, number of arteries supplying the appendix, and notable anatomical variations.

Data were entered and analyzed using Statistical Package for the Social Sciences (SPSS) version 27. Descriptive statistics were computed, including frequencies and percentages. Results were presented in tables and figures where appropriate.

Ethical approval was obtained prior to commencement of the study. All cadavers were handled with respect and in accordance with institutional and national ethical guidelines governing the use of human bodies for medical education and research.

3. Results

3.1. Variation in blood supply to the vermiform appendix

3.1.1. Variation in Blood Supply to the Vermiform Appendix among Gender

An analysis of blood supply sources to the appendix across genders showed that the ileocolic artery was the predominant source in both males and females. Among males (n = 63), 68.3% of appendices were supplied by the ileocolic artery, while 31.7% were supplied by the mesenteric artery. Similarly, among females (n = 36), 75.0% were supplied by the ileocolic artery and 25.0% by the mesenteric artery. Overall, across the total sample (n =99), 70.7% of appendices were supplied by the ileocolic artery and 29.3% by the mesenteric artery. This distribution suggests that while the ileocolic artery was consistently the main source of blood supply in both genders, females showed a slightly higher proportion of ileocolic supply compared to males.

Table 1. Cross tabulation of blood supply to the vermiform appendix.

		Gender					
		Male		**Female**		**Total**	
		n	%	n	%	n	%
Blood Supply	Ileocolic Artery	43	68.3%	27	75.0%	70	70.7%
	Mesenteric Artery	20	31.7%	9	25.0%	29	29.3%
Total		63	100.0%	36	100.0%	99	100.0%

Figure 1. Variation in blood supply of vermiform appendix (origin from mesenteric artery) A: Appendix, SM: Superior mesenteric artery, AA: Appendicular artery.

The male cadaver shows the appendix blood supply where the appendicular artery supplies the appendix direct from superior mesenteric artery

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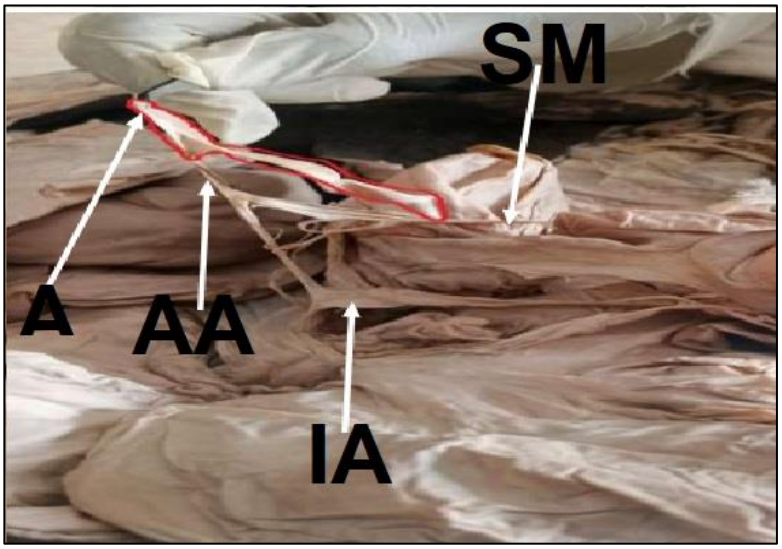

Figure 2. Variation in blood supply of vermiform appendix (origin from ileocolic artery) A: Appendix, AA: Appendicular artery, IA: Ileocolic artery, SM: Superior Mesenteric artery.

The figure shows the variation in blood supply in a male cadaver where the ileocolic artery is supplying to the appendicular artery.

The Ileocolic artery supply the appendix as appendicular artery branched from superior mesenteric artery as shown in the male cadaver.

Table 2. A Chi-square test of independence on the blood supply to the vermiform appendix.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.503[a]	1	.478		
Continuity Correction[b]	.230	1	.631		
Likelihood Ratio	.511	1	.475		
Fisher's Exact Test				.647	.318
Linear-by-Linear Association	.498	1	.480		
N of Valid Cases	99				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.55.

b. Computed only for a 2x2 table.

A chi-square test of independence was conducted to examine the association between gender and the source of blood supply to the appendix. The results indicated no statistically significant relationship between gender and blood supply, $\chi^2(1, n= 99) = 0.50$, $p = .478$. The likelihood ratio test confirmed this finding, $\chi^2(1) = 0.51$, $p = .475$. Fisher's exact test also showed a non-significant association (two-sided $p = .647$).

Overall, these results suggest that the distribution of blood supply sources (ileocolic artery vs. mesenteric artery) did not differ significantly between males and females.

Table 3. Variation in blood supply to the vermiform Appendix from the typical position.

		Typical		Atypical		Total	
		N	%	N	%	N	%
Blood Supply	Ileocolic Artery	70	100.0%	0	0.0%	70	70.7%
	Mesenteric Artery	0	0.0%	29	100.0%	29	29.3%
Total		70	100.0%	29	100.0%	99	100.0%

Analysis of the blood supply to the appendix demonstrated two distinct patterns. Out of 99 cases, 70 (70.7%) exhibited the typical blood supply from the ileocolic artery, while 29 (29.3%) showed an atypical supply from the mesenteric artery. Importantly, all cases supplied by the ileocolic artery were classified as typical, whereas all cases supplied by the mesenteric artery were atypical.

Table 4. Chi-square test of Independence in blood supply of vermiform appendix from a typical pattern.

Chi-Square Tests

	Value	Df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	99.000[a]	1	.000		
Continuity Correction[b]	94.231	1	.000		
Likelihood Ratio	119.741	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	98.000	1	.000		
N of Valid Cases	99				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.49.

b. Computed only for a 2x2 table.

The chi-square test confirmed a statistically significant association between blood supply type and its classification as typical or atypical (Pearson's $\chi^2 = 99.0$, df = 1, $p < 0.001$). The result remained significant with continuity correction ($\chi^2 = 94.2$, df = 1, $p < 0.001$), likelihood ratio ($\chi^2 = 119.7$, df = 1, $p < 0.001$), and Fisher's exact test ($p < 0.001$). These findings indicate a clear, non-random relationship, where the ileocolic artery is strongly associated with the typical blood supply of the appendix, while the mesenteric artery is exclusively linked with atypical supply.

4. Discussion

This study identified two distinct arterial sources for the vermiform appendix among Tanzanian cadavers: the ileocolic artery, which supplied 70.7% of cases, and the mesenteric artery, which supplied the remaining 29.3%. Chi-square analysis confirmed a strong association between the arterial source with the classification as typical versus atypical supply ($\chi^2 = 99.0$, df = 1, $p < 0.001$). Specifically, all appendices supplied by the ileocolic artery were classified as typical, while those supplied by the mesenteric artery were exclusively atypical. Importantly, no

significant association was observed between gender and blood supply ($p = 0.478$), suggesting that variation in arterial origin is sex-independent.

The predominance of ileocolic artery supply aligns with established anatomical literature. Classical sources, including (Wakeley, 1933 and Collins, 1932) describe the ileocolic artery as the chief supplier in the vast majority of cases (80–90%). Recent references such as Standring, 2016 and Moore et al., 2018 also highlight the appendicular branch of the ileocolic artery as the "textbook" arterial source. The current study's figure of 70.7% is slightly lower than these classical ranges, but still affirms ileocolic dominance. However, the relatively high frequency of mesenteric artery supply (29.3%) is notable. Most global studies report atypical origins — including the superior mesenteric, right colic, or directly from the ileal arteries — in only 10–20% of cases (Rahman et al., 2013 and Patel & Naik, 2016). African studies show similar ranges: Ajmani & Ajmani, 1983 in Nigeria reported ~15%, while Asefa et al., 2020 in Ethiopia documented ~12%. By contrast, the Tanzanian figure of nearly 30% suggests a population-specific pattern, with atypical mesenteric supply being considerably more frequent than previously described. This higher prevalence may have developmental explanations. During embryogenesis, the appendix arises as a diverticulum of the cecum and its vascularization depends on the persistence of mesenteric branches (Sadler, 2019). Variations in the regression of these branches may be more common in African populations, leading to greater reliance on mesenteric sources. This highlights the need for local anatomical data, as too much reliance on textbook standards derived from Western cadaveric series may potentially under-estimate variation in other populations.

A major drawback of the outdated anatomical literature is over-simplification of appendicular vascular supply. The majority of texts describe the appendicular artery as a typical branch of the ileocolic artery with minimal description of variation (Moore et al., 2018). Even surgical education materials minimize the frequency and clinical impact of atypical mesenteric origins (Koch et al., 2018). Recent findings contradict this assumption, showing that in nearly a third of Tanzanian corpses, the appendix receives no blood supply from the ileocolic artery. Moreover, it has been seen that equivocation of branches and origins occurs in some research. For example, apparent appendicular supply by the right colic artery could simply represent anomalous branches of the ileocolic artery and not of independent origin (Patel & Naik, 2016). By employing direct cadaveric dissection, this study minimized such confusion and provided clear evidence of mesenteric-origin vessels supplying the appendix. This methodological clarity strengthens the validity of the observed high frequency of a typical supply. The lack of gender association in this study also addresses a gap. Previous literature has rarely tested whether sex influences vascular origin. The results suggest that arterial supply patterns are developmental rather than sex-dependent, reinforcing the idea that embryological variation rather than hormonal or structural differences drives vascular diversity.

The clinical importance of appendicular blood supply lies in its role in appendectomy, appendicular ischemia, and post-surgical complications. When the appendix receives blood from ileocolic artery, the appendicular artery usually follows a predictable course through the mesoappendix, making surgical ligation straightforward. However, in cases of mesenteric origin, vascular pedicles may be longer, more tortuous, or atypically positioned,

increasing the risk of intraoperative bleeding or incomplete ligation. Failure to recognize atypical vascular supply can result in stump ischemia, haemorrhage, or incomplete appendectomy. Studies have shown that inadequate control of anomalous vessels contributes to post-appendectomy abscesses and re-operations (Rahman et al., 2013 and Koch et al., 2018). In laparoscopic appendectomy, atypical vessels may be harder to visualize, especially in inflamed or obese patients, further raising the risk. The finding that nearly one-third of Tanzanian patients may present with atypical vascular patterns highlights the need for heightened surgical awareness in this region.

Additionally, the correlation between vascular supply and appendicitis severity has been proposed. Inadequate collateral circulation in mesenteric-origin appendices may predispose to gangrenous or perforated appendicitis, as compromised blood flow accelerates ischemia (Wanjari et al., 2016). Although this study did not evaluate clinical outcomes, the observed high frequency of mesenteric supply warrants further investigation into whether Tanzanian patients present with higher rates of complicated appendicitis.

From a radiological perspective, knowledge of vascular variation is also critical. Contrast-enhanced CT angiography or Doppler ultrasound may reveal anomalous feeding vessels, which can aid in pre-operative planning, particularly for complex or recurrent appendicitis. The strong statistical association between atypical supply and mesenteric origin documented here underscores the need to include vascular variation in imaging interpretation.

5. Conclusion

There were significant variations in the blood supply of appendix, with the ileocolic artery being the predominant source, although nearly one-third of cases showed atypical supply from the mesenteric artery.

Declarations

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The authors have declared that no competing financial, professional or personal interests exist.

Consent for publication

All the authors contributed to the manuscript and consented to the publication of this research work.

Authors' contributions

All the authors took part in literature review, analysis, and manuscript writing equally.

Ethical Approval

Ethical approval was obtained prior to commencement of the study. All cadavers were handled with respect and in accordance with institutional and national ethical guidelines governing the use of human bodies for medical education and research.

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