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Variation of The Blood Supply in The Vermiform Appendix: Systemic Review Study

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ABSTRACT

BACKGROUND

Anatomical variations may influence predisposition to diseases, symptomatology,clinical examination, investigation and patient management including operative surgery(1) Indeed, there are reports that a substantial proportion of clinical malpractice may be attributed to ignorance of anatomical variations.The vermiform appendix is a part of large intestine, situated in right iliac fossa. It is a vestigeal organ in humans. Detailed knowledge about the normal and variant anatomy in vermiform anatomy is important for the surgeons during the surgery. The anatomical knowledge is also useful to the radiologist for diagnosing. (2) The appendicular artery arises from the inferior division of ileocolic artery which is the terminal branch of superior mesenteric. In some cases it happen that the appendicular artery arising from the posterior caecal branch of ileocolic artery.Also the double appendicular arteries have been observed in some cases where appendicular arteries are arising from inferior & superior divisions of ileocolic artery(3)The accessory appendicular artery supplies other parties of appendix except the tip.The precise knowledge of vascular variation and planning of conducting surgical and radiological procedures(4) This study is not only important for surgeons but this variation also signifies regional importance.

OBJECTIVES

1. To determine the variation of origin and distribution of blood supply in vermiform appendix in relation to age and gender using the published studies
2. To establish the misdiagnosis and surgical problem related to the variation in blood supply in vermiform appendix.

METHODOLOGY

The authors assessed the PROSPERO ID 1037988 for all published or ongoing research available related to the title to avoid any further duplication. Accordingly, the result showed that there were no ongoing or published articles in the area of this title. Therefore, this review and meta-analysis was registered in the PROSPERO database with an identification number of CRD42022384838 on 28 April 2025. This review and meta-analysis was conducted to verify the pooled possible variation of blood supply in vermiform appendix resource-limited settings. Scientific consistency was formulated by using the preferred reporting items of systematic reviews

The research articles were genuinely searched using PubMed, Scopus,Cochrane Library, Web of Science, free Google database search engines, GoogleScholar, and Science Direct databases. Published studies were searched and screened for inclusion in the final analysis, and studies without sound methodologies and review and meta-analysis were not included in the analysis. Participants: This review analyzed data from 217 cadavers specimen as reported by primary studies. Five articles were included in this systematic review and meta-analysis. The articles that had incomplete information and casereports were excluded from the study.

RESULT:

In five published studies with total of 262 cadaveric sample .The following results were obtained through the cross section study using the above sample space.The ileocolic artery arises independently from superior mesenteric artery in 96.88% of cases and ends by dividing into superior and inferior division in 93.76% of cases.The anterior and posterior caecal arteries arise by a common trunk in 56.25%. The appendicular artery arises from inferior division in 46.88%, ileal branch 28.13%, ileocolic artery 18.75% and from arterial arcade in 6.25% of cases. 21.87% of cases showed additional(Accessory appendicular artery).

Tthe mesoappendix and arterial pattern of appendix in 60 vermiform appendices:

- Extension up to whole length of the appendix in 46 specimens,
- Extension up to 2/3 of length of the appendix in 14 specimens,
- Extension up to half of the length of the appendix in none of the specimens.

Vermiform appendix was supplied by single appendicular artery in majority of the cases (52), but accessory appendicular artery(8) was also found to be present in mesoappendix The main appendicular artery arose from the ileocolic artery in48 cases ileal artery in 8 cases and posterior caecal artery in 4 cases. The accessory appendicular artery was seen to originate in contrast from the main branch, predominantly
from posterior caecal artery than the ileocolic artery

CONCLUSION:

The prevalence and Incidence of variation in origin and distribution of blood supply in vermiform appendix were reviewed in five published studies. The study of the blood supply in vermiform appendix gives a guide to the surgeons during appendectomy. The shorter the extent of the vermiform appendix, the more risk of gangrenous complications. The main appendicular artery arose from ileocolic, posterior caecal and ileal arteries but not at all from the anterior caecal artery.

Knowledge of the presence of accessory appendicular artery is of utmost importance to prevent hemorrhage during surgery, and 13% of the specimens had an accessory artery. The most common origin of the accessory appendicular artery was from the posterior caecal artery, followed by the ileocolic artery. This study, hence, gives more insight to the anatomical aspects of the vermiform appendix and appendicular arterial pattern for surgeons during abdominal and laparoscopic surgeries and radiologists in identifying the accessory branches if present.

KEY WORDS:
Vermiform Appendix, Appendicular Arterial Supply, Accessory Appendicular Artery., Appendicectomy.

1. INTRODUCTION

The appendix is a narrow tube like structure lying in the right iliac fossa. It is part of large intestine and its base is attached to the posterolateral surface of the caecum just below ileocaecal junction, the tip is free and it may be present in retrocaecal, subcaecal, pre/post ileal or pelvic positions. It resembles worms and that's why known as vermiform appendix(3)

Bacterial infection and other inflammation of appendix known as appendicitis is an emergency condition in all age groups. This is treated by removal of it known as appendicectomy. Detailed knowledge about the normal and variant anatomy is important for the surgeons during the surgery. The anatomical knowledge is also useful to the radiologist for diagnosing the appendicular artery in angiograms(5)

Acute appendicitis is the most common cause of acute abdomen in young adolescents and appendectomy is often the first major surgical procedure performed by a surgeon. Precise knowledge of vascular variation and planning of conducting surgical and radiological procedures is important during appendectomy(6)

Variant anatomy is a fundamental part of anatomical science which is related to abnormalities in human body structure. If the anatomical difference from the norm does not alter function, it is not believed a congenital malformation or developmental defect but, instead, called anatomical variation. Variation is the scale of probable change for any distinctive of species(7)

Man is always fascinated by the anomalies that he comes across during the study of anatomy. Vascular anomalies always pose a great challenge to the anatomists and surgeons. The surgical trauma to the sustaining blood vessels is irreparable and lead to fatal necrosis of the part involved. Variation is the law of nature. Every human being is unique to such an extent that even identical twins are not exactly the same. Some of the variations are of considerable clinical significance such as vascular ones(8)

There is no general agreement in the literature about the arterial blood supply of the vermiform appendix. Published papers and standard text-books contain differing statements about the number of arteries which supply this organ and also about the immediate derivation of these vessels . Some authoritative sources such as state that the appendix is supplied by only one artery; but other workers claim that it is supplied by more than one vessel. Little information is available in the literature about the distribution and pattern of branching of the appendicular arteries(4)

The appendix develops from the midgut of the intestinal loop so its arterial supply is received from superior mesenteric artery. Superior mesenteric artery arises from the abdominal aorta at the level of first lumbar vertebra(5).Appendicular artery, a branch derived from ileocolic artery. It is the terminal branch derived from the right side of the superior mesenteric.

The main appendicular artery is defined as one which runs in the crescentic fold of the meso-appendix to the tip of the appendix; and the accessory appendicular artery as one which supplies other parts of the appendix except the tip(4) The terminal part of the artery lies on the wall of the appendix and may be thrombosed in appendicitis, which results in distal gangrene or necrosis. Accessory appendicular artery is the one which supplies other parts of the appendix except the tip. These
are common and many individuals possess two or more arteries of supply .(8)

During surgery sound knowledge of the origin of appendicular artery, its variations and accessory appendicular arteries is very important to avoid complications(5).

Methodology

This study reviews the articles on variation of blood supply in vermiform appendix.This research aims to find the origin and distribution of blood supply in vermiform appendix and its importance in surgical,radiological and anatomical aspect.Six studies with sample size of 262 conducted on data base of PUbMED,scopus,springer, science direct. The English articles with similar subject as were found from 1978 to 2022.

Inclusion criteria

1.All studies with cadaveric sample discusss the variation on the origin of blood supply of vermiform appendix.

2.. All studies with cadaveric sample discuss the variation in distribution of blood supply of vermiform appendix.

Data collection

217 sample collected from different sources which both national and International studies

1.Study of arterial supply of caecum and appendix: a cadaveric study" with 25 samples,

2.Cadaveric study on the origin of the appendicular artery with 50 adult cadavers

3.A cadaveric study of anatomical variations in the
arterial supply of vermiform appendix with 50 adult cadavers.

4.A study of arterial supply in caecum and vermiform appendix in human with 32 cadaveric sample

5. The blood supply of the vermiform appendix in Nigerians with 100 cadaveric sample

6. **A comprehensive study of mesoappendix and arterial pattern of appendix with 60 cadaveric sample.**

Data analysis

The sample of 262 cadavers collected from six English studies by fed into statistical package for social sciences (SPSS version 28).Analysed using the same software . The data were summarized by using tables and Images which show the pattern of variation in origin of blood supply in vermiform appendix.

Ethical clearance and consideration

No ethical clearance needed for systemic and meta- aanalysis review.

2. RESULT.

Vermiform appendix was supplied by single appendicular artery in majority of the cases (52), but accessory appendicular artery (8) was also found to be present in mesoappendix (Table 1). The main appendicular artery arose from the ileocolic artery in 48 cases (Figures 1,2), ileal artery in 8 cases and posterior caecal.

Table 1.The incendence appendicular blood supply

NO.	ARTERIAL SUPPLY	NO OF SPECIMEN
1.	Single artery	200
2.	Double artery	17
total		217

FIGURE 1:Main appendiculary A:ILEOLOC ARTERY B;APPENDICULAR ARTERY C:ACCESSORY ARTERY

TABLE 2

The origin of Main Appendicular Blood Supply

NO	ORIGIN	NO SPECIMEN	PERCENTAGE(%)
1	ILIECOLIC ARTERY	201	92.6
2	ILEAL ARTERY	10	4.6
3	ANTERIOR CAECAL ARTERY	6	2.7
4	POSTERIOR CAECAL ARTERY	NIL	0

FIGURE 2

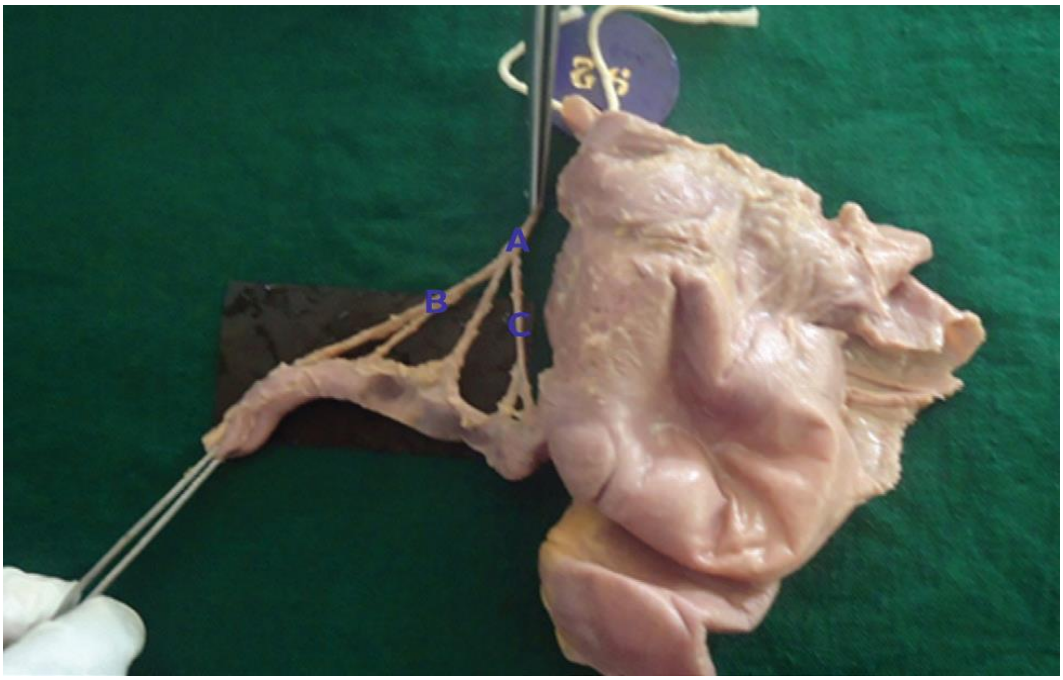


FIGURE 2:ACCESSORY APPENDICULAR ARTERY **.A.** ILEOCOLIC ARTERY B.APPENDICULAR ARTERY C.ACCESSORY APPENDICULAR ARTERY.

ORIGIN OF ACCESSORY APPENDICULAR ARTERY

TABLE 3

NO.	ORIGIN ARTERY	NO SPECIMEN	PERCENTTAGE(%)
1	ILIECOLIC ARTERY	187	86.1
2	ILIAL ARTERY	NIL	0
3	POSTERIOR CEACA ARTERY	30	13.8
4.	ANTERIOR CEACLA	NIL	0

	ARTERY		

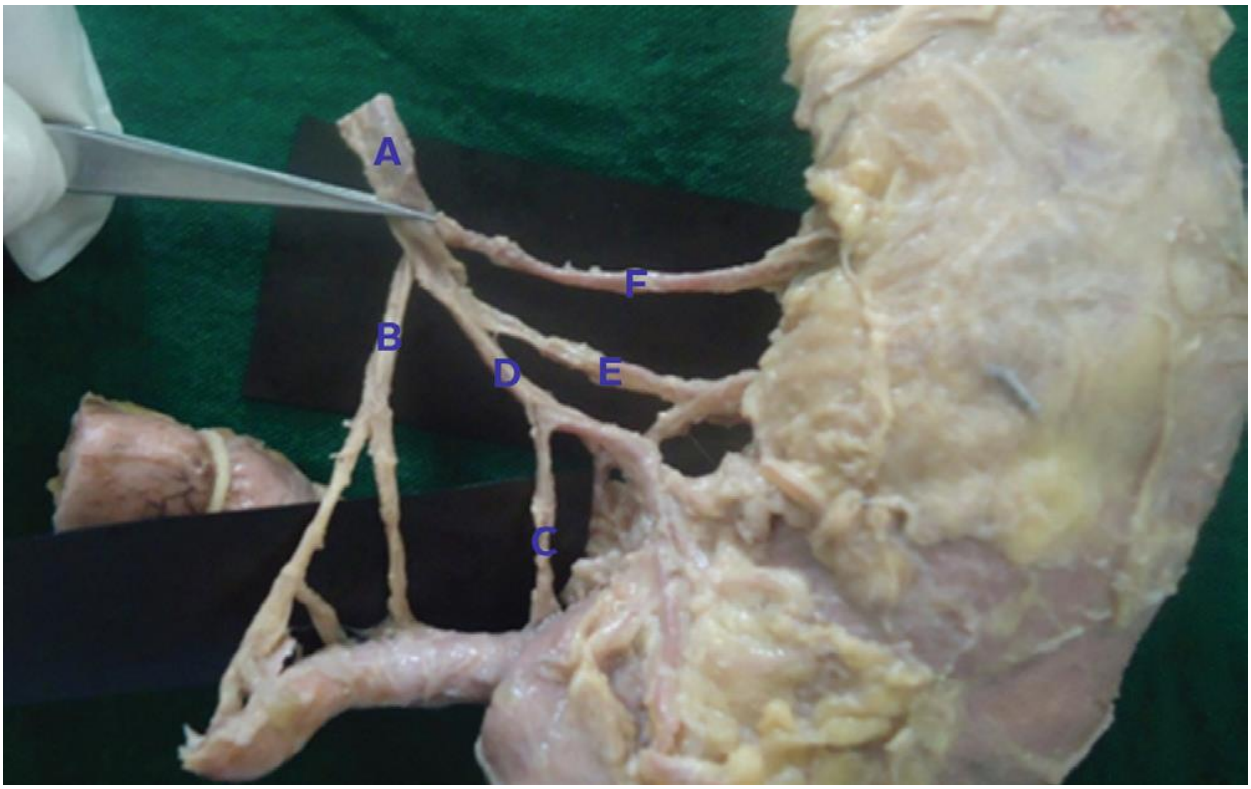
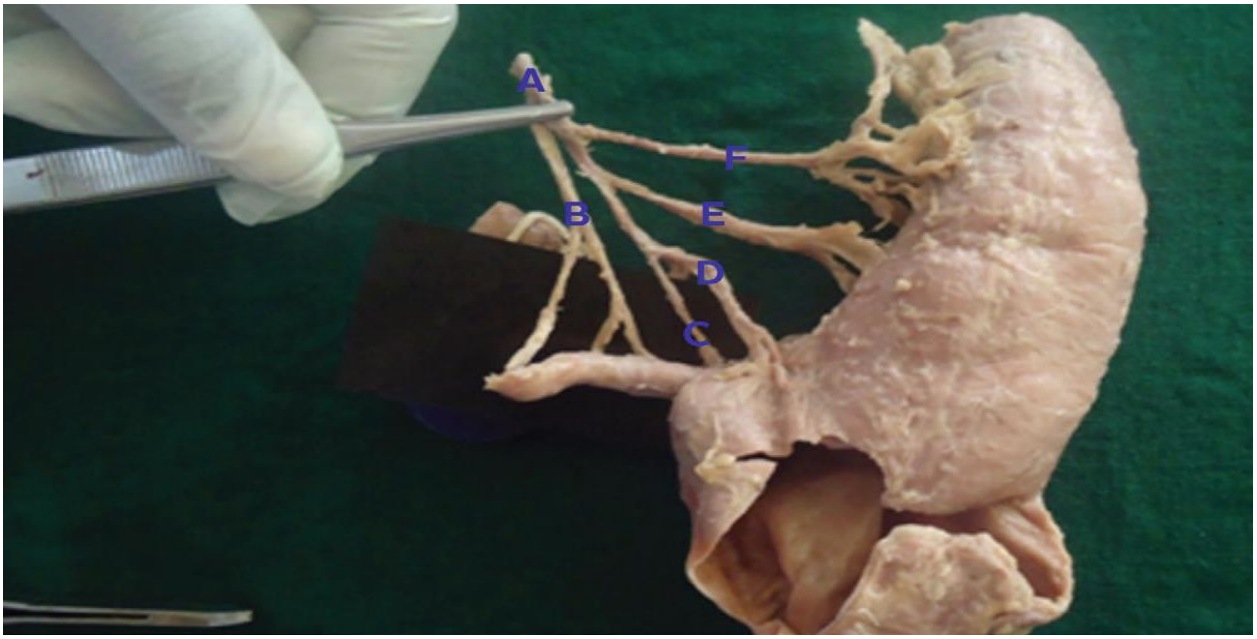


FIGURE 3: ACCESSORY APPENDICULAR ARTERY A. ILEOCOLIC ARTERY B. APPENDICULAR ATERY C: ACCESSORY APPENDICULAR ARTERY D. POSTERIOR CAECAL ARTERY E.ANTERIOR CAECAL ARTERY F.ASCENDIC BRANCH



3. DISCUSSION

Acute appendicitis, a surgical emergency, requires a detailed understanding of its presentation and diagnosis which is of crucial importance in its overall surgical management. The morbidity and mortality are related to the presenting stage of the disease and are substantially higher in cases of perforation(9). Meticulous knowledge of possible variations in blood supply of appendix is very important to surgeons for early valuable help in the management of appendicitis and prevention early perforation and gangrene of appendix(10)

According to many authors, the vermiform appendix is the only organ in the human body which has multiple definitive anatomical positions. Its position varies from individual-to-individual(11)

Blood vessels of the vermiform appendix

There is no general agreement about the arterial supplying for the human vermiform appendix. The inferior and superior mesenteric arteries are supplying the large intestine(12) The ileocolic artery is the lowest branch on the right of superior mesenteric artery; it directs right and downward at the back of the peritoneum, toward the right iliac fossa where this artery undergoes division into inferior and superior branches .

The inferior branch is anastomosed with the termination of superior mesenteric artery, while the superior is anastomosed with right colic artery. The psoas major muscle, testicular (or ovarian) vessels, and right ureter are anteriorly crossed by the ileocolic artery throughout its course . The ileocolic artery which is the end branch of superior mesenteric artery has four sets of branches

1..The ascending colic artery directs over the ascending colon to supply its basal portion.
2Posterior and anterior caecal arteries distribute to the back and front of the caecum and supplying the caecum.
3.Ileal branches that run to left and upwards above the lower ileal portion (the terminal ileum), and supplying this part of the small intestine; then it ends by anastomosing to the termination of superior mesenteric artery.

4.The appendicular artery which supplies the appendix is the terminal branch of the ileocolic artery; and descends posterior to the terminal end of the ileum and gets inside the mesoappendix at a short interval close to the appendicular base. Following given off a small recurrent branch that gets anastomosed to a branch of posterior caecal artery, it directs -at first- near to and then enters into the meso-appendicular free border.

Occasionally an accessory appendicular artery can exist but, in the majority of the population, the appendicular artery is regarded as an “end-artery” and thrombosis of it leads to appendicular necrosis(13)
24

Therefore, the main appendicular artery is that one, which runs in the crescentic fold of the mesoappendix to the appendicular tip, whereas the accessory appendicular artery provides other parts of the appendix except for the tip. Branches of the appendicular artery divide into fine ramifications on the walls of the appendix and anastomose freely while the terminal part of the main appendicular artery supplying the tip is usually an end-artery with no anastomosis with other branches .

The variations in the origin of appendicular artery were studied by many authors as they are not uncommon. In the present study 50 specimenswere dissected and the origin of the appendicular artery were found, photographed, documented and compared with the findings by authors in previous studies.

According to Pitynski et al (1992) and Aridom Bet al. (2012), the appendix was supplied by single branch from the ileocolic branch of superior mesenteric artery in human foetuses [3,4].In the present study 44 out of 50 specimens the appendix was supplied by single branch from ileocolic artery.

Williams PL, Warwick R (1980) and Susan stadring (2005) described in their text book that the appendicular artery originates from the inferior division of ileocolic branch of superior mesenteric artery [5,1]. In the present study in 42 specimens the origin was from the inferior

Division of ileocolic branch.

In their study of the appendicular artery Beaton et al (1953), Ranganathan (2002) and Shenoy (2009) found that the appendicular artery takes its origin from the posterior caecal branch of ileocolic artery [6-8]. In the present study thesame finding was found in 2 specimens.

Kelly HA, Hurdon E (1905), Shah MA, Shah M(1946), Solanke TF (1968) and Michels NA (1963) described that the appendicular artery may arise as a single branch or double / accessory branches from ileocolic branch (14). In the present study in 5 out of 50 cases double appendicular arteries were found (Fig. 1 & 2).

The appendicular artery is an end artery from its midpoint and as it very close to the wall, it gets easily thrombosed during acute inflammation. The distal appendix is easily necrosed and hence, perforation is common. There is no unanimity in the literature about the origin of the main appendicular artery. Some authors claim that it arises solely from the ileocolic, while others claim that it comes off from one of the branches of the ileocolic artery (15).

The majority of those authors who have noted the presence of accessory appendicular arteries claim that these arteries invariably arise from the anterior or posterior caecal artery and cause significant intra-op as well as post-op bleeding 11). The systematization of the vascularization of the appendix differs according to the number and the type of arteries supplying it.

The main appendicular artery is defined as one which runs in the crescentic fold of the mesoappendix to the tip of the appendix; and the accessory appendicular artery (from ileocolic artery or its branches) as one which supplies other parts of the appendix except the tip. In this study, the main artery was

invariably the branch of ileocolic artery (80%), ileal artery (13.3%)and posterior caecal artery (6.6%). We did not come across even
a single artery that originated from anterior caecal artery. The
main appendicular artery arises from inferior division of superior mesenteric artery in 46.88%, ileal branch 28.13%, ileocolic artery 18.75% and from arterial arcade in 6.25% of cases. 21.87%
of cases showed additional appendicular artery in a study by Hosmani (16)

.In this study, appendix was supplied by a single appendicular artery in 87% of the cases, but accessory appendicular artery was also found to be present in the mesoappendix, and it was seen arising from various closely related arteries.

In the incidence is totally in contrast, as there were 80% of cases showing the presence of an accessory appendicular artery, and in 20% of cases supplied only by single appendicular artery. In this present study, the incidence of double appendicular arteries supplying the appendix was about 13%. The same has been observed by Nirmaladevi as 10% (21) and Toriola as 9% (20) but not by Ashwini Balasaheb, which has been found as 40% (22).

The accessory appendicular artery was seen to originate in contrast from the main branch, predominantly from posterior caecal artery than the ileocolic artery in our study as in concordance with Ajmani et.al , though we differ in that, there were no accessory arteries arising from anterior caecal artery. Solanke et al. have cited that there were extensive arterial anastomoses between the arteries supplying the appendix. We differ and contradict this statement, as there were nil arterial anastomoses observed in the current study, confirming that each individual branch was its own end artery, confounding the risk of gangrene. The anastomotic pattern can really be studied by injecting a suitable dye and the pattern of distribution seen by radiological examination in the living, which is the further scope of this study.

4. CONCLUSION

Study of the variation in origin and distribution in vermiform appendix gives a guide to the surgeons during appendectomy. The more vasculature the more risk of gangrenous complications. The main appendicular artery arose from ileocolic, posterior caecal and ileal arteries but not at all from the anterior caecal artery. Knowledge of the presence of accessory appendicular artery is of utmost importance to prevent hemorrhage during surgery, and 13% of the specimens had an accessory artery. The most common origin of the accessory appendicular artery was from the posterior caecal artery, followed by the ileocolic artery.

This study, hence, gives more insight to the anatomical aspects of the mesoappendix and appendicular arterial pattern for surgeons.

Variations in course of artery can completely misguide the surgeon in ligating the artery
especially in laparoscopic surgeries and can lead to alarming hemorrhage. Failure of the mesoappendix to reach the tip reduces the vascularization to the tip of the organ making it more liable to become

gangrenous. Surgeons should keep in mind the possibility of accessory appendicular arteries as well as variations in the course of main and accessory appendicular artery during laparoscopic surgeries

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