STUDY OF ARTERIAL SUPPLY OF CAECUM AND APPENDIX

By

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LIST OF ABBREVIATIONS USED

SMA - Superior mesenteric artery

ICA - Ileocolic artery

SD - Superior division of ileocolic artery

ID - Inferior division of ileocolic artery

CCA - Common caecal artery

ACA - Anterior caecal artery

PCA - Posterior caecal artery

ASA - Ascending colic artery

IB - Ileal branch

MA - Main appendicular artery

AAA - Accessory appendicular artery

CA - Caeco-appendicular artery

AA - Arterial arcade

A - Anterior view

P - Posterior view

ABSTRACT

Background and objectives:

A precise knowledge of vascular anatomy of caecum and vermiform appendix is a must while doing surgical procedures like right hemicolectomy, appendicectomy and reconstructive microsurgeries using appendix. The aim is to study the arterial supply of the caecum and vermiform appendix, the findings of which may reveal more anatomical details including variations.

Materials and Methods:

25 specimens of caecum and appendix with their arteries intact were dissected, removed from cadavers and preserved, the ileocolic artery and its branches to the caecum and vermiform appendix were traced carefully, painted with red acrylic paint and observations recorded.

Results:

The ileocolic artery originated separately from superior mesenteric artery in 92% of specimens and terminated by dividing into superior and inferior division in 80% of specimens.

The common caecal artery was seen in 52% of specimens. The common caecal artery which gave rise to anterior caecal artery in 40% and posterior caecal artery in 36% of specimens was the most common source of origin of these two arteries.

The commonest source of origin of main appendicular artery was ileocolic artery in 28% of specimens; least common was from superior division of ileocolic artery in 4% of specimens. In 40% of specimens appendix received more than one appendicular artery.

Arterial arcades were present in 12 specimens (48%) mainly between superior and inferior divisions of ileocolic artery.

Interpretation and conclusion:

From this study we conclude that the anatomical details such as origin, number of arteries and pattern of branching of the caecal and appendicular arteries are not only important for ablative surgeries but also in reconstructive microsurgeries using appendix for the survival of graft.

Keywords: Caecum, Vermiform appendix, Superior mesenteric artery, Ileocolic artery, Common caecal artery, Anterior caecal artery, Posterior caecal artery, Appendicular artery.

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INTRODUCTION

Variation is the law of nature. Every human is unique anatomically to such an extent that even identical twins are not exactly alike. Some of the variations are of considerable clinical significance such as vascular ones. Vascular anomalies always pose a great challenge to the anatomists and surgeons. The surgical trauma to the blood vessels is sometimes irreparable and may lead to fatal necrosis of the part being supplied by that vessel. Holstead, an American surgeon has said "the best way to avoid injury to the sustaining blood vessel is to know how, when and where to ligate them". Therefore it is the responsibility of anatomists to study the variations of the arteries, the knowledge of which helps the surgeons to avoid intraoperative and postoperative complications like hemorrhage.[1]

Darwin and his followers postulated that the appendix was vestigial organ and useless. But in the present day it is regarded as a specialized organ rather than as a degenerate or vestigial structure, in view of its rich blood supply and histological differentiation.[2]

The caecum has got great surgical significance as it is prone to many pathological conditions like ileocaecal tuberculosis, carcinoma, volvulus, intussusception, inflammatory bowel diseases, angiodysplasia, varices, isolated caecal infarction, congenital anomalies like diverticular diseases, non descent, hypo descent, hyper descent, retroperitoneal caecum with Jackson's paracolic membrane and mobile caecum.

The vermiform appendix carries even greater significance as 'Appendicitis' is the most commonly encountered condition in surgical practice apart from other conditions like angiodysplasia, carcinoid tumour, mucocele and diverticular diseases albeit with lower incidence.[1,3]

Therefore a clear understanding of the arterial supply of the caecum and appendix is a must for the surgeons while performing procedures like appendicectomy, mesenteric lengthening in case of pouch anal anastomosis[4], therapeutic embolisation in case of haemorrhage[5] and for laparoscopic surgeries[6].

The vascularised appendix has been used on its pedicle and subsequently in free transplant with success to rebuild urethra, ureters, the uterine tubes and extra hepatic biliary tracts. The precise knowledge of arterial supply of appendix is not only important for ablation of the appendix but also for various reconstructive microsurgeries using appendix to guarantee the survival of the whole of the transplant. At least two vessels are required to ensure the whole of its vascularisation.[7]

Superior mesenteric angiogram or ileocolic angiogram helps to diagnose carcinoma of caecum in situations where the routine investigations like barium enema and colonoscopy have missed the diagnosis and are also helpful in diagnosing angiodysplasia of Caecum.[8]

There is no general agreement in the available literature about the arterial supply of caecum and vermiform appendix. Published papers and standard textbooks contain differing statements about the number of arteries supplying caecum and appendix. Studies by Koster & Weintrob (1928)[9], Bruce et al (1964)[10] and Pitynski et al (1992)[11] showed that appendix is supplied by single appendicular artery .While other studies done by Kelly & Hurdon (1905)[12], Shah & Shah (1946)[13], Solanke (1968)[14]revealed more than one artery supplying appendix. However most authors agree that whatever may be the number of appendicular arteries, they are either derived from ileocolic artery or its branches.

In view of the discrepancies in the literature about the anatomy of arterial supply of caecum and vermiform appendix the present study was undertaken to determine the origin, pattern of branching and anastomosis of caecal and appendicular arteries in the south Indian population.

OBJECTIVES OF STUDY

1) This work has been done to study the arterial supply of the caecum and vermiform appendix, to determine the origin, number of arteries and pattern of branching.

ANATOMY OF THE CAECUM

The caecum is located at the commencement of the large intestine in the right iliac fossa, occupying a triangular gap bounded by the right lateral plane, the transtubercular plane and lateral half of the inguinal ligament.

It is a large cul-de-sac continuous superiorly with the ascending colon, and on the posteromedial side receiving the terminal part of the ileum, and the vermiform appendix on the medial side. Its average dimension is about 6cms in length and 7cms in breadth. It rests posteriorly on the iliacus and psoas major, being separated from both muscles by their covering fasciae and the peritoneum and posterior to it is the retrocaecal recess, which frequently contains the appendix.

The lateral cutaneous nerve of the thigh intervenes between iliacus and caecum, anteriorly it is related to the anterior abdominal wall with intervening greater omentum if the caecum is empty, and some coils of small intestine may be interposed. Usually it is entirely enveloped by peritoneum, but sometimes peritoneal covering is incomplete; the superior part of the posterior surface being uncovered and connected to iliac fascia by areolar tissue. Commonly caecum enjoys considerable movement so that, it may be herniated through the right inguinal canal. The outer aspect of the caecum is almost covered by peritoneum and there are many fat filled projections of peritoneum on the surface of the caecum known as ‘appendices epiploicae’.

The three taenia coli are present on the surface of caecum. On its anterior surface are seen branches of anterior caecal artery and corresponding veins and on the posterior surface the posterior caecal artery and its branches with corresponding veins.

ANATOMY OF VERMIFORM APPENDIX

The vermiform appendix is a narrow worm shaped (vermian) tubular structure, which arises from the posteromedial caecal wall, 2 cm below the end of the ileum. It may occupy one of several positions. The commonest positions are retrocaecal, retrocolic and pelvic. Other positions are occasionally seen especially when there is a long meso-appendix allowing greater mobility. These include subcaecal, pre-ileal and post-ileal. The three taeniae coli on the ascending colon and caecum converge on the base of the appendix and merge into its longitudinal muscle. The anterior caecal taenia is usually distinct and can be traced to the appendix which affords a guide to its location in clinical practice. Its length varies from 2-20cms. It is connected by a short mesoappendix to the lower part of the ileal mesentery; the fold is usually triangular extending almost to the appendicular tip along the whole viscus. The lumen of the appendix is small and opens into the caecum by an orifice lying below and slightly posterior to the ileo-caecal opening. It is sometimes, guarded by a semilunar mucosal fold forming a valve. The lumen may be widely patent in early childhood; it is partially or wholly obliterated in the later decades of life. It usually contains numerous patches of lymphoid tissue and it decreases in size from early adulthood.

ARTERIAL SUPPLY OF CAECUM AND VERMIFORM APPENDIX

The arterial supply of the midgut is derived from the superior mesenteric artery, which is a ventral branch of the abdominal aorta at the level of first lumbar vertebra (at transpyloric plane). The arterial supply of the caecum, appendix, terminal part of the ileum and part of the ascending colon is derived from the ileocolic artery, the branch of the superior mesenteric artery.

The ileocolic artery divides into many large branches, which ramify and supply the muscular coat. After dividing into smaller branches in the submucous layer pass to the mucus membrane. The ileocolic artery is the lowest of the branches from the right side of the superior mesenteric artery, below the origin of the right colic artery. It passes downwards and to the right behind the peritoneum towards the right iliac fossa, where it divides into superior and inferior branches. The inferior branch divides into

a) Ascending colic branch.

b) Anterior caecal branch, supplying the anterior surface of the caecum.

c) Posterior caecal branch, supplying the posterior surface of the caecum.

d) Appendicular artery supplying the appendix.

e) Ileal branch, which runs upwards and to the left on the lower part of the ileum, supplying this part of the small intestine and ends by anastomosing with the termination of the superior mesenteric artery.[15]

The main appendicular artery is defined as one which runs in the cresentic fold of the mesoappendix to the tip of appendix giving numerous branches which supply whole length of appendix including its tip. 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.[14]

Caeco-appendicular artery is given off by the posterior caecal artery supplying the adjoining parts of the caecum and the base of appendix.[16]

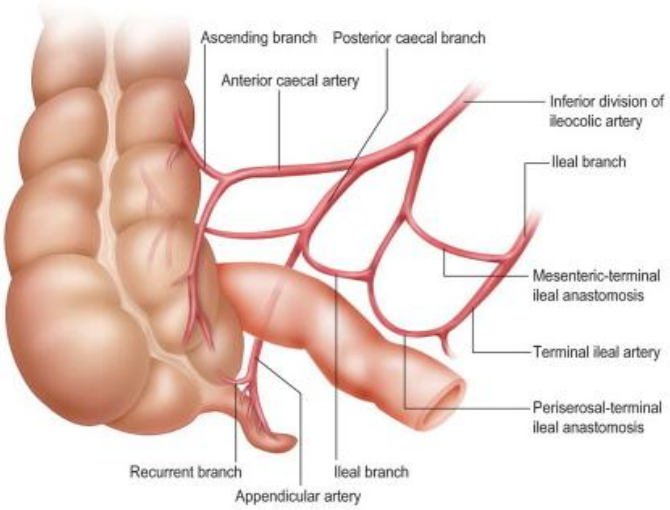


Figure showing arteries of caecum and appendix

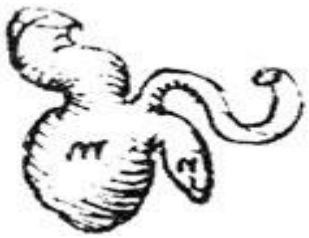
EMBRYOLOGY

The primordium of the caecum and vermiform appendix- the caecal swelling (diverticulum) appears during 6th week of intra uterine life as an elevation on the antimesenteric border of the caudal limb of the midgut loop. At about 11thweek it starts increasing in length, the basal portion grows in proportion with large intestine whereas the distal portion grows more in length, hence at the end of foetal life the caecum is conical in shape. The wide base joining the ascending colon and the apex tapering gradually into the vermiform appendix, such caecum is called as infantile caecum which in some people remains same throughout life. As caecum begins to expand the medial part of the valve does not enlarge as much as rest. The lateral part grows much more rapidly and eventually forms the apex and most of the body of caecum, while the original apex with vermiform appendix is pushed into retrocaecal position.[17]

REVIEW OF PREVIOUS WORKS

The Vermiform appendix present only in human beings, certain arthropod apes and the wombat was probably first noted as early as Egyptian civilization (3000 BC).The Egyptian inscriptions described the appendix as 'worm of the intestines'.[18]

Leonardo da Vinci (1504-1506) has clearly depicted the vermiform appendix in his anatomical drawings.



Earliest known drawing of the appendix, by Leonardo da Vinci.[19]

Berengario Dacarpi has first described the Vermiform appendix in 1521 and Vido Vidins (1530) has first named the worm like organ as Vermiform Appendix.

Andreas Vesalius in the year 1543 dedicated his groundbreaking work of human anatomy 'De humanis corporis fabrica' (on the fabric of the human body) to Charles V in which he had illustrated about Vermiform Appendix in detail.[2]

Morgagni in 1719 noted the absence of appendix for the first time.[20]

Claudius Amyand performed the first recorded successful appendicectomy in 1735.[2]

John Chiene (1868) has noted the complete obliteration of the main trunks of Coeliac and Mesenteric arteries because of aneurysm of abdominal aorta in a 65 year old female cadaver. In this case the dye was injected from femoral artery, the dye entered ileocolic artery to supply Caecum and Appendix through extra peritoneal system of vessels.[21]

Sir Fredric Treves (1885) studied the relationship between the ceacum, appendix and ileum. He states that mesoappendix is not primary mesentery but a peritoneal fold raised secondarily by the appendicular artery along its course to the appendix.[22]

Surgical interest in the appendix arose since 1886 by the recognition of it's inflammation by R H Fitz, Professor of Pathological anatomy who first used the term 'acute appendicitis' for inflammation of appendix and gave a detailed description of the condition.[2]

Kelly and Hurdon (1905) had first drawn the attention towards accessory appendicular artery and found this in 66% of appendices studied. In their study the main appendicular artery supplied the distal three quarters of the appendix while an accessory appendicular artery supplied proximal fourth.[12]

Morris and Jackson (1914) mention that ileo-colic artery descends behind the peritoneum towards the caecum, where it divides into a colic branch and an ileal branch which passes between the layers of the mesentery and anastomoses with the termination of the superior mesenteric artery. Near the site of division the ileo-colic artery gives off anterior and posterior caecal branches. Posterior caecal branch gives origin to main appendicular artery and sometimes caeco-appendicular artery. Main appendicular artery supplies whole of appendix up to the tip. Caeco-appendicular artery supplies adjoining part of caecum and root of the vermiform appendix.[16]

Koster and Weintrobe (1928) studied 100 appendices and state that the appendicular artery is single and it arises from ileocolic artery, further they state that the appendicular artery enters base of appendix and runs up to the tip of appendix in the free margin of mesoappendix. They mentioned that in few cases the appendicular artery instead of ending at the tip of the appendix, ran around the extremity and received numerous anastomoses.[9]

Bradley in 1929 stated congenital absence of the vermiform appendix was a rare anomaly. He found only two cases of congenital absence of appendix out of 8,102 cases examined in the autopsy and dissecting room .[20]

Wakeley (1933) analysed the position of Vermiform appendix in 10,000 cases and reported that the commonest position was retrocaecal (65.28%).The position of appendix posterior to the caecum is reflected in the disposition of its blood vessels. The arteries to appendix are derived from the ileocolic artery or from posterior caecal branch and he also reported the relative rarity of absence of appendix.[23]

Shah and Shah (1946) studied the arterial pattern of appendix in 60 Pakistani cadavers and stated that 42 cases (70%) had single appendicular artery and in 8 cases (30%) it was double. In 80% of cases accessory appendicular arteries either arose from anterior or posterior caecal arteries. They observed that the most common origin of single appendicular artery was the terminal branch of ileocolic artery along with caecal arteries. They also reported the most common origin of double arteries to appendix was from the anterior or posterior caecal arteries. Whenever the artery to the appendix arose from the posterior caecal artery it supplied portion of appendix nearer to the base.[13]

Hollinshead (1956) in his book "Anatomy for surgeons" illustrates that the ileocolic artery arises from the right side of the superior mesenteric artery, later dividing into five branches which arise in a variable manner as the artery nears the ileo-caecal junction. These branches are –

1) Anterior caecal artery

2) Posterior caecal artery

3) Appendicular artery

4) Ascending colic branch

5) Ileal branch

The anterior caecal artery essentially continues the course of the ileocolic artery, passing on the anterior surface of the caecum at or little above the upper border of the ileocaecal junction. Here it raises a fold of peritoneum, which is called the vascular fold of the caecum. The posterior caecal artery may arise with anterior caecal artery, but frequently arises above and passes behind the ileocaecal junction to supply the posterior surface of the caecum.[24]

Michel et al (1963) in their study found the anterior and posterior caecal arteries arising from a common trunk or independently in 36% and 64% respectively. The most common origin for both arteries and the common trunk was an arcade in between colic and ileal branches in 76%, less frequently from either of colic or ileal branches or from the ileo-colic trunk.[25]

Bruce et al (1964) stated that the artery to the appendix is single and is a branch of ileocolic artery. The appendicular artery does not anastomose with any other artery and this is the main reason for gangrene of appendix which occurs if appendicular artery gets obstructed.[10]

Solanke (1968) studied the blood supply of vermiform appendix in 100 Nigerian cadavers by injecting barium sulfate suspension into superior mesenteric artery and X-rays were taken. Following observations were made

1) In 84% of specimens ileocolic artery remained as single and in 16% of specimens it divided into medial and lateral branches.
2) The main appendicular artery was arising from ileocolic artery in 50%, ileal branch in 32%, medial colic in 13%, ascending colic branch in 3%, anterior ceacal branch in 1%, arterial loop between ascending colic and ileal branch in 1%.
3) Accessory appendicular arteries were present in 80% cases which was probably the reason for rarity of appendicitis in Nigerians.[14]

Solanke (1970) studied the morphology of appendix in Nigerians and reported the increased frequency of pelvic position, the relative rarity of appendicitis in Africans due to the dual blood supply.[26]

Anson and Mcvey (1971) described variations in the origin, branching and termination of the caecal and appendicular arteries as follows:

1) Anterior and posterior caecal arteries originate from an arcade between colic and ileal branches and appendicular artery from the ileal branch.
2) Anterior and posterior caecal arteries originate from colic branch and appendicular artery from ileal branch.
3) Anterior and posterior caecal arteries have common origin from an arcade and appendicular artery from ileocolic artery proper.
4) Anterior and posterior caecal arteries have common origin from an arcade and appendicular artery from colic branch and bifurcates high.
5) Anterior and posterior caecal arteries have common origin from ileal branch and appendicular branch from posterior caecal artery.
6) One anterior caecal and two posterior caecal arteries have common origin from an arcade and appendicular artery from ileal branch.
7) Multiple arcades are present between ileal and colic branches. Anterior and posterior caecal arteries originate from one of the arcades and appendicular artery from ileal branch.
8) Anterior and posterior caecal arteries originate from an arcade between ileal and colic branches and two appendicular arteries, one from the arcade and other from the ileal branch.[27]

Baer et al (1976) analysed the caecal vasculature in search for vascular malformations in 39 specimens of caecum taken from autopsy, state that the ileocolic artery courses towards the ileo caecal valve in small bowel mesentery, divides giving off an ascending branch and an ileal branch. The main vessel continues, giving off an appendicular artery and an artery which forms an arcade by anastomosing with the ascending branch of ileocolic artery. Distal to this the vessel divides into four to six anterior and posterior vasarectae which supply the caecum.[28]

Ures et al (1979) has studied the angiographic anatomy of the caecal artery in 80 cadavers and demonstrated the following:

1) The common caecal trunk seen in 76.2% of the cases had its origin from the right colic artery in 15% and from the ileal artery in 61.2% observations.
2) The anterior and posterior caecal arteries had a separate origin in 23.7% cases. In 8.7% cases the anterior caecal artery had its origin from the right colic artery and, the posterior caecal artery originated directly from the ileal artery. In 13.8% both caecal arteries originated directly from the ileal artery and, in 1.2% cases anterior caecal artery originated from the right colic artery and the posterior caecal artery from the ileocolic artery.[29]

Katezarski et al (1979) studied the morphology and arterial pattern of vermiform appendix in 103 cadavers in Zambians and demonstrated more than one appendicular artery in 39.8% of cadavers.[30]

Gerlock (1981) has reported the infarction of caecum after therapeutic embolization of ileocolic artery for the treatment of angiodysplasia of colon because the caecum is supplied by straight arteries which are end arteries. Thus the ileocolic artery may not be a good candidate for therapeutic embolization.[5]

Vandamme and Bonte (1982) studied 87 ileocolic preparations by means of post mortem arteriography combined with dissection and corrosion method, and observed that ileocolic artery terminated by dividing into caecal arteries after giving colic and ileal branches.[31]

Ajmani and Ajmani (1983) studied 100 Indian cadavers (Uttar Pradesh) and demonstrated more than one appendicular artery in 39% of cadavers.[32]

Basmajian (1983) in "Grant's Methods of Anatomy" states that the ileocolic artery descends subperitoneally towards ileocaecal junction crossing inferior vena cava and right ureter and bifurcates into ascending and descending branches. Ascending branch supplies ascending colon, descending branch divides into anterior caecal, posterior caecal, appendicular arteries and ileal branch. The appendicular artery descends behind the end of ileum and runs in the free edge of mesoappendix. Commonly appendix is supplied by two arteries.[33]

Lumley et al (1983) states that the superior mesenteric artery in the mesentery supplies small intestine and ends in the right iliac fossa by dividing into ileocolic and right colic arteries. Ileocolic artery descends to right and divides into ascending and descending branches. Descending branch divides into anterior and posterior caecal arteries. Posterior caecal artery gives rise to appendicular artery.[34]

Bergman et al (1988) in "Compendium of human anatomic variation" mentioned 6 major variations of appendicular and caecal arteries based on 200 specimens as below.

1) In 35% of specimens caecum is supplied by anterior and posterior caecal arteries, which are the terminal branches of the ileocolic artery by a common trunk. The appendix is supplied by appendicular artery, which takes its origin from ileal branch.
2) In 28.5% of cases caecum is supplied by anterior and posterior caecal arteries, which arise directly from the ileocolic artery without a common trunk. There is anastomosis

between right colic, caecal and ileal branches. The appendix is supplied by appendicular artery, which is a direct branch from the ileocolic artery.

3) In 13.5% cases the caecum is supplied by anterior and posterior caecal arteries, which arise by a common trunk from ileocolic artery. The appendicular artery arises, directly from the ileocolic artery.
4) In 6.5% cases the ileocolic artery ends by dividing into 3 posterior caecal arteries and 1 anterior ceacal artery. The appendix is supplied by appendicular artery arising directly from the ileocolic artery.
5) In 5% of cases the ileocolic artery divides into common caecal and right colic arteries. The common caecal artery divides into anterior and posterior caecal arteries supplying caecum. The anterior caecal artery gives off ileal branch. The appendicular artery arises from the posterior caecal artery.
6) In 4% of cases the caecum is supplied by the anterior and posterior caecal arteries, which arise from an arcade formed between right colic and ileal branches. The appendix is supplied by the appendicular artery, which arises from the anterior caecal artery.[35]

Kornblith et al (1992) in their study on superior mesenteric artery in 400 cadavers found that superior mesenteric artery courses to the right lower quadrant of abdomen, reaching the caecum, it anastomoses with ileocolic artery thus forming superior mesenteric loop. The ileocolic artery is the only constant branch of the superior mesenteric artery but has many variants in its distribution. It is an important angiographic landmark.

In 76% of 200 dissections there was ileocolic loop formed by ileal and colic branches of ileocolic artery .The anterior and posterior ceacal arteries most commonly arise separately from ileocolic loop .The anterior caecal artery arises from ileal side of

loop while posterior caecal artery originates from colic side. The appendicular artery in 62% of specimens arises from ileal side of loop. Another noteworthy point is that there is a small recurrent ileal artery which unites either with the ileocolic loop or a caecal branch or ileal branch which was seen in 39% of specimens.[36]

Pitynski et al (1992) studied the variability of the arterial pattern of vermiform appendix in 50 human dead fetuses aged between 12 and 20 weeks of gestation by the injection method and found that single appendicular artery was the commonest mode of supply and most of the time arising from the ileocolic artery.[11]

Pitynski et al (1993) studied Ten human vermiform appendices obtained from fetal corpses (160.0-240.0 mm of CRL) using injection-micro corrosion method. Blood vascular bed reproduced with this method was observed with scanning electron microscope (SEM). The appendix received some small afferent arterial branches of the appendicular artery which was commonly arising from ileocolic artery. These small arterial branches pierced the muscular layer and reached the sub mucosal plexus. Small arterioles arising from this plexus climbed the mucosa and formed honeycomb-like capillary meshes at the luminal surface level. These capillaries were drained by the collecting veins, which descended through the mucosa and joined the submucosal plexus. The large efferent veins arising from the submucosal plexus passed through the muscular layer and continued with the appendicular vein. In the mucosal and submucosal layers, several spherical basket-like casts of the germinal center (lymphoid follicle) were seen. In the parafollicular region (primary follicle), casts of post capillary venules with prominent surface undulations were relatively frequently observed.[37]

Ranganathan TS (1996) in “A Text Book of Human Anatomy” describes that caecum is supplied by anterior and posterior caecal branches of ileocolic artery; they descend on the respective surface of caecum to supply. The appendicular artery is a

branch of ileocolic artery, reaches the appendix through the mesoappendix. There may be an accessory appendicular artery arising from posterior caecal artery, it is called as – artery of Sheshachalam.[38]

Yada et al (1997) states that analysis of vascular anatomy and lymph node metastases warrant radical segmental bowel resection for colon cancer .They has studied the colonic arterial branching variations in 273 patients who underwent superior mesenteric angiography and found that ileocolic artery arose from superior mesenteric artery alone. They concluded that the ileocolic artery always arose from superior mesenteric artery and lymph node metastases of caecal carcinoma were limited to nodes along the ileocolic artery, caecal cancer could be cured by ileocaecal resection.[39]

Simon et al (2000) have mentioned blood supply of appendix as follows. The appendicular arteries may originate from the colic branch of the ileocolic artery, the ileocolic arcade or the anterior or posterior caecal arteries, which may then communicate with ileal branch of the superior mesenteric artery. The caecum is supplied by the anterior and posterior caecal arteries, which are terminal branches of the ileocolic artery. These end arteries may arise from either the ileal or colic branch of the ileocolic artery or from an inconstant arcade that may form between vessels.

Schumpelick et al (2000) mentions that caecum derives its blood supply from the anterior caecal artery, posterior caecal artery and ascending ramus of the ileocolic artery; the appendix is supplied by appendicular artery which originates from:

a) Iliac ramus of the ileocolic artery in 35% cases
b) Ileocolic artery in 28%
c) Anterior caecal artery in 20%
d) Posterior caecal artery in 12%
e) Ileocaecal artery in 3%
f) Ascending colic ramus of ileocolic artery in 2% of cases.[3]

Larsen(2002) in ‘Anatomy –development , function & clinical correlations’ states that the ileocolic artery is the most inferior branch of superior mesenteric artery which gives rise to ileal branches, an appendicular branch, anterior caecal artery, posterior caecal artery, ascending colic branch. At times the ileocolic artery, right colic artery & middle colic branch may share common origin from superior mesenteric artery and ileocolic artery, right colic artery may share a common trunk**.**[41]

Gopalipour (2003) studied the position of appendix in 117 cadavers in south Iran. The following observations were made -pelvic position of appendix (33.3%) as most common, appendicular artery a branch of ileocolic artery is present in free border of mesoappendix, in 65.8% of cadavers the mesoappendix failed to reach the tip and in 34.2% the mesoappendix extended up to the tip.[42]

Sinnatamby (2006) in “Last’s anatomy” states that ileocolic artery arises from the right side of Superior mesenteric artery low down in the base of the mesentery. It descends to right iliac fossa & divides into superior &inferior branches .The superior branch runs up along the left side of ascending colon to anastomose with right colic artery. The inferior branch runs to ileocolic junction & gives off anterior and posterior caecal arteries, an appendicular artery & an ileal branch which ascends to the left of ileum to anastomose with terminal branch of Superior mesenteric artery. The appendicular artery runs behind the terminal ileum to enter the mesoappendix, as it does so it gives off a recurrent branch which anastomoses with a branch of posterior caecal artery.[43]

Ouattara (2007) has studied the terminal arterial vascularisation of the appendix in 25 specimens from West Africa by intra arterial injection of a mixture composed of minium and then dissected .The observations were as follows.

Type 1: vascularisation of the whole length of the appendix by only the main appendicular artery in 24% of cases.

Type 2: vascularisation of the appendix by the main appendicular artery associated with one or several accessory appendicular arteries in 36% of cases.

Type 3: vascularisation of the appendix by the main appendicular artery associated the caeco-appendicular artery in 20% of cases.

Type 4: vascularisation of the appendix by the main appendicular artery associated with the caeco-appendicular artery and one or several accessory appendicular arteries in 12% of cases.

Type 5: vascularisation of the appendix, guaranteed by a network of main vessels (vascular branches) in 8% of cases.[7]

Susan Standring (2008) in 'Gray's Anatomy' states that the ileocolic artery approaches the superior border of the ileocolic junction and divides into-

1) Superior division which supplies ascending colon

2) Inferior division which further divides into anterior and posterior caecal arteries, appendicular artery and ileal artery.

Appendicular artery descends behind the terminal ileum to enter the mesoappendix and gives off a recurrent branch, which anastomoses with a branch of the posterior caecal artery; the anastomosis is sometimes extensive. The main appendicular artery approaches the tip of the organ at first near to, and then in the edge of the mesoappendix. The terminal part of the artery lies on the wall of the appendix. Accessory arteries are common, and many individuals possess two or more arteries of supply.[15]

Snell (2008) in "Clinical Anatomy by regions" states that the Ileocolic artery, a branch of superior mesenteric artery passes downwards and to right, it gives rise to a superior branch that anastomoses with right colic artery and an inferior branch that anastomoses with end of the superior mesenteric artery. The inferior branch gives rise to

anterior, posterior caecal arteries and an ileal branch, the appendicular artery is a branch of posterior caecal artery.[44]

Romanes (2008) in 'Cunningham's manual' illustrates that the ileocolic artery may arise with right colic or separately lower down from superior mesenteric artery. It passes downwards, to the right and ends by dividing into ascending and descending branches. Descending branch supplies part of ascending colon, the caecum, appendix and terminal ileum. The anterior caecal branch crosses the ileocaecal junction in the fold of peritoneum called the vascular fold of caecum, the posterior caecal branch crosses posterior to the ileocaecal junction. The appendicular artery passes behind the terminal part of ileum into the mesoappendix.[45]

Hennawy et al (2009) reported a case of isolated ileocolic artery occlusion in a 57 year old hypertensive male because of complete thrombosis which was diagnosed by CT-angiogram of abdomen, caecum was found gangrenous on exploratory laparotomy. The caecum is at a risk of ischaemia as it is supplied by end arteries and they proposed that the caecum like the splenic flexure is a "watershed area", with poor blood supply relative to that of the adjacent intestine because of poor collateral vessel flow.[46]

Boleken et al (2010) have noted appendix duplication with persistent cloaca and type 2 pouch colon in a 7 day old girl on exploratory laparotomy admitted with provisional diagnosis of imperforate anus.There was normal caecum with two appendices located at opposing directions, each of them had its own appendicular artery, both of which were arising from ileocolic artery.[47]

Kulkarni & Kulkarni (2011) have noted the variations in the arteries of appendix in 3 cases.

In case 1: The main appendicular artery branch of posterior caecal artery supplied the tip of appendix by running through mesoappendix ,accessory appendicular artery branch of

anterior caecal artery supplied the tip of appendix by passing circumferentially around anterior wall of caecum from left to right and then behind it.

In case 2: The main appendicular artery which was branch of ileocolic artery entered the mesoappendix which was passing in front of ileum instead of behind.

In case 3: The appendicular artery first branch of ileocolic artery entered ileocolic fold of peritoneum gave small branch to caecum and continued as appendicular artery in mesoappendix which was again anterior to ileum.[48]

Geethanjali et al (2011) have done a study on vermiform appendix in 52 cadavers and noted the pelvic position of the appendix (36.54%) as most common position, mesoappendix reached the tip in 69.23% of cases and in 30.77% of cases it failed to reach the tip. Failure of mesoappendix to reach the tip reduces the vascularisation to the tip of the appendix making it more liable to become gangrenous and hence early perforation occurs during inflammation.[49]

Bergman et al in anatomy atlases.org (accessed on May 2011) mentioned that the ileocolic artery arose independently from superior mesenteric artery in 63% of individuals, in the remainder it arose as a common trunk with right colic artery, it divided into anterior caecal, posterior caecal and ileal branches. Appendicular artery had a variable origin; it was either from ileocolic artery or its branches.[50]

MATERIALS AND METHODS

SOURCE OF DATA:

The study of arterial supply of caecum and appendix was conducted on 25 specimens of caecum and appendix with their arteries intact. The specimens were obtained from cadavers of Department of Anatomy, _____.

METHOD OF DATA COLLECTION:

Sample size: 25 specimens of caecum and appendix with intact arteries.

With proportion of variations of appendicular artery 80%[14], 20% allowable error and 95% confidence limit the calculated sample size is 25.

$n= (1.96)^2 \, p \, q/L^2$

p= Proportion of variations of appendicular artery = 80%

q= 100-p

L= allowable error = 20%

METHODOLOGY:

The specimens of caecum, appendix, part of ascending colon, terminal part of ileum and part of superior mesenteric artery with ileocolic artery were separated from the surrounding structures after noting relation of ileocolic artery and its branches. Then two ligatures were applied, one on the ascending colon 20cms from the ileocolic junction and another one on the terminal ileum, 5cms from the ileocaecal junction. The appendix and caecum were removed en mass along with arteries. The collected specimens were preserved in 5% formalin.

After preservation the specimens were dissected, cleaned and numbered. The ileocolic artery and its branches- the anterior caecal, posterior caecal and appendicular arteries were traced. Later arteries were painted with red acrylic paint in order to make

them bold and photographs were taken. The observations were recorded with regard to number, origin and branching pattern of caecal, appendicular arteries.

MATERIALS USED:

Scalpel, blunt and pointed forceps, thread, red acrylic paint and paint brush.

INCLUSION CRITERION:

Specimens of caecum and appendix with intact arteries were included.

EXCLUSION CRITERION:

Specimens of caecum and appendix with some pathology were excluded.

STATISTICAL ANALYSIS:

Data was analysed using the following statistical methods:

1) Mean +/_ standard deviation

2) Percentages

3) Pie - diagrammatic representation

Study was carried out for a period of one and half years from Nov 2010 to April 2012.

OBSERVATIONS

Specimen 1

Ileocolic artery was found to arise from right side of superior mesenteric artery, divided into superior & inferior divisions. Inferior division divided into common caecal artery and Ileal branch.

Common caecal artery divided into appendicular, anterior caecal, two posterior caecal and ascending colic arteries. Anterior caecal artery divided into two branches to supply anterior wall of caecum, posterior caecal arteries were supplying posterior wall of caecum.

Appendicular artery was running in the mesoappendix giving numerous branches to appendix. Mesoappendix extended up to the tip of appendix.

Specimen 2

Ileocolic artery was arising from right side of superior mesenteric artery, divided into superior and inferior divisions. Inferior division divided into appendicular and common caecal arteries.

Common caecal artery divided into anterior caecal, three posterior caecal and ascending colic arteries. Anterior caecal artery supplied anterior wall of caecum. Posterior caecal arteries were supplying posterior wall of caecum.

Appendicular artery divided into two branches. One branch supplied tip and distal half, the other branch supplied base and proximal half of appendix. Mesoappendix extended up to the tip of appendix.

Specimen 3

Ileocolic artery was a terminal branch of superior mesenteric artery, divided into superior and inferior divisions.

Inferior division divided into ascending colic, accessory appendicular, two anterior caecal, three posterior caecal arteries and ileal branch. Anterior and posterior caecal arteries were supplying anterior and posterior wall of caecum respectively.

There were three appendicular arteries, the main appendicular artery was arising from ileocolic artery and supplied the tip and distal half of appendix, accessory appendicular artery arising from inferior division supplied middle part of appendix, caeco-appendicular artery arising from posterior caecal artery supplied base of appendix. Mesoappendix extended up to three fourth of appendix.

Specimen 4

Ileocolic artery was arising from right side of superior mesenteric artery, divided into superior and inferior divisions.

Arterial arcade was formed by superior and inferior divisions giving rise to ascending colic, anterior caecal, four posterior caecal arteries and ileal branch. Anterior and posterior caecal arteries were supplying anterior and posterior wall of caecum respectively.

Main appendicular artery was arising from lower posterior caecal artery, running in mesoappendix giving multiple branches to appendix. Mesoappendix extended up to the tip of appendix.

Specimen 5

Ileocolic artery was found to arise from right side of superior mesenteric artery, divided into superior and inferior divisions to form an arterial arcade.

Ascending colic, anterior caecal, two posterior caecal, main appendicular arteries and ileal branch were arising from arterial arcade. Anterior caecal artery was supplying anterior wall of caecum, two posterior caecal arteries were forming an arterial arcade giving rise to four posterior caecal arteries to supply posterior wall of caecum.

Main appendicular artery was running in the mesoappendix giving numerous branches to appendix. Mesoappendix extended up to the tip of appendix.

Specimen 6

Ileocolic artery was arising as terminal branch from superior mesenteric artery, divided into superior and inferior divisions. Inferior division divided into main appendicular and common caecal arteries.

Common caecal artery divided into anterior caecal and two posterior caecal arteries to supply anterior and posterior wall of caecum respectively, two posterior caecal arteries formed an arterial arcade with main appendicular artery.

Main appendicular artery was running in mesoappendix giving rise to numerous branches. Mesoappendix extended up to the tip of appendix.

Specimen 7

Ileocolic artery was found to arise from right side of superior mesenteric artery dividing into superior and inferior divisions. These divisions were forming an arterial arcade giving rise to ascending colic artery, appendicular, common caecal arteries and ileal branch.

Common caecal artery divided into anterior caecal artery which supplied anterior wall of caecum and three posterior caecal arteries supplying posterior wall of caecum.

Main appendicular artery was running in mesoappendix giving rise to numerous branches. Mesoappendix extended up to the tip of appendix.

Specimen 8

Ileocolic artery was found to arise from right side of superior mesenteric artery, divided into main appendicular, common caecal arteries, and ileal branch.

Common caecal artery divided into anterior and two posterior caecal arteries supplying anterior and posterior wall of caecum respectively.

Main appendicular artery was running in mesoappendix giving rise to numerous branches to appendix. Mesoappendix was extending up to three fourth of appendix

Specimen 9

Ileocolic artery was arising as terminal branch from superior mesenteric artery and divided into superior and inferior divisions. Superior division divided into main appendicular, ascending colic and common caecal arteries.

The common caecal artery was forming an arterial arcade with ascending colic artery giving rise to two anterior caecal arteries and three posterior caecal arteries which supplied anterior and posterior wall of caecum respectively.

Main appendicular artery was running in mesoappendix giving rise to numerous branches to appendix. Mesoappendix extended up to the tip of appendix.

Specimen 10

Ileocolic artery was arising from right side of superior mesenteric artery, divided into superior and inferior divisions. Inferior division divided into anterior caecal, posterior caecal and common caecal arteries.

The common caecal artery divided into anterior caecal, two posterior caecal and main appendicular arteries.

Main appendicular artery was running in mesoappendix giving rise to numerous branches to appendix. Mesoappendix extended up to the tip of appendix.

Specimen 11

Ileocolic artery was arising from right side of superior mesenteric artery, divided into ascending colic artery, common caecal artery and ileal branch.

The common caecal artery divided into two branches and formed an arterial arcade to give rise to anterior caecal and three posterior caecal arteries which supplied anterior and posterior wall of caecum respectively

Main appendicular artery was arising from lower posterior caecal artery, giving numerous branches to appendix. Mesoappendix extended up to three fourth of appendix.

Specimen 12

Ileocolic artery was arising from right side of superior mesenteric artery and divided into superior and inferior divisions. These divisions were forming an arterial arcade giving rise to ascending colic, posterior caecal, common caecal artery and an ileal branch.

The common caecal artery divided into two branches which formed an arterial arcade to give rise to two anterior caecal and two posterior caecal arteries which supplied anterior and posterior wall of caecum respectively.

Main appendicular artery was arising from common caecal artery, giving numerous branches to appendix. Mesoappendix extended up to three fourth of appendix.

Specimen 13

Ileocolic artery was arising from right side of superior mesenteric artery, divided into superior and inferior divisions which were forming an arterial arcade, to give rise to ascending colic artery, main appendicular, two anterior caecal, four posterior caecal arteries and ileal branch.

Lower anterior caecal artery was running on anterior surface of caecum giving numerous branches to it, turned backwards along ileocaecal junction to form one caeco-appendicular artery to supply base of appendix. Posterior wall of caecum was supplied by four posterior caecal arteries, the lower posterior caecal artery gave rise to another caeco-appendicular artery to supply base of appendix.

Main appendicular artery was giving numerous branches to appendix. Mesoappendix extended up to the tip of appendix.

Specimen 14

Ileocolic artery was arising from right side of superior mesenteric artery, divided into ascending colic, common caecal artery and ileal branch.

The common caecal artery divided into two branches and formed an arterial arcade to give rise to anterior caecal and four posterior caecal arteries which supplied anterior and posterior wall of caecum respectively

Main appendicular artery was directly arising from ileocolic artery, third posterior caecal artery gave rise to caeco-appendicular artery to supply base of appendix. Mesoappendix extended up to three fourth of appendix.

Specimen 15

Ileocolic artery was arising from right side of superior mesenteric artery, divided into superior and inferior divisions.

Superior division divided into ascending colic, anterior caecal and posterior caecal arteries.

Main appendicular artery was arising from posterior caecal artery, giving numerous branches to appendix. Mesoappendix extended up to the tip of appendix.

Specimen 16

Ileocolic artery was arising as a common trunk with right colic artery from superior mesenteric artery, divided into superior and inferior divisions.

Superior division divided into ascending colic, anterior caecal and posterior caecal arteries.

Main appendicular artery was arising directly from ileocolic artery and supplied distal three fourth of appendix, accessory appendicular artery was arising from ileal branch , supplied proximal one fourth of appendix. Mesoappendix extended up to three fourth of appendix.

Specimen 17

Ileocolic artery was arising from right side of superior mesenteric artery, divided into ascending colic, anterior caecal, posterior caecal artery and an ileal branch.

Anterior caecal and posterior caecal arteries supplied anterior and posterior wall of caecum respectively.

Main appendicular artery was arising directly from ileocolic artery and supplied distal three fourth of appendix, accessory appendicular artery was arising from ileal branch, supplied proximal one fourth of appendix. Mesoappendix extended up to the tip of appendix.

Specimen 18

Ileocolic artery was arising from right side of superior mesenteric artery, divided into superior and inferior divisions.

Superior division divided into anterior caecal and posterior caecal arteries which supplied anterior and posterior wall of caecum respectively.

Main appendicular artery was arising directly from ileocolic artery and supplied distal three fourth of appendix. Mesoappendix extended up to three fourth of appendix.

Specimen 19

Ileocolic artery was arising as a terminal branch of superior mesenteric artery, divided into superior and inferior divisions.

Superior division supplied ascending colon as ascending colic artery, inferior division divided into common caecal artery and main appendicular artery. Ascending colic artery formed an arterial arcade with common caecal artery to give rise to two anterior caecal and upper three posterior caecal arteries which supplied anterior and posterior wall of caecum respectively. Ascending colic artery formed an arterial arcade

with main appendicular artery to give rise to accessory appendicular and lower posterior caecal artery.

Main appendicular artery arising from inferior division supplied distal half of appendix, accessory appendicular artery arising from an arterial arcade between ascending colic and main appendicular artery supplied middle one fourth of appendix and caeco-appendicular artery arising from lower posterior caecal artery supplied base of appendix. Mesoappendix extended up to the tip appendix.

Specimen 20

Ileocolic artery was arising from right side of superior mesenteric artery, divided into superior and inferior divisions.

Ascending colic artery, main appendicular, two anterior caecal, two posterior caecal arteries and ileal branch were arising from the arterial arcade formed by two divisions of ileocolic artery.

Main appendicular artery supplied distal three fourth of appendix, lower posterior caecal artery gave rise to accessory appendicular artery to supply proximal one fourth of appendix. Mesoappendix extended up to the tip of appendix.

Specimen 21

Ileocolic artery was arising as a terminal branch of superior mesenteric artery, divided into superior and inferior divisions to form an arterial arcade.

Ascending colic artery, main appendicular, accessory appendicular, anterior caecal, four posterior caecal arteries and ileal branch were arising from the arterial arcade.

Main appendicular artery supplied distal three fourth of appendix, accessory appendicular artery supplied proximal one fourth of appendix. Mesoappendix extended up to the tip of appendix.

Specimen 22

Ileocolic artery was arising as a terminal branch of superior mesenteric artery, divided into superior and inferior divisions.

Superior division continued as anterior caecal artery, inferior division divided into main appendicular, posterior caecal arteries and ileal branch. Anterior and posterior caecal arteries supplied anterior and posterior wall of caecum respectively.

Main appendicular artery was running in mesoappendix giving numerous branches to appendix. Mesoappendix extended up to the tip of appendix.

Specimen 23

Ileocolic artery was arising as a terminal branch of superior mesenteric artery, divided into ascending colic, common caecal and main appendicular arteries.

The common caecal artery divided into accessory appendicular, anterior caecal, posterior caecal arteries and an ileal branch. Anterior and posterior caecal arteries supplied anterior and posterior wall of caecum respectively.

Main appendicular artery supplied distal three fourth of appendix, accessory appendicular artery supplied base of appendix. Mesoappendix extended up to the tip of appendix.

Specimen 24

Ileocolic artery was arising from right side of superior mesenteric artery, divided into superior and inferior divisions. Inferior division divided into main appendicular and common caecal arteries.

The common caecal artery divided into ascending colic, anterior caecal, two posterior caecal arteries and an ileal branch.

Main appendicular artery supplied distal three fourth of appendix, caeco-appendicular artery originating from posterior caecal artery supplied proximal one fourth of appendix. Mesoappendix extended up to the tip of appendix.

Specimen 25

Ileocolic artery was arising as a common trunk with right colic artery from superior mesenteric artery, divided into superior and inferior divisions.

Superior division divided into ascending colic, anterior caecal and three posterior caecal arteries.

Main appendicular artery arose from lower posterior caecal artery running in mesoappendix giving numerous branches to appendix. Mesoappendix extended up to three fourth of appendix.

KEY TO PHOTOGRAPHS

1 – Superior mesenteric artery

2 – Ileocolic artery

3 – Superior division of Ileocolic artery

4 – Inferior division of Ileocolic artery

5 – Common caecal artery

6 – Anterior caecal artery

7 – Posterior caecal artery

8 – Main Appendicular artery

8a –Accessory Appendicular artery

8ca – Caeco-appendicular artery

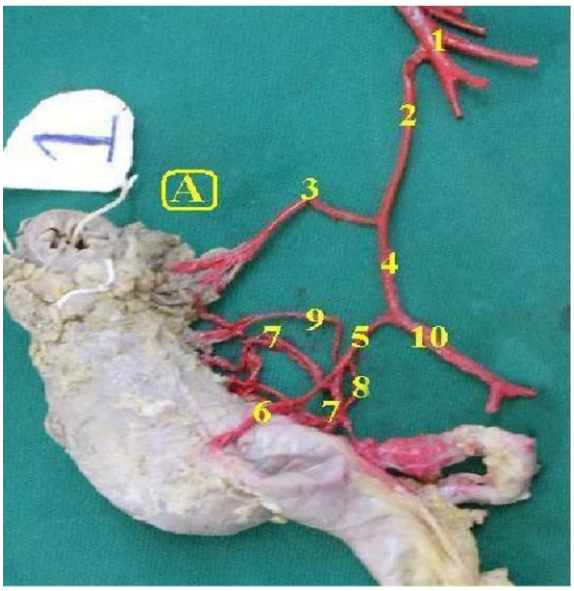
9 – Ascending colic artery

10– Ileal branch

11- Right colic artery

A – Anterior view

P – Posterior view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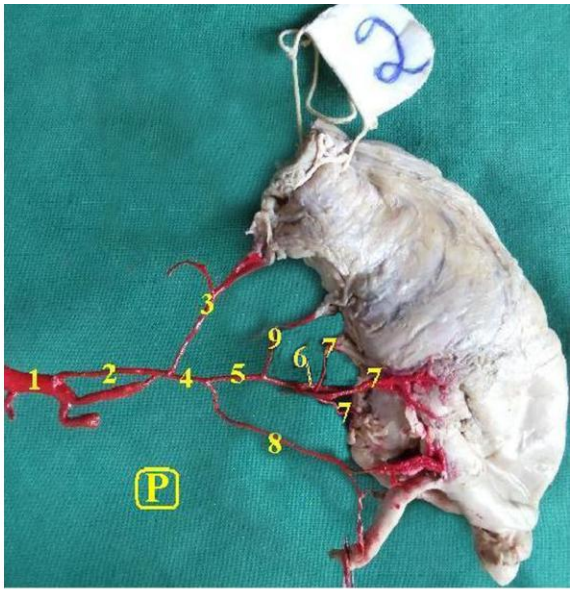
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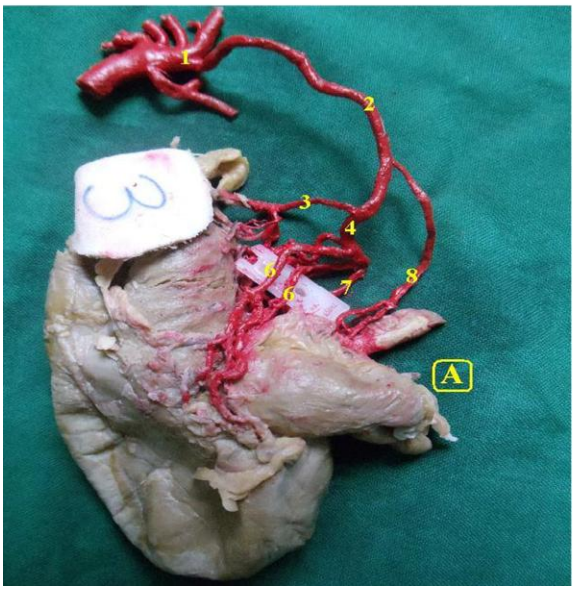
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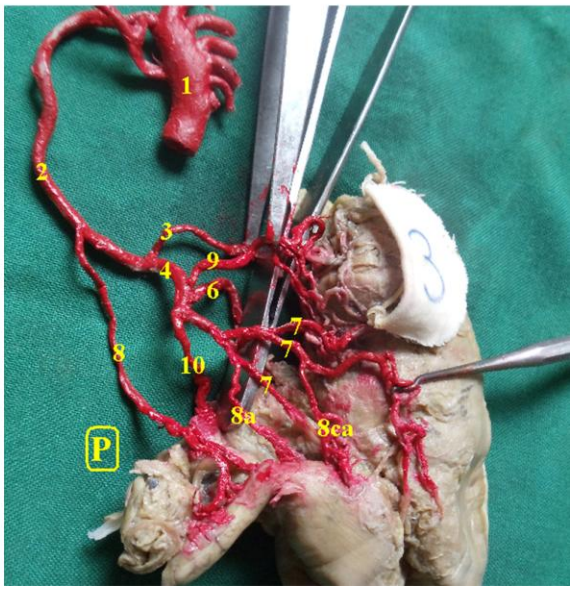
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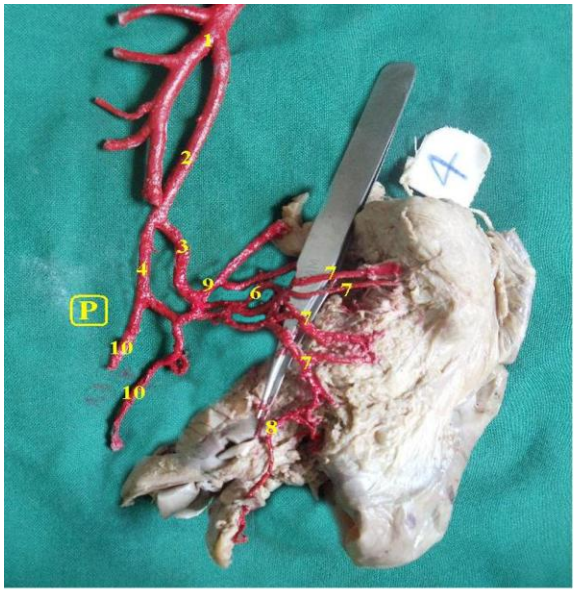
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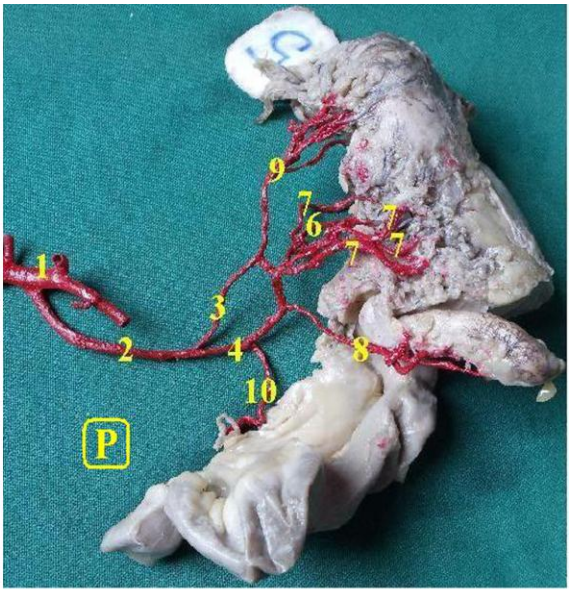
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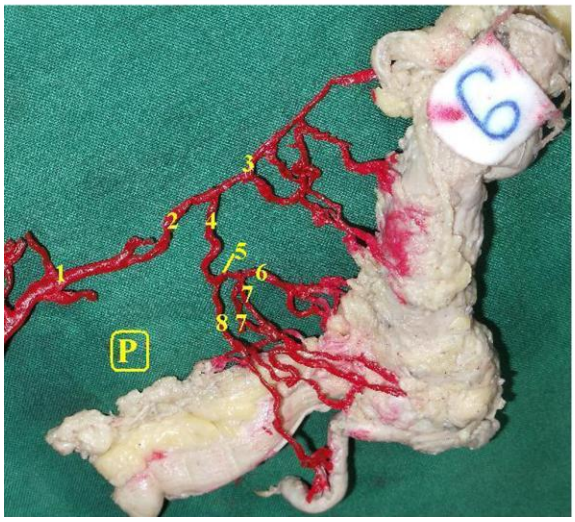
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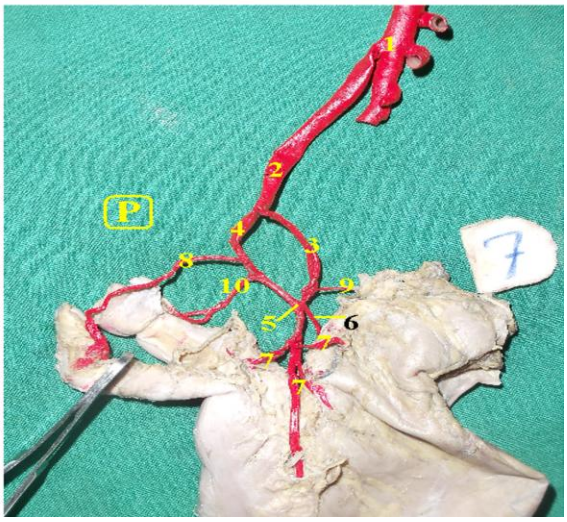
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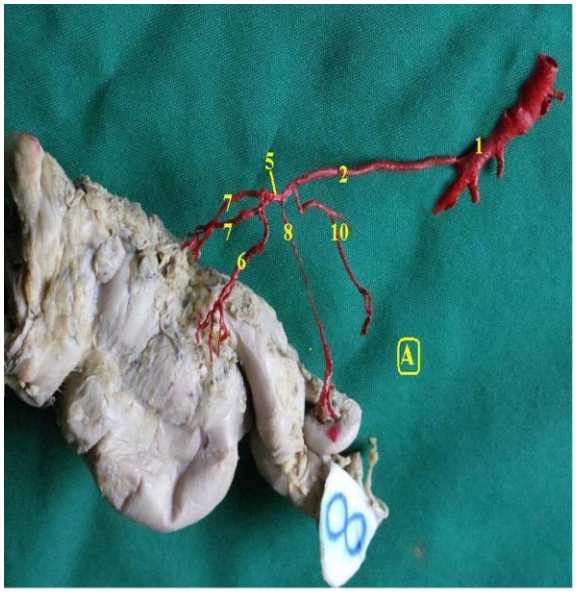
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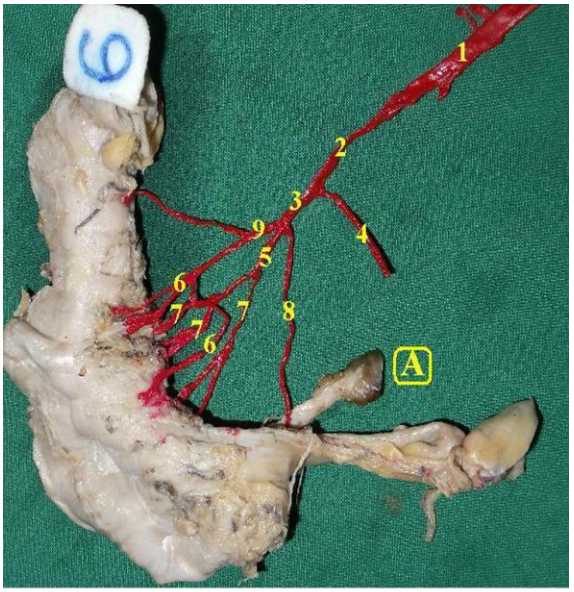
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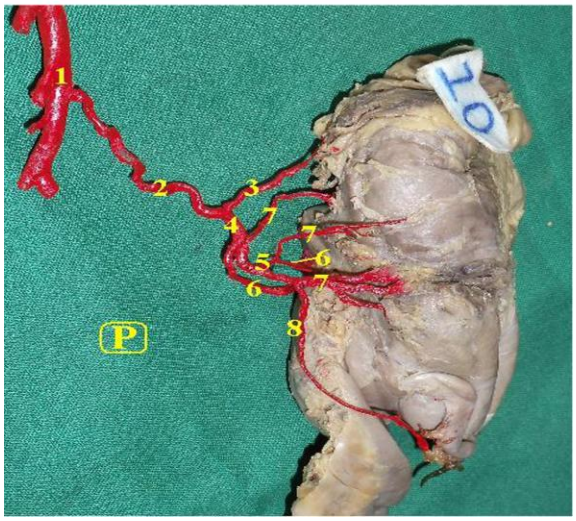
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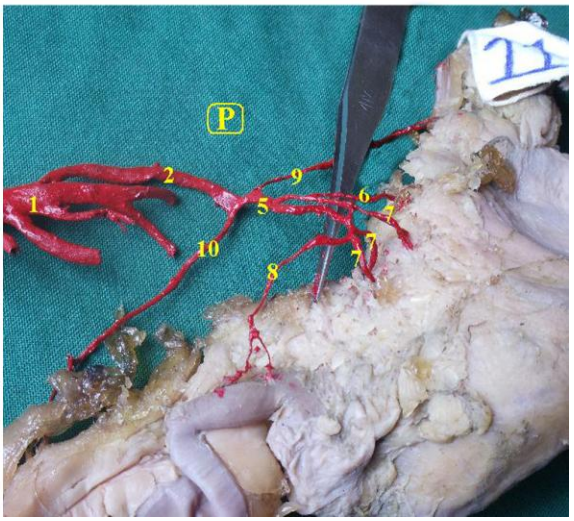
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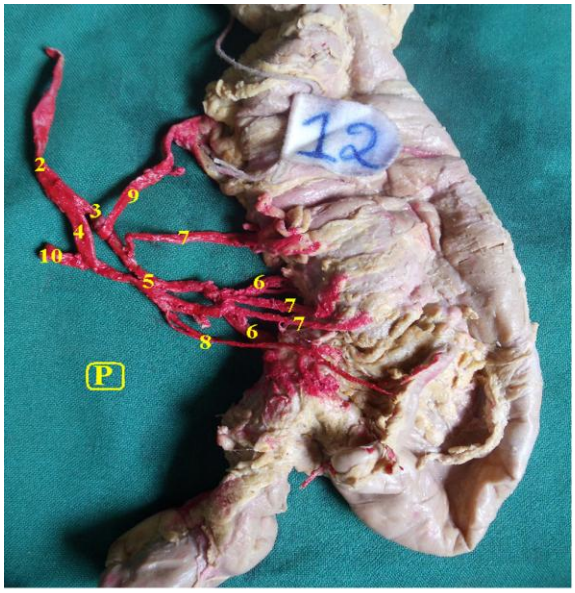
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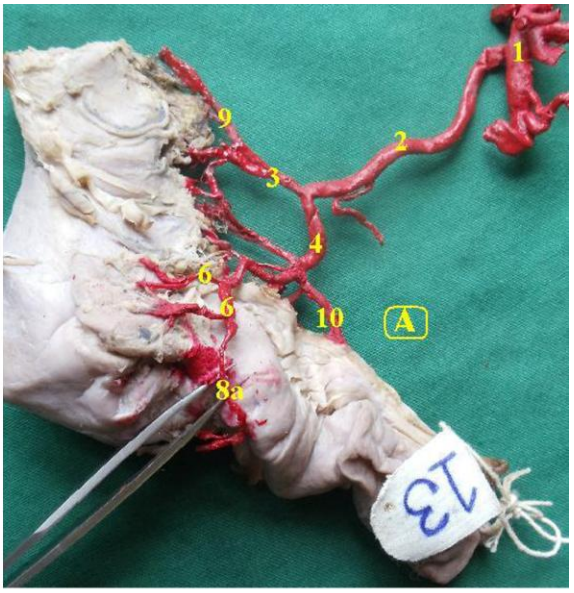
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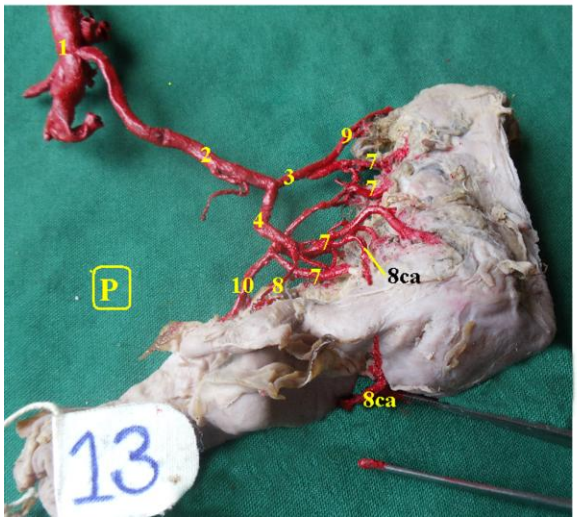
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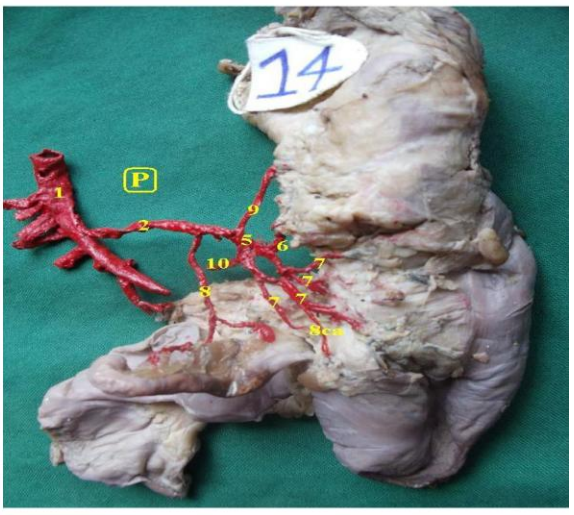
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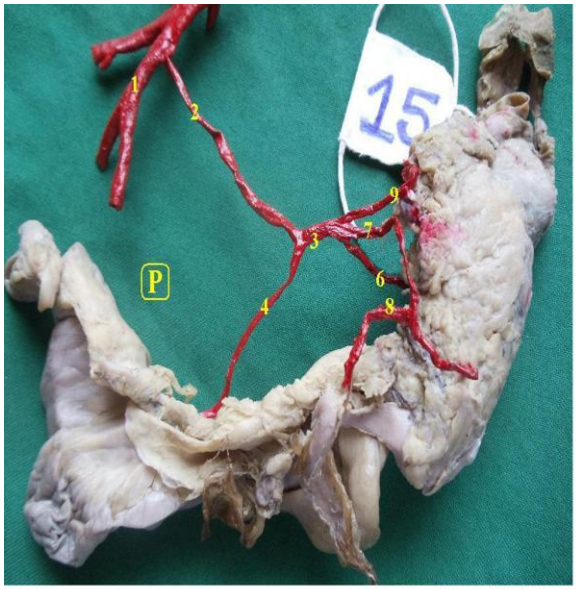
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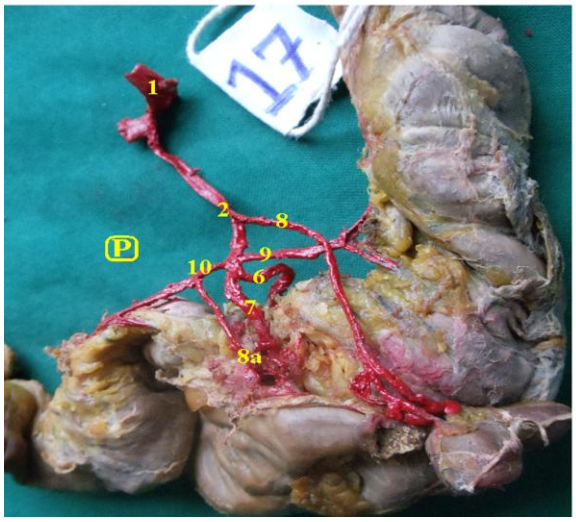
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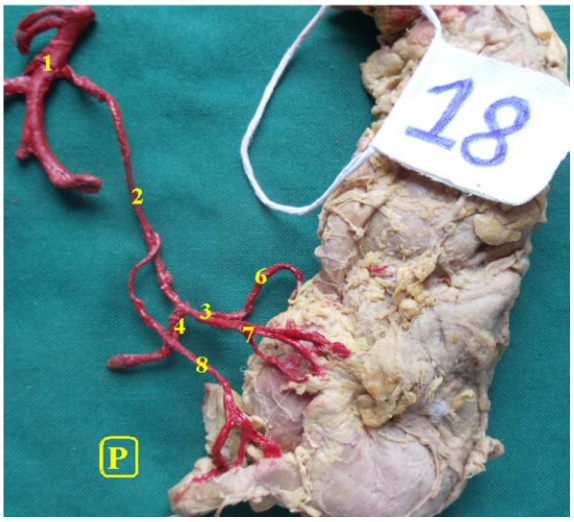
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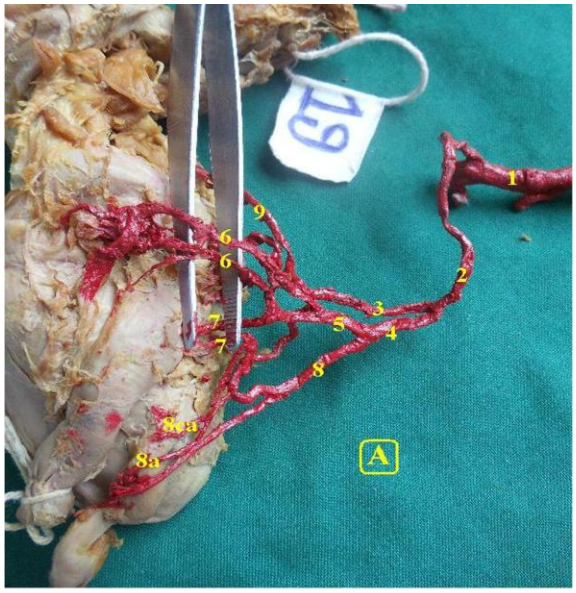
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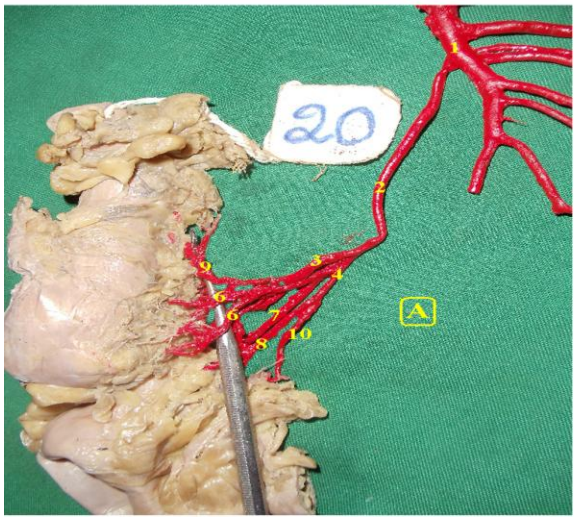
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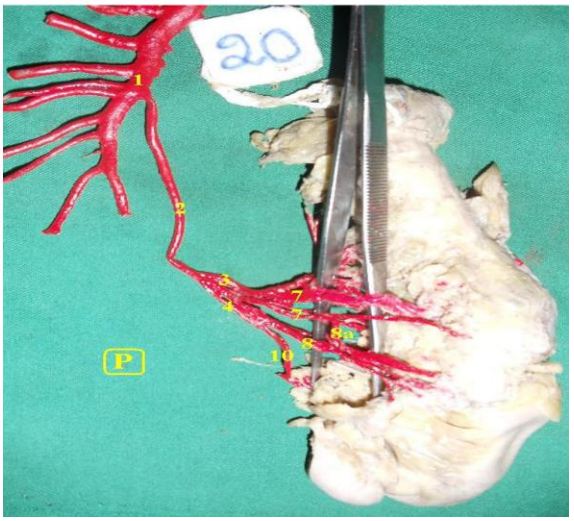
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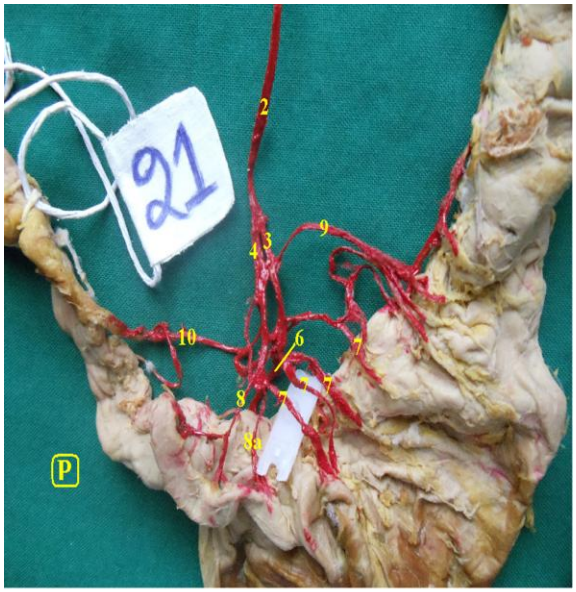
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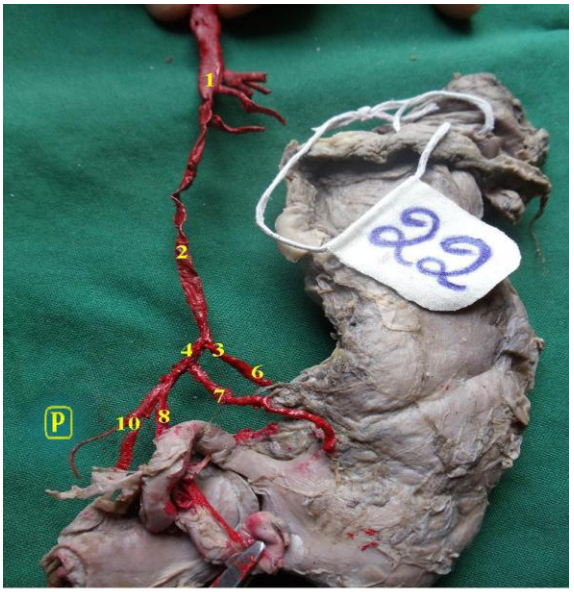
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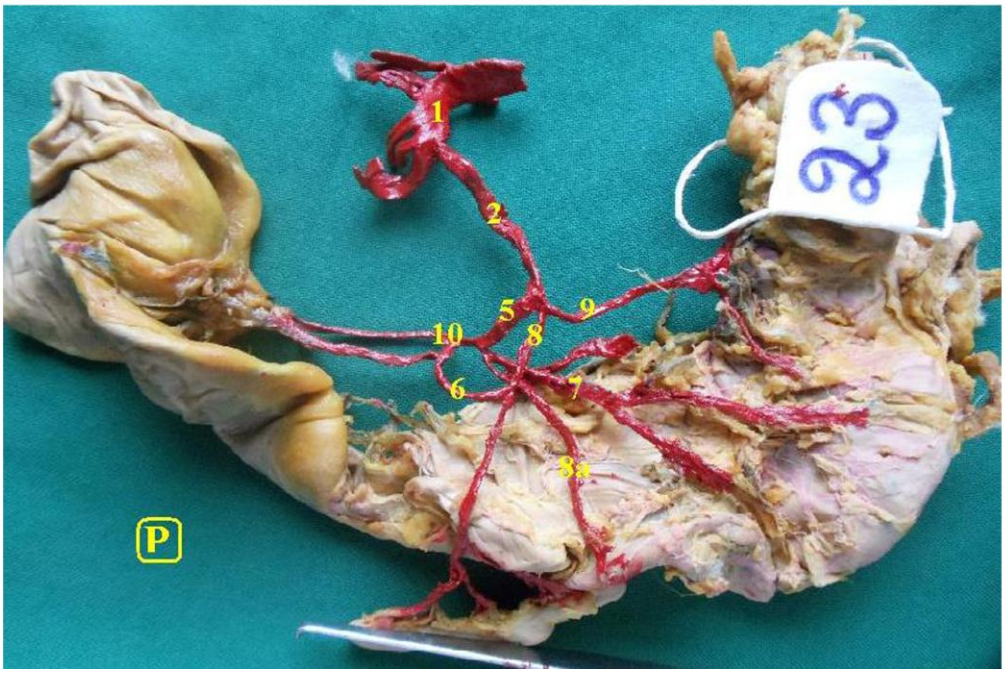
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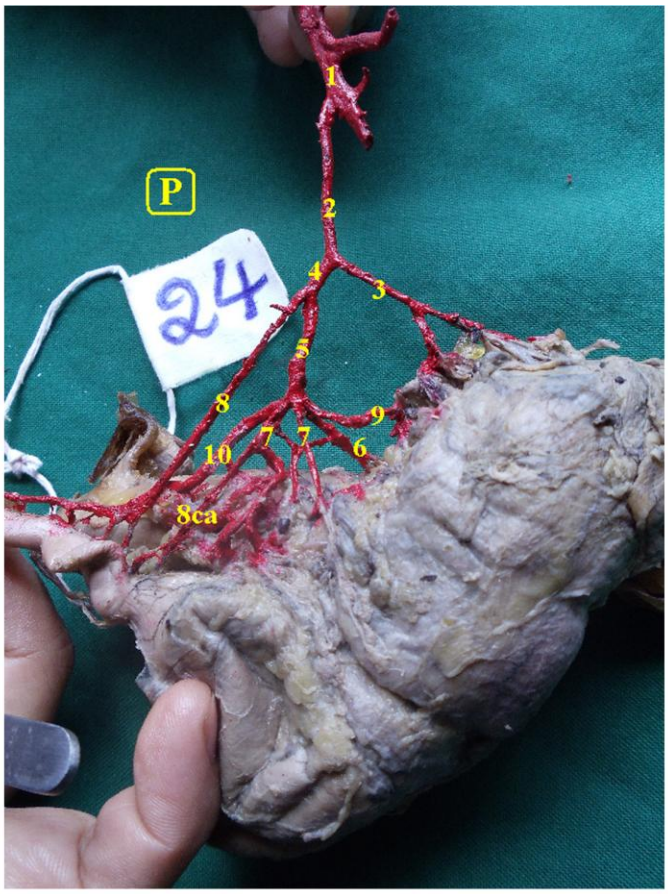
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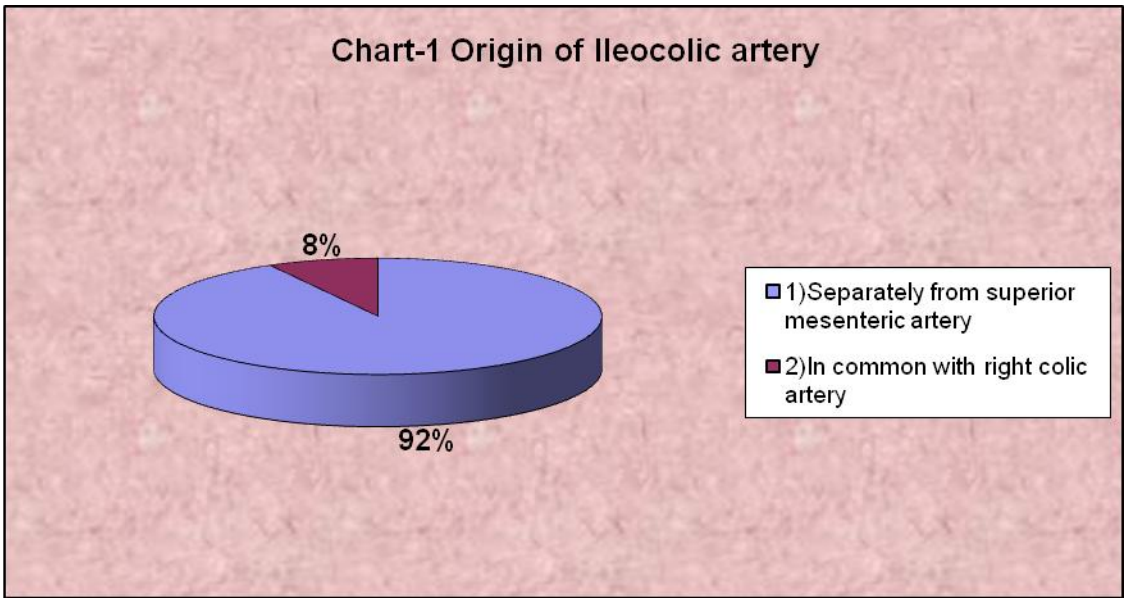
RESULTS

In the present study 25 specimens were studied for the arteries supplying caecum and vermiform appendix.

The ileocolic artery arose separately from superior mesenteric artery in 23 cases (92%) and in 2 cases (8%) it arose from a common trunk along with right colic artery from superior mesenteric artery. (Chart-1)

TABLE-1 ORIGIN OF ILEOCOLIC ARTERY

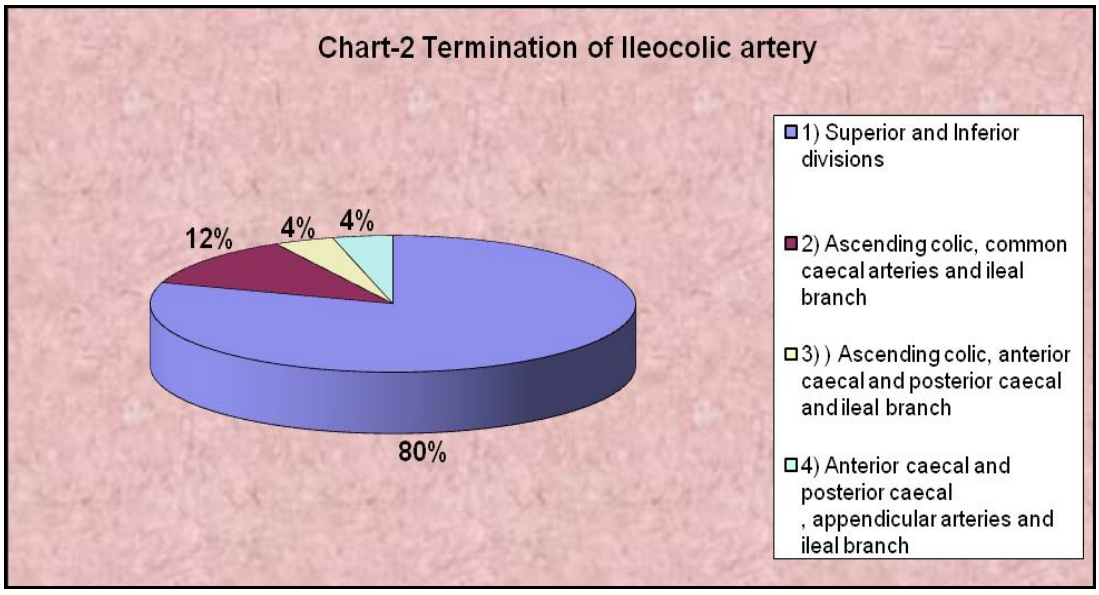
Source	Specimens	Percentage
1)Separately from superior mesenteric artery	23	92
2)In common with right colic artery	2	8
Total	25	100



The ileocolic artery terminated by dividing into superior and inferior divisions in 20 specimens (80%), ascending colic, common caecal arteries and ileal branch in 3 specimens (12%), ascending colic, anterior caecal, posterior caecal and ileal branch in 1 specimen (4%) and into anterior caecal, posterior caecal, appendicular arteries and ileal branch in 1 specimen (4%).(Chart-2)

TABLE-2 TERMINATION OF ILEOCOLIC ARTERY

Termination of Ileocolic Artery	Specimens	Percentage
1) Superior and Inferior divisions	20	80
2) Ascending colic, common caecal arteries and ileal branch	3	12
3)) Ascending colic, anterior caecal, posterior caecal and ileal branch	1	4
4) Anterior caecal and posterior caecal , appendicular arteries and ileal branch	1	4
Total	25	100

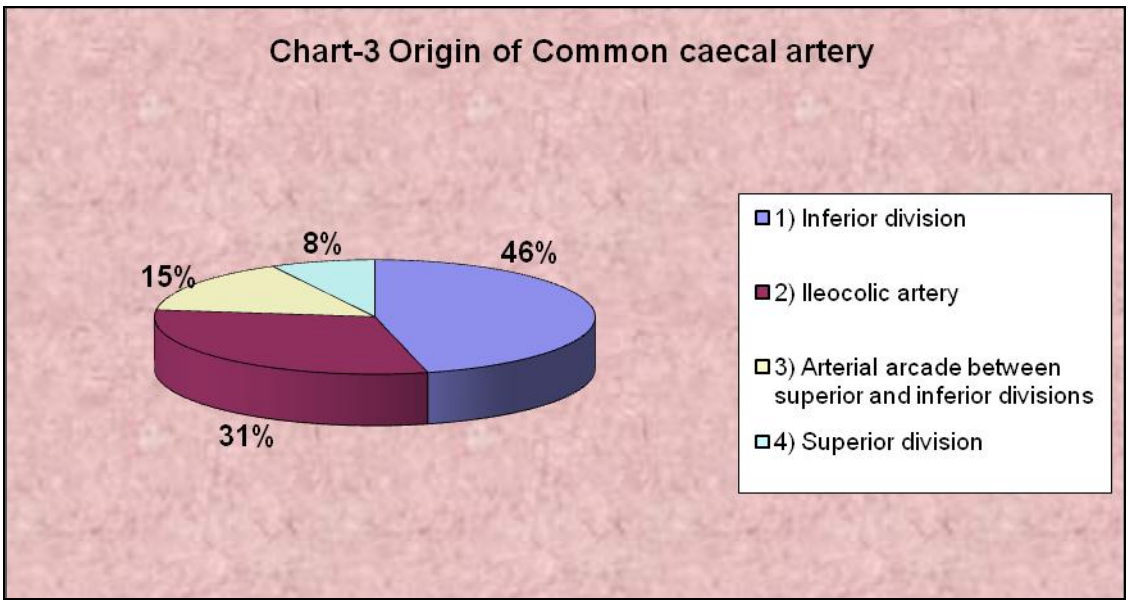


In the present study common caecal artery was seen in 13 specimens (52%) out of 25 specimens.

TABLE-3 ORIGIN OF COMMON CAECAL ARTERY

Source	Specimens	Percentage
1) Inferior division	6	46.2
2) Ileocolic artery	4	30.7
3) Arterial arcade between superior and inferior divisions	2	15.4
4) Superior division	1	7.7
Total	13	100

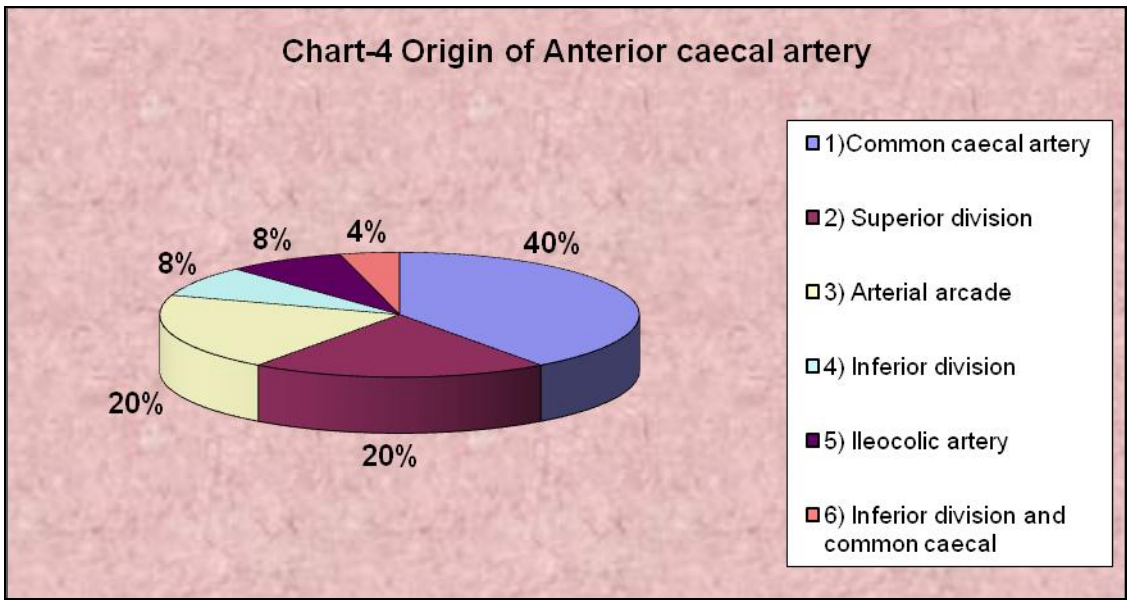
Out of 13 specimens, common caecal artery was arising from inferior division in 6 specimens (46.2%), ileocolic artery in 4 specimens (30.7%), arterial arcade between superior and inferior divisions in 2 specimens (15.4%) and from superior division in 1 specimen (7.7%). (Chart-3)



The anterior caecal artery originated from common caecal artery in 10 specimens (40%), superior division in 5 specimens (20%), arterial arcade in 5 specimens (20%), inferior division in 2 specimens (8%), ileocolic artery in 2 specimens (8%) and from both inferior division and common caecal artery in 1 specimen (4%).(Chart-4)

TABLE-4 ORIGIN OF ANTERIOR CAECAL ARTERY

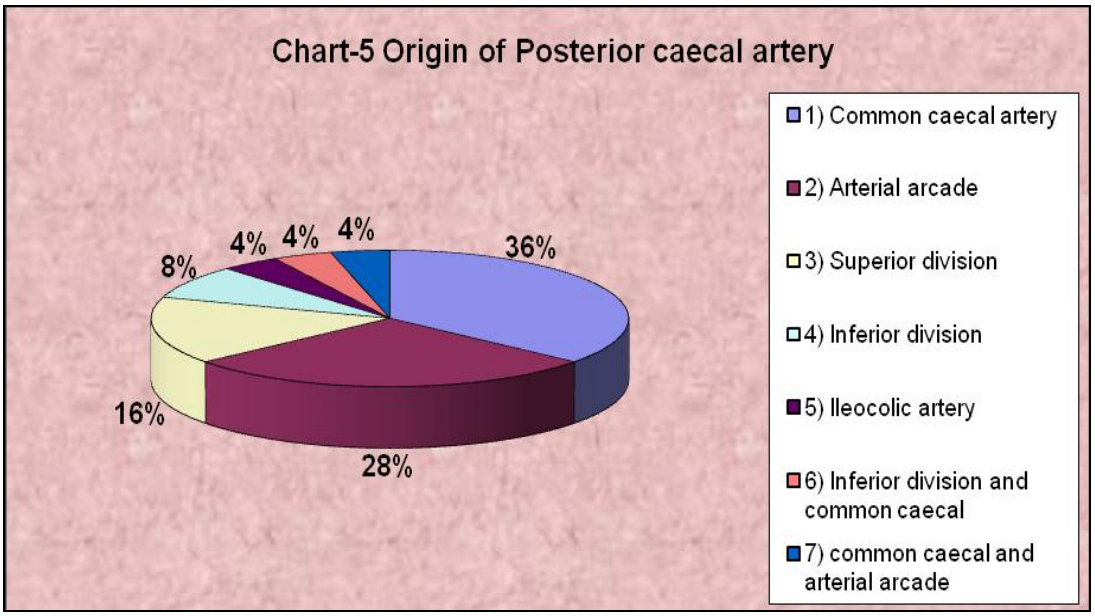
Source	Specimens	Percentage
1)Common caecal artery	10	40
2) Superior division	5	20
3) Arterial arcade	5	20
4) Inferior division	2	8
5) Ileocolic artery	2	8
6) Inferior division and common caecal	1	4
Total	25	100



The posterior caecal artery originated from common caecal artery in 9 specimens (36%), arterial arcade in 7 specimens (28%), superior division in 4 specimens (16%), inferior division in 2 specimens (8%), ileocolic artery in 1 specimen (4%), both inferior division and common caecal artery in 1 specimen (4%) and from both common caecal and arterial arcade in 1 specimen (4%). (Chart-5)

TABLE-5 ORIGIN OF POSTERIOR CAECAL ARTERY

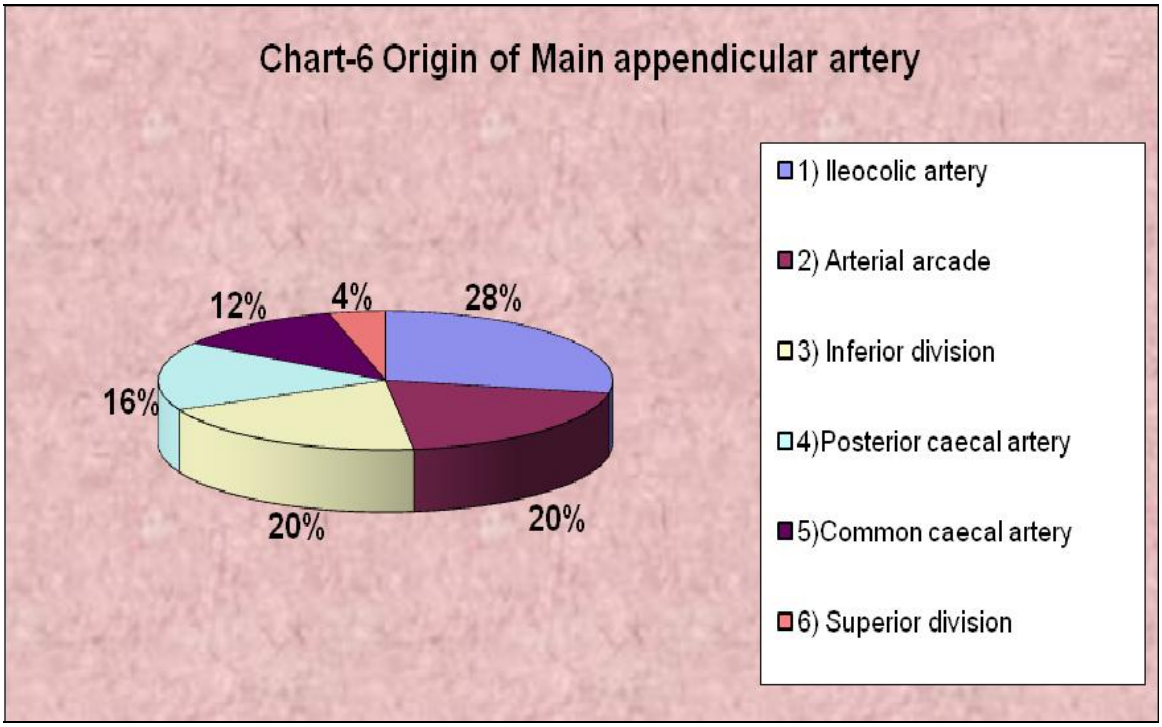
Source	Specimens	Percentage
1) Common caecal artery	9	36
2) Arterial arcade	7	28
3) Superior division	4	16
4) Inferior division	2	8
5) Ileocolic artery	1	4
6) Inferior division and common caecal	1	4
7) common caecal and arterial arcade	1	4
Total	25	100



The main appendicular artery was arising from ileocolic artery in 7 specimens (28%), arterial arcade in 5 specimens (20%), inferior division in 5 specimens (20%), posterior caecal artery in 4 specimens (16%), common caecal artery in 3 specimens (12%) and from superior division in 1 specimen (4%). (Chart-6)

TABLE-6 ORIGIN OF MAIN APPENDICULAR ARTERY

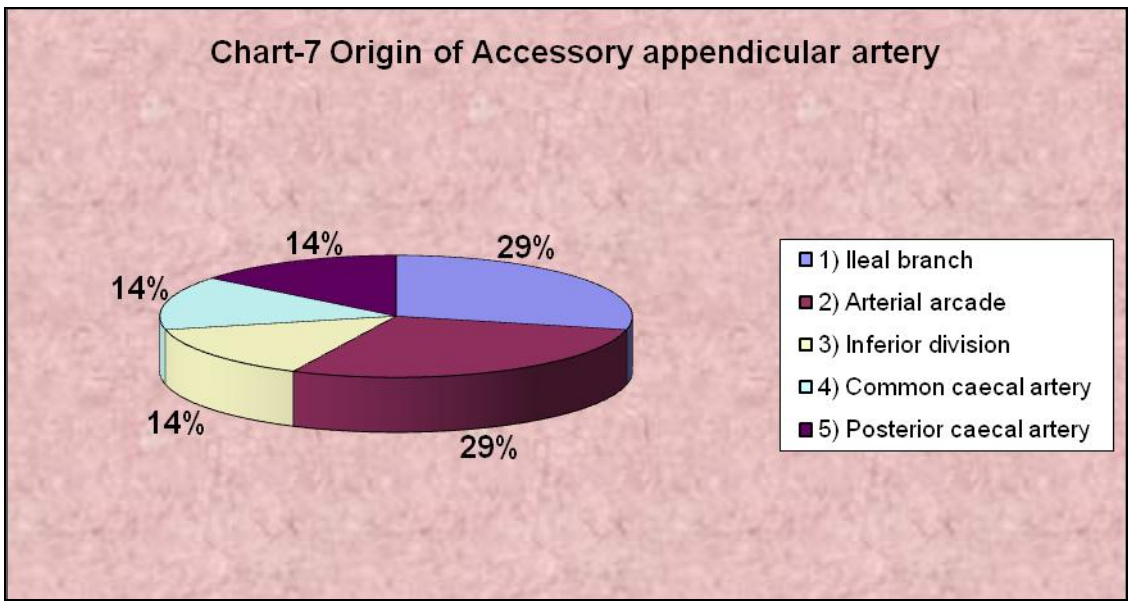
Source	Specimens	Percentage
1) Ileocolic artery	7	28
2) Arterial arcade	5	20
3) Inferior division	5	20
4)Posterior caecal artery	4	16
5)Common caecal artery	3	12
6) Superior division	1	4
Total	25	100



The accessory appendicular arteries were present in 7 specimens (28%).Out of 7 specimens accessory appendicular arteries arose from ileal branch in 2 specimens (29%), arterial arcade in 2 specimens (29%), inferior division in 1 specimen (14%), from common caecal artery in 1 specimen (14%) and from posterior caecal artery in 1 specimen (14%). (Chart-7)

TABLE-7 ORIGIN OF ACCESSORY APPENDICULAR ARTERY

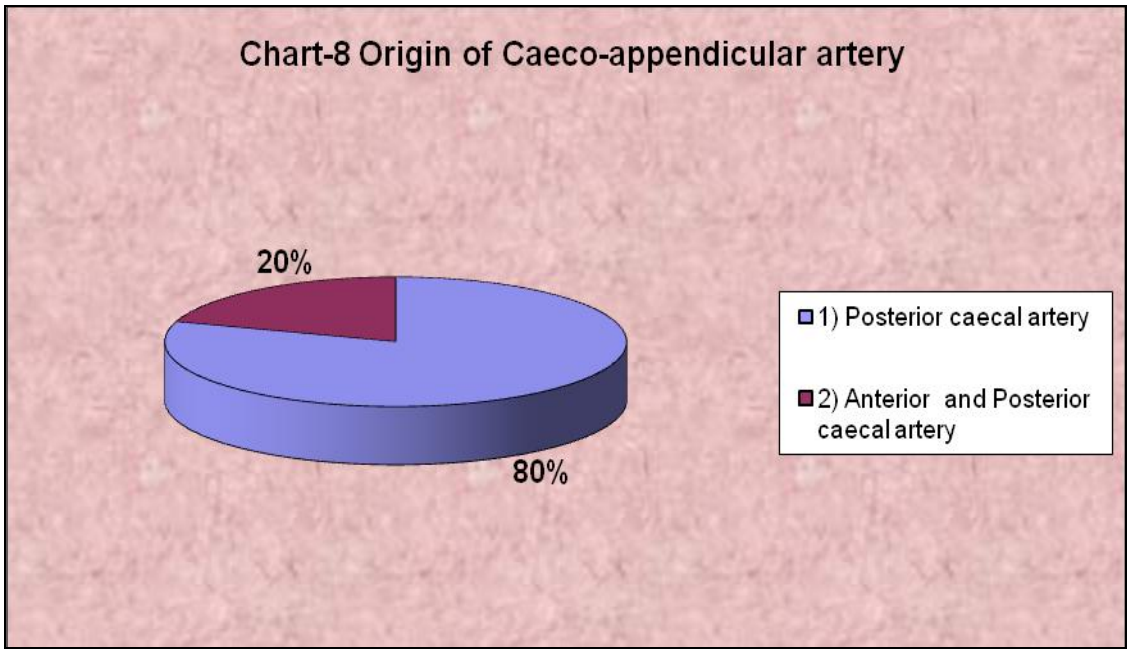
Source	Specimens	Percentage
1) Ileal branch	2	29
2) Arterial arcade	2	29
3) Inferior division	1	14
4) Common caecal artery	1	14
5) Posterior caecal artery	1	14
Total	7	100



The caeco-appendicular artery was seen in 5 specimens (20%), out of these caeco-appendicular artery was originating from posterior caecal artery in 4 specimens (80%) and in 1 specimen (20%) it had its origin from both anterior and posterior caecal arteries. (Chart-8)

TABLE 8-ORIGIN OF CAECO-APPENDICULAR ARTERY

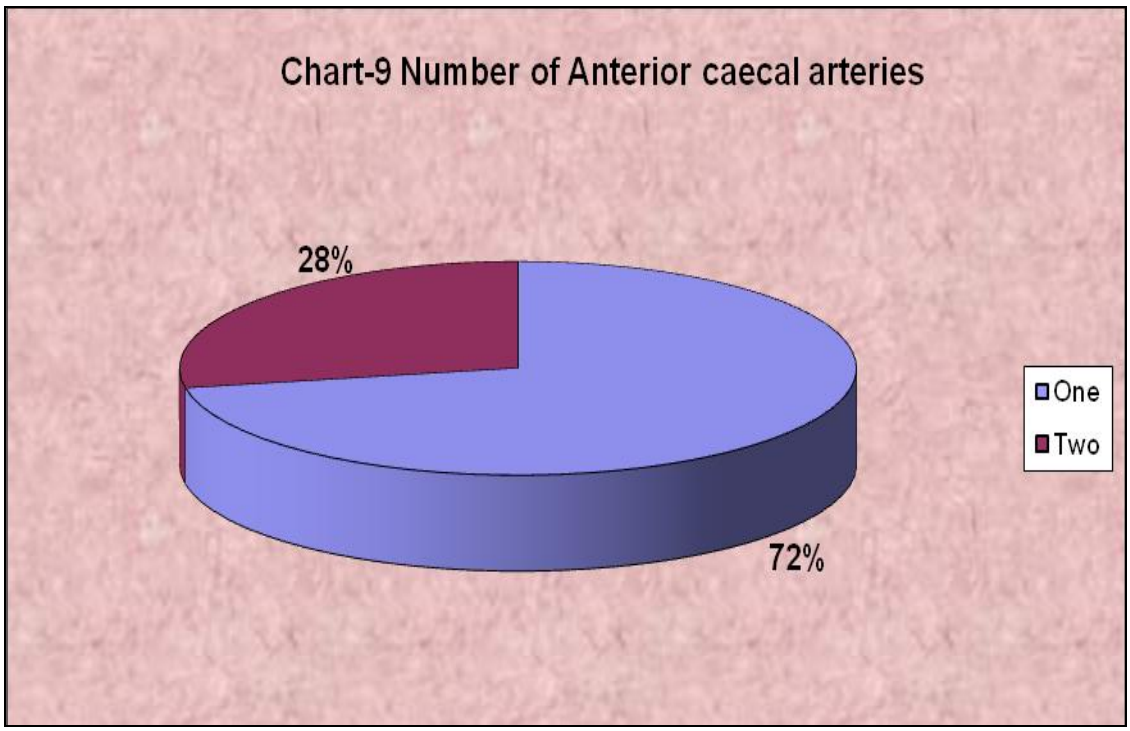
Source	Specimens	Percentage
1) Posterior caecal artery	4	80
2) Anterior and Posterior caecal artery	1	20
Total	5	100



In the present study out of 25 specimens 18 specimens had single anterior caecal artery and 7 specimens had 2 anterior caecal arteries. (Chart-9)

TABLE 9-NUMBER OF ANTERIOR CAECAL ARTERIES

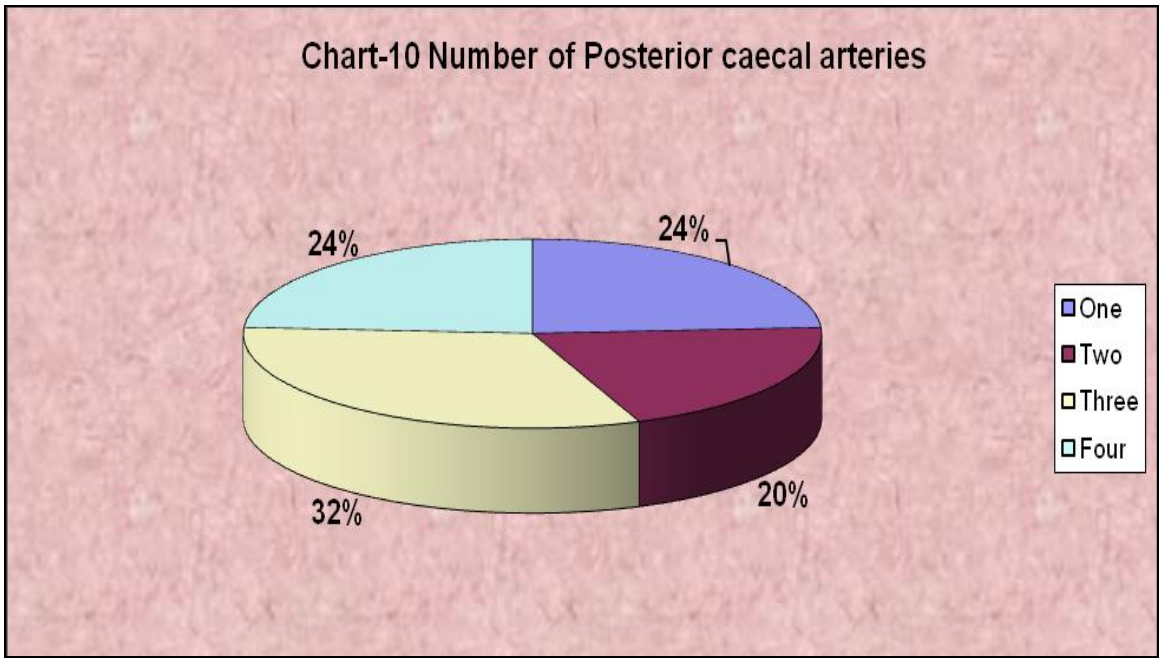
Number	Specimens	Percentage
One	18	72
Two	7	28
Total	25	100



In the present study out of 25 specimens-6 specimens (24%) had single posterior caecal artery, 5 specimens (20%) had 2 posterior caecal arteries, 8 specimens (32%) had 3 posterior caecal arteries and 6 specimens (24%) had 4 posterior caecal arteries. (Chart-10)

TABLE10-NUMBER OF POSTERIOR CAECAL ARTERIES

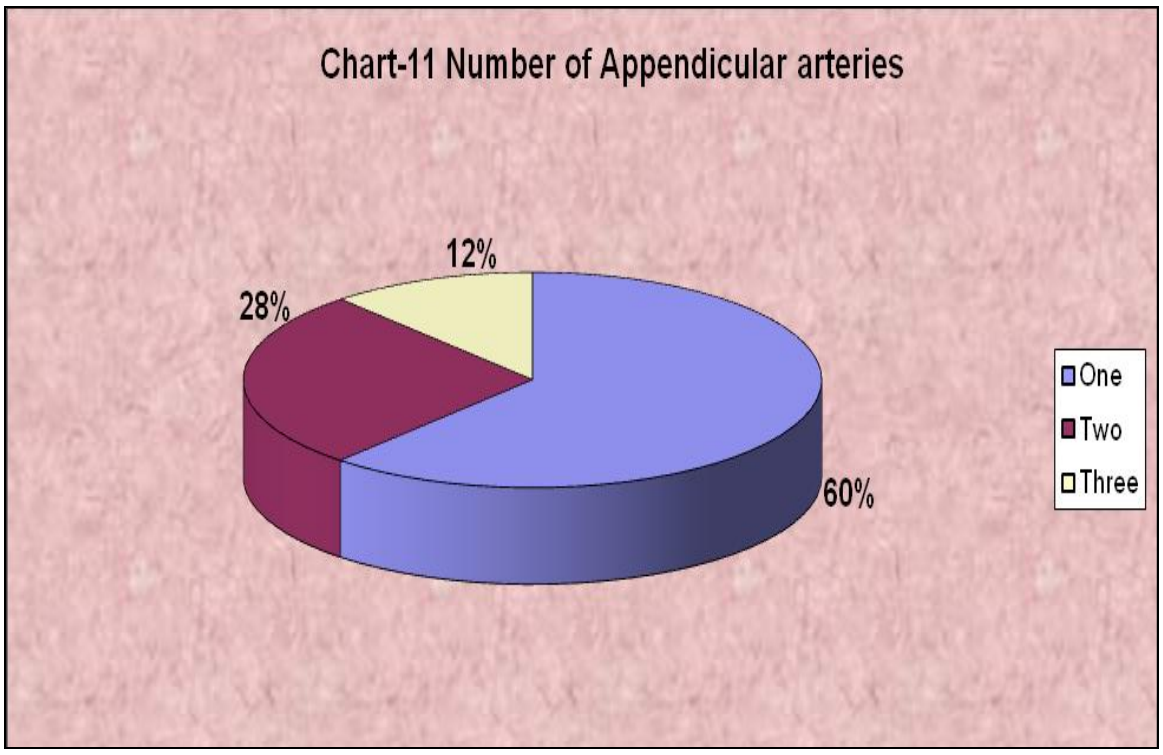
Posterior caecal artery	Specimens	Percentage
One	6	24
Two	5	20
Three	8	32
Four	6	24
Total	25	100



The appendix was supplied by single appendicular artery in 15 specimens (60%) and in 10 specimens (40%) it received more than one appendicular artery. 7 specimens (28%) had 2 arteries, 3 specimens (12%) had 3 arteries. (Chart-11)

TABLE 11-NUMBER OF APPENDICULAR ARTERIES

Appendicular artery	Specimens	Percentage
One	15	60
Two	7	28
Three	3	12
Total	25	100



Arterial arcades were present in12 specimens (48%), out of 12 specimens arterial arcades were present between superior and inferior divisions of ileocolic artery in 5 specimens (42%), between two branches of common caecal artery in 3 specimens (25%), between main appendicular artery and posterior caecal artery in 1 specimen (8.3%), between common caecal artery and ascending colic artery in 1 specimen (8.3%), in 1 specimen (8.3%) two arcades were present one between common caecal artery and ascending colic artery another between ascending colic artery and main appendicular artery, in one more specimen(8.3%) two arcades were present one between superior and inferior divisions another between two branches of common caecal artery.

Chart 12- Formation of Arterial Arcades

Formation of Arterial arcades between	Specimens	Percentage
1) Superior and inferior divisions	5	42
2) Two branches of common caecal artery	3	25
3) Main appendicular artery and posterior caecal artery	1	8.3
4) Common caecal artery and ascending colic artery	1	8.3
5) One between common caecal artery and ascending colic artery, another between ascending colic artery and main appendicular artery	1	8.3
6)One between superior and inferior divisions another between two branches of common caecal artery	1	8.3
Total	12	100

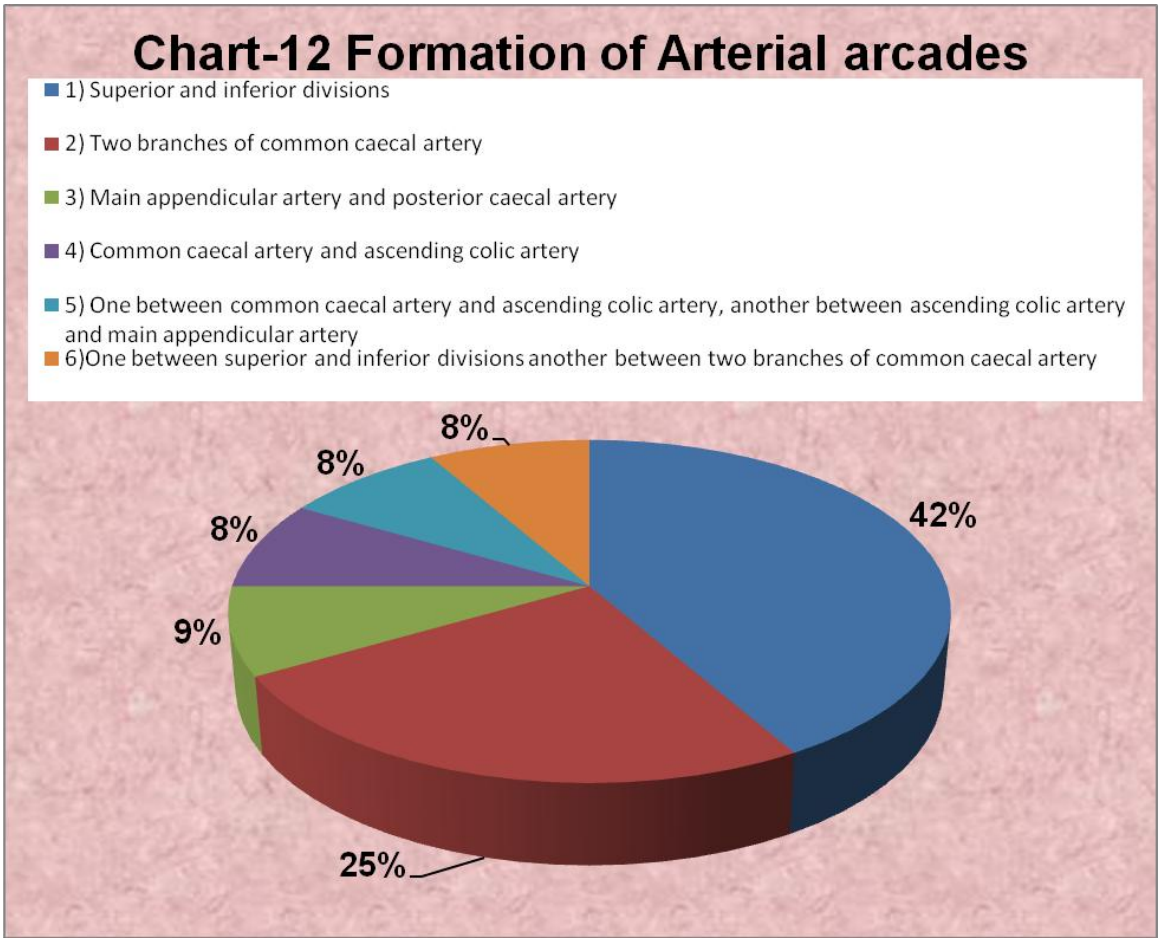


Chart-12 Formation of Arterial arcades
1) Superior and inferior divisions
2) Two branches of common caecal artery
3) Main appendicular artery and posterior caecal artery
4) Common caecal artery and ascending colic artery
5) One between common caecal artery and ascending colic artery, another between ascending colic artery and main appendicular artery
6)One between superior and inferior divisions another between two branches of common caecal artery
42%
25%
9%
8%
8%
8%

DISCUSSION

Quest for knowledge is integral to Human evolution. And this inquisitiveness of human mind has led to many inventions in various fields of science. The same curiosity is the history behind investigative work on the arteries. The publication of Andreas Vesalius's 'De humanis corporis fabrica' (1543) marked the establishment of modern anatomy. The knowledge of arterial pattern of caecum and appendix is essential for surgeons and radiologists as it helps to predefine the abnormality by invasive and non invasive studies. Therefore anatomy of these arteries is an increasingly essential component for many therapeutic and surgical procedures.

In the present study 25 specimens were studied for the arteries supplying Caecum and vermiform appendix and the findings of the study have been compared with those of previous studies.

ORIGIN OF ILEOCOLIC ARTERY

In the present study ileocolic artery arose separately from superior mesenteric artery in 23 cases (92%), in 2 cases (8%) it arose as a common trunk with right colic artery. (Table-1)

Bergman et al in anatomy atlases.org mentions that the ileocolic artery arises independently from the superior mesenteric artery in 63% of individuals; in the remainder, it arises as a common trunk, usually with the right colic artery.[50]

A study done on 200 cadavers by Kornblith (1992) mentions that in 8% cases it originated as a common trunk with right colic artery from superior mesenteric artery. [36] Morris (1914)[16], Larsen (2002)[41], Romanes (2008)[45] have also mentioned the same.

Susan Standring (2008) states that right colic artery arises along with ileocolic artery in 10% of cases and then the artery is called as accessory right colic artery.[15]

TERMINATION OF ILEOCOLIC ARTERY

- In the present study the ileocolic artery terminated by dividing into superior and inferior divisions in 20 specimens (80%). (Table-2)

Morris (1914) found that ileocolic artery divided into colic and ileal branches.[16]

According to Solanke (1968) in 84% of specimens ileocolic artery remained as single and in 16% of specimens it divided into medial and lateral branches.[14]

Kornblith (1992) stated that in 76% of specimens ileocolic artery divided into colic and ileal branches.[36]

Sinnatamby (2006), Snell (2008), Susan Standring (2008) state the same pattern of termination.[43]

- In the present study the ileocolic artery terminated by dividing into ascending colic, common caecal artery and an ileal branch in 3 specimens (12%).

A study done on 87 ileocolic specimens by Vandamme and Bonte (1982) found the same pattern of termination of ileocolic artery.[31]

Bergman et al (1988) stated that ileocolic artery trifurcated into ascending colic, common caecal and ileal branch in 35% specimens; common caecal artery later divided into anterior and posterior caecal arteries.[35] Baer et al (1976) have also mentioned the same.[28]

- In the present study the ileocolic artery divided into ascending colic, anterior caecal, posterior caecal and ileal branch in 1specimen (4%) and into anterior caecal, posterior caecal, appendicular arteries and ileal branch in 1 specimen (4%).

ORIGIN OF COMMON CAECAL ARTERY

In the present study common caecal artery is seen in 13 specimens out of 25 (52%). (Table-3)

- Out of 13 specimens common caecal artery was arising from inferior division in 6 specimens (46.2%).

Anson and Mcvey (1971) mentioned the origin of common caecal artery from inferior division.[27]

A study done on 80 cadavers by Ures et al (1979) observed that common caecal artery arose from inferior division in 61.2%.[29]

- Out of 13 specimens common caecal artery was arising from ileocolic artery in 4 specimens (30.7%).

Bergman et al (1988) mentioned that common caecal artery arose from ileocolic artery in 53.5% specimens.[35]

Baer et al (1976) have stated that ileocolic artery continues as common caecal artery after giving colic and ileal branches.[28]

- Out of 13 specimens common caecal artery was arising from arterial arcade between superior and inferior divisions in 2 specimens (15.4%).

A study done by Michel (1963) found that common caecal artery arose from an arcade between colic and ileal branches in 76% of cases.[25]

Kornblith et al (1992) in their study on 400 cadavers state that common caecal artery rarely originates from ileocolic loop. Anson and Mcvey (1971) also described the similar origin of common caecal artery.[36]

- Out of 13 specimens common caecal artery was arising from superior division in 1 specimen (7.7%).

Anson and Mcvey (1971) described the rare origin of common caecal artery from superior division.[27]

ORIGIN OF ANTERIOR AND POSTERIOR CAECAL ARTERIES

- In the present study anterior caecal artery originated from common caecal artery in 10 specimens (40%) and in 15 specimens (60%) it had different origin. Posterior caecal artery originated from common caecal artery in 9 specimens (36%) and in 16 specimens (64%) it had different origin. (Table 4&5)

Michel et al (1963) in their study found that anterior and posterior caecal arteries were either arising from a common caecal artery or separately in 36% and 64% respectively.[25]

Ures et al (1979) studied the angiographic anatomy of the anterior and posterior caecal arteries in 80 cadavers and found that they were arising either from a common caecal artery or separately in 76.2% and 23.7% of cases respectively.[29]

Bergman et al (1988) mentions that common caecal artery gave rise to anterior and posterior caecal arteries in 53.5% of specimens and in 46.5% of specimens they were arising separately from different sources.[35]

- In the present study anterior caecal artery originated from superior division in 5 specimens (20%) and posterior caecal artery arose from superior division in 4 specimens (16%).

Michel (1963) states that anterior and posterior caecal arteries originate from superior division less frequently.[25]

Anson and Mcvey (1971) described that colic (superior) branch gave rise to anterior and posterior caecal arteries which supplied anterior and posterior wall of caecum respectively.[27]

- In the present study an arterial arcade gave rise to anterior caecal artery in 5 specimens (20%) and posterior caecal artery in 7 specimens (28%).

Bergman et al (1988) stated that anterior and posterior caecal arteries originated from arterial arcade in 4% of specimens.[35]

A study on 400 cadavers by Kornblith et al (1992) found that anterior and posterior caecal arteries were originating from ileocolic loop in 76% of cases.[36]

- In the present study inferior division gave rise to both caecal arteries in 2 specimens (8%).

Michel (1963) described the rare origin of anterior and posterior caecal arteries from inferior division.[25]

Ures et al (1979) in their study on 80 cadavers have found that in 13.8% of cases both caecal arteries were arising from ileal (inferior) branch.[29]

Lumley et al (1983) has found the origin of anterior and posterior caecal arteries from descending branch.[34]

The origin of both anterior and posterior caecal arteries from inferior division of ileocolic artery has also been explained by Basmajian (1983)[33], Sinnatamby (2006)[43], Susan Standring (2008)[15], Snell (2008)[44], Romanes (2008)[45].

- In the present study anterior caecal artery originated from ileocolic artery in 2 specimens (8%) and posterior caecal in 1 specimen (4%).

Morris and Jackson (1914) mention that ileo-colic artery descends behind the peritoneum towards the caecum, divides into colic, ileal, anterior and posterior caecal branches.[16]

Hollinshead (1956) has explained that ileocolic artery continued as anterior caecal artery passing over anterior surface of caecum to supply it, posterior caecal artery may arise with anterior caecal or directly from ileocolic.[24]

Michel (1963) has noted origin of both caecal arteries from ileocolic artery.[25]

A study done by Ures et al (1979) on 80 cadavers observed that in 1.2% of cases posterior caecal artery arose from the ileocolic artery.[29]

Bergman et al (1988) mentioned that anterior and posterior caecal arteries arose directly from ileocolic artery in 35% of cases.[35]

Simon et al (2000) have mentioned that ileocolic artery terminated as straight arteries which supplied anterior and posterior walls of caecum.[40]

- In the present study anterior and posterior caecal arteries originated from both inferior division and common caecal artery in 1 specimen (4%). And in 1 specimen (4%) only posterior caecal artery arose from both common caecal and arterial arcade.

ORIGIN OF MAIN APPENDICULAR ARTERY

- In the present study main appendicular artery was arising from ileocolic artery in 7 specimens (28%). (Table-6)

Koster and Weintrobe (1928) studied 100 appendices and stated that the appendicular artery arose only from ileocolic artery.[9]

Bruce et al (1964) states that the artery to the appendix is single and is a branch of ileocolic artery.[10]

Solanke (1968) has studied the blood supply of vermiform appendix in 100 Nigerian cadavers and stated that appendicular artery originated from ileocolic artery in 50% of cases.[14]

Bergman et al (1988) in "Compendium of human anatomic variation" mentioned that appendicular artery originated from ileocolic artery in 48.5% specimens based on a study of 200 specimens.[35]

Pitynski et al (1992) studied the variability of the arterial pattern of vermiform appendix in 50 human dead fetuses aged between 12 and 20 weeks of gestation by the injection method and found that appendicular artery was arising from the ileocolic artery in most of the cases.[11]

Schumpelick et al (2000) mentioned that the appendix was fed from appendicular artery which originated from ileocolic artery in 28% of specimens.[3]

Ouattara (2007) has studied the terminal arterial vascularisation of the appendix in 25 specimens from West Africa by intra arterial injection method and found the origin of appendicular artery from ileocolic artery in 35% of cases.[7]

Wakeley (1933)[23], Hollinshead (1956)[24], Anson and Mcvey (1971)[27], Baer et al (1976)[28], Larsen (2002)[41], Gopalipour (2003)[42], Susan Standring (2008)[15], Boleken et al (2010)[47], Kulkarni & Kulkarni (2011)[48], Bergman et al in anatomy atlases.org (accessed on May 2011)[50] have also stated that appendicular artery originates from ileocolic artery.

- In the present study main appendicular artery was arising from arterial arcade in 5 specimens (20%).

Solanke (1968) has studied the blood supply of vermiform appendix in 100 Nigerian cadavers and found appendicular artery originating from arterial arcade in 1% of cases.[14]

Kornblith et al (1992) in their study on 400 cadavers found the origin of appendicular artery from arterial arcade in 76% of specimens.[36]

Ouattara (2007) has found the origin of appendicular artery from arterial arcade in 34.75% of cases.[7]

Anson and Mcvey (1971)[27], Simon et al (2000)[40] also mentioned same site of origin.

- In the present study main appendicular artery was arising from inferior division in 5 specimens (20%).

Solanke (1968) has studied the blood supply of vermiform appendix in 100 Nigerian cadavers and found appendicular artery originating from ileal (inferior) branch in 32% of cases.[14]

Bergman et al (1988) found that appendicular artery arose from inferior division in 35% of specimens out of 200 specimens.[35]

Schumpelick et al (2000) mentions that the appendix receives its blood supply from appendicular artery which originated from iliac ramus of the ileocolic artery in 35% of specimens.[3]

Ouattara (2007) found the origin of appendicular artery from ileal (inferior) branch in 35% of cases.[7]

Anson and Mcvey (1971)[27], Basmajian (1983)[33], Sinnatamby (2006)[43], Romanes (2008)[45], Bergman et al in anatomy atlases.org (accessed on May 2011) have also described the same[50].

- In the present study main appendicular artery was arising from posterior caecal artery in 4 specimens (16%).

Shah and Shah (1946) studied the arterial pattern of appendix in 60 Pakistani cadavers and state that in 80% of cases accessory appendicular arteries either arise from anterior or posterior caecal arteries.[13]

Bergman et al (1988) found that appendicular artery arose from posterior caecal artery in 4 % of specimens out of 200 specimens.[35]

Schumpelick et al (2000) mentions appendicular artery originated from posterior caecal artery in 12% of specimens.[3]

Ouattara(2007) has found the origin of appendicular artery from posterior caecal artery in 13% of cases.[7]

Morris and Jackson (1914)[16], Lumley et al (1983)[34], Simon et al (2000)[40], Snell (2008)[44], Kulkarni & Kulkarni (2011)[48], Bergman et al in anatomy atlases.org (accessed on May 2011)[50] stated the same.

- In the present study main appendicular artery was arising from common caecal artery in 3 specimens (12%).

- In the present study main appendicular artery was arising from superior division in 1 specimen (4%).

Solanke (1968) has studied the blood supply of vermiform appendix in 100 Nigerian cadavers and found the origin of appendicular artery from ascending colic (superior) branch in 3% of cases.[14]

Schumpelick et al (2000)[3] mentioned that the appendix was fed from appendicular artery which originated from ascending colic ramus of ileocolic artery in 2% of cases. Anson and Mcvey (1971)[27], Simon et al (2000) [40]stated the same.

ORIGIN OF ACCESSORY APPENDICULAR ARTERY

- In the present study accessory appendicular arteries were present in 7 specimens (28%).Out of 7 specimens accessory appendicular arteries were arising from ileal branch in 2 specimens (29%), arterial arcade in 2 specimens (29%), inferior division in 1 specimen (14%), common caecal artery in 1 specimen (14%) and from posterior caecal artery in 1 specimen (14%). (Table-7)

Anson and Mcvey (1971) mention that accessory appendicular arteries also supply appendix and they originate from inferior division of ileocolic artery[27].

Ouattara (2007) has studied the terminal arterial vascularisation of the appendix in 25 specimens from West Africa by intra arterial injection method and found accessory appendicular arteries in 12 specimens (48%). They found the origin of accessory appendicular arteries from posterior caecal artery in 6 specimens and from arterial arcade in 6 specimens.[7]

ORIGIN OF CAECO-APPENDICULAR ARTERY

In the present study caeco-appendicular artery was seen in 5 specimens (20%). Out of these, caeco-appendicular artery was originating from posterior caecal artery in 4 specimens (80%) and in 1 specimen (20%) it arose from both anterior and posterior caecal arteries. (Table-8)

Morris and Jackson (1914) observed caeco-appendicular artery normally arose from posterior caecal artery.[16]

Ouattara (2007) has studied the arterial supply of the appendix in 25 specimens from West Africa by intra arterial injection method and found caeco-appendicular arteries in 8 cases (32%) all of them originating from posterior caecal artery.[7]

In the 13th specimen of present study anterior caecal artery was running on anterior surface of caecum giving numerous branches to it, turned backwards along ileocaecal junction to form a caeco-appendicular artery to supply base of appendix. Kulkarni & Kulkarni (2011)[48] have also explained the same.

NUMBER OF ANTERIOR CAECAL ARTERIES

In the present study out of 25 specimens 18 specimens had single anterior caecal artery and 7 specimens had 2 anterior caecal arteries. (Table-9)

NUMBER OF POSTERIOR CAECAL ARTERIES

In the present study out of 25 specimens, 6 specimens (24%) had single posterior caecal artery, 5 specimens (20%) had 2 posterior caecal arteries, 8 specimens (32%) had 3 posterior caecal arteries and 6 specimens (24%) had 4 posterior caecal arteries. (Table-10)

NUMBER OF APPENDICULAR ARTERIES

In the present study appendix was supplied by single appendicular artery in 15 specimens (60%) and in 10 specimens (40%) it received more than one appendicular artery. 7 specimens (28%) had 2 arteries, 3 specimens (12%) had 3 arteries. (Table-11)

Kelly and Hurdon (1905) had first time drawn attention towards accessory appendicular artery and showed them in 66% of specimens studied.[12]

Koster and Weintrobe (1928) studied 100 appendices and stated the appendicular artery is single.[9]

Shah and Shah (1946) studied the arterial pattern of appendix in 60 Pakistani cadavers and found 42 cases (70%) having single appendicular artery and 18 cases (30%) having more than one artery.[13]

Bruce et al (1964) stated that the artery to the appendix is single and is a branch of ileocolic artery.[10]

Solanke (1968) has studied the blood supply of vermiform appendix in 100 Nigerian cadavers and stated accessory appendicular arteries were present in 80% of cases which was probably the reason for rarity of appendicitis in Nigerians.[14]

Katezarski et al (1979) studied the morphology and arterial pattern of vermiform appendix in 103 cadavers in Zambians and demonstrated more than one appendicular artery in 39.8% of cadavers.[30]

Ajmani and Ajmani (1983) studied 100 Indian cadavers (Uttar Pradesh) and demonstrated more than one appendicular artery in 39% of cadavers.[32]

Basmajian (1983) explains that commonly appendix is supplied by two arteries.

Pitynski et al (1992) found single appendicular artery as the commonest mode of supply to appendix based on a study of 50 human dead fetuses.[33]

Ouattara (2007) has studied the terminal arterial vascularisation of the appendix in 25 specimens from West Africa by intra arterial injection method and found that in 24% of specimens appendix was supplied by main appendicular artery (single) alone. In 76% of cases it was supplied by either accessory appendicular arteries or Caeco-appendicular arteries or by both along with main appendicular artery.[7]

Susan Standring (2008) in 'Gray's Anatomy' illustrates that accessory appendicular arteries are common and many individuals possess two or more arteries of supply.[15]

FORMATION OF ARTERIAL ARCADES

In the present study arterial arcades were present in 12 specimens (48%). Out of 12 specimens arterial arcades were present between superior and inferior divisions of ileocolic artery in 5 specimens (42%), between two branches of common caecal artery in

3 specimens (25%), between main appendicular artery and posterior caecal artery in 1 specimen (8.3%), between common caecal artery and ascending colic artery in 1 specimen (8.3%), in 1 specimen (8.3%) two arcades were present one between common caecal artery and ascending colic artery another between ascending colic artery and main appendicular artery, in one more specimen(8.3%) two arcades were present one between superior and inferior divisions another between two branches of common caecal artery.

Kornblith et al (1992) in their study on superior mesenteric artery found that in 76% of 200 dissections there was ileocolic loop formed by ileal and colic branches of ileocolic artery which gave rise to caecal and appendicular arteries.[36]

CONCLUSION

A comprehensive study of arteries of caecum and vermiform appendix was carried out in the Department of Anatomy, _____, on 25 specimens of human caecum and appendix of both sexes by dissection method. The present study shows some differences with respect to the results from the available literature.

The ileocolic artery originated separately from superior mesenteric artery in 92% of specimens and terminated by dividing into superior and inferior divisions in 80% of specimens. The common caecal arteries were seen in 52% of specimens. The common caecal artery which gave rise to anterior caecal artery in 40% and posterior caecal artery in 36% of specimens was the most common source of origin of these two arteries.

The commonest source of origin of main appendicular artery was ileocolic artery in 28% of specimens; least common was from superior division of ileocolic artery in 4%. In 40% of specimens appendix received more than one appendicular artery. The accessory appendicular arteries were seen in 28% of specimens and caeco-appendicular arteries were seen in 20% of specimens.

The 13th specimen of present study showed variant origin of caeco-appendicular artery from anterior caecal artery. Anterior caecal artery was running on anterior surface of caecum giving numerous branches to it, turned backwards along ileo-caecal junction to form a caeco-appendicular artery to supply base of appendix.

Arterial arcades were present in 12 specimens (48%), mainly between superior and inferior divisions of ileocolic artery (42%). In 3 specimens (25%) arterial arcade was present between two branches of common caecal artery which gave rise to caecal and appendicular arteries.

SUMMARY

The present study was intended to go through the details of origin, number and branching pattern of arteries of caecum and appendix in 25 specimens of caecum and appendix by dissection method.

Better anatomical knowledge about the caecal and appendicular arteries and their variations is essential for surgeons while operating on the ileocolic region for treating conditions such as appendicitis, carcinoma of caecum, ileocaecal tuberculosis, caecal volvulus, and intussusception and also in treating congenital anomalies of caecum and appendix.

The details of origin, number and branching pattern of appendicular arteries help the surgeons to use the appendix with its pedicle or as free transplant in many reconstructive microsurgeries such as to rebuild urethra, ureters, the uterine tubes and extra hepatic biliary tracts.

The same knowledge is also helpful in the interpretation of superior mesenteric or ileocolic angiograms by radiologists.

Work done in the present study was just like exploring the tip of iceberg. The rest of it needs to be explored.

REFERENCES

1) Neil J, Mortensen MC, Oliver J. The small and large intestines. In: Russel RCG, Norman SW, Christopher, Bulstrode JK. Bailey and Love's short practice of Surgery. 24th Edn. London: Arnold Publications; 2004: 1153-86.

2) Glover JW. Answers in Genesis .The human vermiform appendix-A general surgeon's reflections. Journal of creation-1988[Cited on 23 July 2012]. Available from http: //www. answersingenesis.org/articles/tj/v3/n1/ human vermiform appendix.org/docs/357.asp.

3) Schumpelick V, Dreuw B, Ophoff K, Prescher A. Appendix and Caecum Embryology, Anatomy and Surgical applications. The Surgical Clinics of North America 2000; 80: 296-316.

4) Martel P, Blanc P, Bothereau H, Malafosse M, Gallot D. Comparative anatomical study of division of the ileocolic pedicle or the superior mesenteric pedicle for mesenteric lengthening. British Journal of Surgery 2002; 89: 775-8.

5) Gerlock AJ, Muhletaler CA, Berger JL, Halter SA, O'Leary JP, Avant GR. Infarction after embolization of the ileocolic artery. Cardiovascular Interventional Radiology 1981; 4: 202-5.

6) Zucker KA. Laparoscopic appendicectomy. In: Josloff RK, Zucker KA. Surgical laparoscopy. 2nd Edn. Philadelphia: Lippincott Williams and Wilkins; 2001: 231-2.

7) Ouattara D, Kipre YZ, Broalet E, Seri FG, Angate HY, Bi N'Guessan GG. Classification of the terminal arterial vascularization of the appendix with a view to its use in reconstructive microsurgery. Surg Radiol Anat 2007; 29: 635–41.

8) Ho S, Jackson J. The Angiographic Diagnosis of Colonic Carcinoma. Clinical Radiology 1998; 53: 345-9.

9) Koster H, Weintrob M. The blood supply to the appendix. Archs Surg 1928; 17: 577-86.

10) Bruce J, Walmesley R, Ross JA. Manual of Surgical Anatomy. Edinburgh and London: E and S Livingstone; 1964: 377-8.

11) Pitynski K, Skawina A, Gorezyca J, Kitliński M, Kitliński Z. Arterial vascularization of the vermiform appendix in human fetus. Folia Morphol (Warsz) 1992; 51: 159-64.

12) Kelly HA, Hurdon E. The Vermiform Appendix and its Diseases. Philadelphia: W. B. Saunders; 1905: 189.

13) Shah MA, Shah M. The arterial supply of the appendix. Anatomical Record 1946; 95: l457-60.

14) Solanke TF. The blood supply of vermiform appendix in Nigerians. J. Ant. 1968; 102: 353-61.

15) Standring S. Large intestine. In: Borley NR. Gray's Anatomy-The Anatomical basis of clinical practice. 40th Edn. Edinburgh: Churchill Livingstone; 2008: 1141-5.

16) Morris HO, Jackson CM. The blood vascular system of abdomen. [Cited on17 September 2012]. Available from http://www. Ebooksread.com/Morris's human anatomy; a complete systematic treatise by English and American authors.

17) Moore KL, Persaud TVN. The digestive system-Midgut. The developing human-Clinically oriented Embryology. 8thEdn. Philadelphia: Saunders; 2008: 227-8.

18) Bhasin SK, Khan AB, Kumar V, Sharma S, Saraf R. Vermiform appendix and acute appendicitis. JK Science review article 2007; 9: 167-70.

19) Theobald D. The talk origins Archive. The vestigiality of the human vermiform appendix-A modern reappraisal. Updated on 25 July 2012. [Cited on 25 July 2012]. Available from mhtml:file://H:\vestigiality20%of 20%the20%human 20%appendix.mht.

20) Bradley JI. Congenital absence of the Vermiform Appendix. Arch Surg 1929; 18:1904-8.

21) Chiene D. Complete obliteration of coeliac and mesenteric arteries: The viscera receiving their blood supply through the extra-peritoneal system of vessels. J. Anat. Physiol. 1868; 3: 65-72.

22) Treves F. Lectures on the anatomy of intestinal canal and peritoneum in man. British Medical Journal 1885; 1: 527–30.

23) Wakeley CPG. The position of the vermiform appendix as ascertained by an analysis of 10,000 cases. J Anatomy 1933; 67: 277-83.

24) Hollinshead WH. Vessels of abdomen. Anatomy for Surgeons: The Thorax Abdomen and Pelvis Vol.2. London: Cassel; 1956: 492-5.

25) Michels NA, Siddharth P, Kornblith PL, Parke WW. The variant blood supply to the small and large intestines, its importance in regional resections. A new anatomic study based on 400 dissections with complete review of literature. J Int Coll Surgeons 1963; 39: 127-8.

26) Solanke TF. The position, length, and content of the vermiform appendix in Nigerians. British Journal of Surgery 1970; 57:100-2.

27) Anson BJ, McVey CB. Ileocaecal appendiceal region. Surgical anatomy. 5th Edn. Philadelphia: W.B. Saunders Company; 1971:695-8.

28) Baer WJ, Ryan S. Analysis of caecal vasculature in the search for vascular malformations. American Journal of Roentgenology 1976; 126: 394-405.

29) Ures J, Stacchini A, Prates JC, Gatto IM, Ures S Angiographic anatomy of the caecal artery. Arq Gastroenterol. 1979; 16: 8-11.

30) Katzarski M, Gopal Rao VK, Brady K. Blood Supply and position of the vermiform appendix in Zambians. Med J Zambia 1979; 13: 32-4.

31) Vandamme JP, Bonte J. A new look at the blood supply of the ileocolic angle. Acta Anatomica 1982; 113: 1-14.

32) Ajmani ML, Ajmani K. The position, length and arterial supply of vermiform appendix. Anat Anz 1983; 153: 369-74.

33) Basmajian JV. Abdomen-mesenteric vessels. Grant's method of anatomy by regions, descriptive and deductive. 10th Edn. Baltimore: The Williams and Wilkins Company; 1983:167-8.

34) Lumley SP, Craven L, Aiyken T. Alimentry tract. Essential anatomy and some clinical applications. 3rd Edn. Edinburgh: Churchill Livingstone; 1983:123.

35) Bergmann RA, Thompson SA, Afifi AK, Saadeh FA. Compendium of Human Anatomic Variation. 1st Edn. Baltimore-Mucich: Urban and Schwarzenberg; 1988: 405-7.

36) Kornblith PK, Scot J, Boley, Whitehouse BS. Anatomy of the sphlanchnic Circulation. The surgical clinics of North America 1992; 72: 12-5.

37) Pityński K, Skawina A, Gorczyca J, Strek P, Nowogrodzka-Zarórska M. Blood vascular organization of the walls of vermiform appendix from human fetus. Examination of vascular corrosion casts in SEM. Folia Morphol (Warsz) 1993; 52: 109-17.

38) Ranganathan TS. Abdomen-Superior mesenteric artery. A text book of Human Anatomy. 5thEdn. New Delhi: S.Chand and company Ltd; 1996: 327.

39) Yada H, Sawai K, Taniguchi H, Hoshima M, Katoh M, Takahashi T. Analysis of vascular anatomy and lymph node metastases warrants radical segmental bowel resection for colon cancer. World J Surg 1997; 21: 109-15.

40) Simon AM, Birnbaum BA, Jacobs JE. Isolated infarction of the cecum: CT findings in two patients. Radiology 2000; 214: 513-6.

41) Larsen WJ. Abdominal cavity and abdominal viscera. Saunders: Philadelphia; 2002: 244-5.

42) Gopalipour MJ, Arya B, Azarhoosh P, Jahanshahi M. Anatomical variations of vermiform appendix in south east Caspian sea (Gorgan-Iran). J Anat. Soc. India 2003; 52:141-3.

43) Sinnatamby CS. Abdomen –vessels & nerves of gut & gastrointestinal tract. Last's anatomy Regional & applied. 11th Edn. Edinburg: Churchill Livingstone; 2006: 253-66.

44) Snell RS .The abdomen: Part 2 –The abdominal cavity .Clinical Anatomy by regions. 8th Edn. New Delhi: Walter Kluver (India) pvt Ltd; 2008: 243-4.

45) Romanes GJ. The systemic circulation –Branches of abdominal aorta. In: Walls EW. Cunningham's textbook of Anatomy.15th Edn. New York: Oxford University Press Inc.; 2008: 135-7.

46) Hennawy HME, Abdalla MF, El-Osta A, Bedair EMA. Isolated ileocolic artery occlusion presented with segmental bowel infarction: a case report. Cases Journal 2009; 2: 9153.

47) Bolekan ME, Yildiz E, Kaya M, Deniz M. Appendix duplication in association with persistent cloaca and type 2 pouch colon. IJAV 2010; 3: 12-4.

48) Kulkarni UK, Kulkarni DU. Variations in arterial supply of vermiform appendix. IJAV 2011; 4: 52-4.

49) Geethanjali HT, Subhash PL. A study of variations in the position of vermiform appendix. Anatomica Karnataka 2011; 5: 23-31.

50) Bergman RA, Afifi AK, Miyauchi R. Illustrated Encyclopedia of Human Anatomic Variation: Opus II: Cardiovascular System: Arteries: Abdomen. [Cited on 19 May 2011]. Available from http://www.anatomyatlases.org/ Anatomic Variants/Cardiovascular/Text/Arteries/MesentericSuperiorVari.shtml.

PROFORMA

Sp no	Origin of common caecal artery	Origin of anterior caecal artery	Origin of posterior caecal artery	Origin of appendicular artery	Variations

Signature of PG **Signature of Guide**

MASTER CHART

Sp no	Origin of common caecal artery	Origin of anterior caecal artery	Origin of posterior caecal artery	Origin of appendicular artery	Variations
1	ID	CCA	2 from CCA	CCA	2 PCA present
2	ID	CCA	3 from CCA	ID	3 PCA present
3	--	2 from ID	3 from ID	MA from ICA AAA from ID CA from PCA	3 PCA,3 appendicular arteries present
4	--	AA between SD and ID	4 from AA between SD and ID	PCA	AA present between SD and ID, 4 PCA present
5	--	AA between SD and ID	4 from AA between SD and ID	AA between SD and ID	AA present between SD and ID, 4 PCA present
6	ID	CCA	2 from CCA	ID	AA present between MA and PCA,2 PCA present
7	AA between SD and ID	CCA	3 from CCA	AA between SD and ID	AA between SD and ID, 3 PCA present
8	ICA	CCA	2 from CCA	ICA	2 PCA present
9	SD	2 from AA between CCA and ASA	3 from AA between CCA and ASA	SD	AA between CCA and ASA, 2 ACA and 3 PCA present
10	ID	1 from ID and 1 from CCA	1 from ID and 2 from CCA	CCA	2 ACA and 3 PCA present.

KEY TO MASTER CHART-

SMA-Superior mesenteric artery, ICA-Ileocolic artery, SD-Superior division, ID-Inferior division, CCA-Common caecal artery, ACA-Anterior caecal artery, PCA-Posterior caecal artery, ASA-Ascending colic artery, IB-Ileal branch, MA-Main appendicular artery, AAA-Accessory appendicular artery, CA- Caeco-appendicular artery, AA-Arterial arcade.

Sp no	Origin of common caecal artery	Origin of anterior caecal artery	Origin of posterior caecal artery	Origin of appendicular artery	Variations
11	ICA	CCA	3 from CCA	PCA	AA present between 2 branches of CCA,3 PCA present
12	AA between SD and ID	2 from CCA	2 from CCA, 1 from AA between SD and ID	CCA	One AA between SD and ID, another AA between 2 branches of CCA, 2 ACA and 3 PCA present
13	--	2 from AA between SD and ID	4 from AA between SD and ID	MA from AA between SD and ID 2 CA one from ACA, another from PCA	AA present between SD and ID, 2 ACA and 4 PCA, 3 appendicular arteries present
14	ICA	CCA	4 from CCA	MA from ICA CA from PCA	AA present between 2 branches of CCA, 4 PCA and 2 appendicular arteries present
15	--	SD	SD	PCA	
16	--	SD	SD	MA from ICA AAA from IB	AAA from IB
17	--	ICA	ICA	MA from ICA AAA from IB	2 appendicular arteries present
18	--	SD	SD	MA from ICA	
19	ID	2 from AA between CCA and ASA	3 from AA between CCA and ASA 1 from AA between ASA and MA	MA from ID AAA from AA between ASA and MA CA from PCA	One AA present between CCA and ASA, another between ASA and MA,2 ACA and 4 PCA and 3 appendicular arteries present

Sp no	Origin of common caecal artery	Origin of anterior caecal artery	Origin of posterior caecal artery	Origin of appendicular artery	Variations
20	--	2 from AA between SD and ID	2 from AA between SD and ID	MA from AA between SD and ID AAA from PCA	AA between SD and ID,2 ACA, 2 PCA, 2 appendicular arteries present
21	--	AA between SD and ID	4 from AA between SD and ID	MA and AAA from AA between SD and ID	AA between SD and ID,4 PCA, 2 appendicular arteries present
22	--	ICA	ID	ID	SD continued as ACA
23	ICA	CCA	CCA	MA from ICA AAA from CCA	2 appendicular arteries present
24	ID	CCA	2 from CCA	MA from ID CA from PCA	2 PCA and 2 appendicular arteries present
25	--	SD	3 from SD	PCA	3 PCA present

KEY TO MASTER CHART-

SMA-Superior mesenteric artery, ICA-Ileocolic artery, SD-Superior division, ID-Inferior division, CCA-Common caecal artery, ACA-Anterior caecal artery, PCA-Posterior caecal artery, ASA-Ascending colic artery, IB-Ileal branch, MA-Main appendicular artery, AAA-Accessory appendicular artery, CA-Caeco-appendicular artery, AA-Arterial arcade.

B.L.D.E.U'S SHRI.B.M.PATIL MEDICAL COLLEGE, BIJAPUR-586103

INSTITUTIONAL ETHICAL COMMITTEE

Ethical Committee BIJAPUR-586103 OUT WARD No 123/10 Date 19/10/10 BLDEA's Shri B. M. PATIL Med.cal College

DR.M.S.BIRADAR
CHAIRMAN .I.E.C.
BLDEU'S SHRI: B.M.PATIL MEDICAL COLLEGE
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INSTITUTIONAL ETHICAL CLEARANCE CERTIFICATE

The Ethical Committee of this college met on 19-10-2010 at 10-30 am to scrutinize the Synopsis/Research projects of post graduate student/undergraduate student/Faculty members of this college from ethical clearance point of view. After scrutiny the following original/corrected & revised version Synopsis of the Thesis/Research project has been accorded Ethical Clearance.

Title "Study of arterial Supply of Caecum and Appendix" — x — — x —

Name of P.G. /U.G.Student /Faculty member Dr. Ashwini Nuchhi Dept of Anatomy

Name of Guide Dr. B.G.Patil Prof. Anatomy

DR.M.S.BIRADAR
CHAIRMAN
INSTITUTIONAL ETHICAL COMMITTEE

Following documents were placed before E.C.for securitization:
1) Copy of Synopsis/Research project
2) Copy of informed consent form
3) Any other relevant document's