International Journal of Anatomy and Research,
Int J Anat Res 2016, Vol 4(1):2062-68. ISSN 2321-4287
DOI: http://dx.doi.org/10.16965/ijar.2016.141

Original Research Article

SURGICAL SIGNIFICANCE OF INFERIOR MESENTERIC ARTERY AND ITS BRANCHING PATTERN

Raja Reddy Gangam *[1], Sindhura Sadanandam Sharon [2].

*[1] Associate Professor, Department of Anatomy, Rajiv Gandhi Institute of Medical Sciences (RIMS), Adilabad, Telangana, India.

[2] Assistant Professor, Department of Anatomy, Rajiv Gandhi Institute of Medical Sciences (RIMS), Adilabad, Telangana, India.

ABSTRACT

Introduction: Inferior Mesenteric Artery (IMA) is a major anterior branch of the abdominal aorta and is responsible for supplying arterial blood to the organs of the hind gut. The present study was conducted to emphasize branching pattern of the inferior mesenteric artery, anatomical variations and its surgical significance. Knowledge of the arterial supply of the gut is essential for anatomists and surgeons for the safety and survival of patients in standard operative procedures.

Materials and Methods: This study was conducted on 100 cases out of which seventy five were adult cadavers (40 - 70 years) and 25 fetuses (28 – 38 weeks) in the Dept. of Anatomy, Gandhi Medical College, Musheerabad, Secunderabad, Telangana, India.

Results: the most common branching pattern of inferior mesenteric artery was into LCA in 74 (98.66%) cadavers and common sigmoid trunk gave off 3-4 sigmoid arteries. LCA was absent in one (1.33%) case of adult and one (4%) case of fetuses. Bifurcation of LCA has taken place close to its origin in 20% cases and in another 80% of the cases close to its splenic flexure. In 10.67% cases 1st sigmoid has taken origin from LCA and formed loop of anastomoses with ascending branch of LCA. Sigmoid arteries were 1-4 in number with variations observed in the mode of origin and their number. In 20% of cases one sigmoid has taken origin directly from IMA which later continued as superior rectal artery.

Conclusion: The detailed knowledge of anomalous branching pattern of IMA and its distribution is of immense significance for surgeons particularly, when performing laparoscopic abdominal surgery. Knowledge of the arterial supply of the gut is essential for anatomists and surgeons for the safety and survival of patients in standard operative procedures.

KEY WORDS: Abdominal Aorta, Inferior Mesenteric Artery, Sigmoid Arteries, Superior Rectal Artery.

Address for Correspondence: Dr. Raja Reddy Gangam, M.D. Associate Professor, Department of Anatomy, Rajiv Gandhi Institute of Medical Sciences (RIMS), Adilabad-504001. Telangana, India. Mob: 91 9441490535 **E-Mail:** gangamrajareddy@gmail.com

Access this Article online

Quick Response code

DOI: 10.16965/ijar.2016.141

Web site: International Journal of Anatomy and Research
ISSN 2321-4287
www.ijmhr.org/ijar.htm

Received: 08 Feb 2016 Accepted: 20 Feb 2016
Peer Review: 09 Feb 2016 Published (O): 31 Mar 2016
Revised: None Published (P): 31 Mar 2016

INTRODUCTION

Inferior Mesenteric Artery (IMA) is a major anterior branch of the abdominal aorta that supplies arterial blood to the organs of the hind gut. It is the smallest of the three anterior branches of the abdominal aorta. The inferior mesenteric artery, often abbreviated as IMA, is the third main branch of the abdominal aorta. The IMA is responsible for supplying blood flow to the large intestine from the left (or splenic) flexure to the upper part of the rectum. These include the distal one third of the transverse

colon, descending colon, sigmoid colon, as well as most of rectum [1,2].

Branches of IMA: There are three major branches that arise from the IMA. These branches include [3]:

1. Left colic artery
2. Sigmoid arteries
3. Superior rectal artery

All these arterial branches further divide into arcades which then supply the colon at regular intervals.

Left Colic Artery: The left colic artery (LCA) is the first branch of the IMA supplies the distal one third of the transverse colon and the descending colon. After arising from its parent artery, it travels anteriorly to the psoas major muscle, left ureter and left internal spermatic vessels, before dividing into ascending and descending branches.

The ascending branch anastomoses with left branch of the middle colic artery. The descending branch anastomoses with the superior sigmoid artery. From the arches formed by these anastomosis branches are distributed to the distal one third of the transverse colon, and the upper aspect of the descending colon.

Sigmoid (Inferior Left Colic) Arteries: The sigmoid arteries supply the distal descending colon and the sigmoid colon. There are typically 2-4 branches, with the uppermost branch termed the **superior sigmoid artery**. It anastomoses superiorly with the left colic and inferiorly with the superior rectal artery.

Superior Rectal (haemorrhoidal artery) Artery (SRA): The superior rectal artery is the principal continuation of the IMA, supplying the rectum. It descends into the pelvis, crossing the left common iliac artery and vein. At the third sacral vertebra, the artery divides into two terminal branches. It descends one on either side of the rectum and about 10 or 12cm from anus, breaks up into several small branches. It forms collateral network with the middle rectal arteries and inferior rectal arteries [1, 2].

Detailed knowledge of the anatomical variations of the visceral branches of the abdominal aorta is of extreme clinical importance, particularly, when performing laparoscopic abdominal surgery. Further, colonic vascular supply has some weak areas which have been reported to be highly predisposed to ischemic colitis [4-6]. Notable examples are Griffths' point at the left colic flexure [7, 8] and the Sudeck's point at the rectosigmoid region [8-10].

Knowledge of the arterial supply of the gut is essential for anatomists and surgeons for the safety and survival of patients in standard operative procedures. Therefore, the present study was undertaken to emphasize inferior mesenteric artery, its branching pattern and its surgical significance. The enlightenment and proper knowledge of IMA and its branching pattern as mentioned above will provide the surgeon with proper guidelines in ligating the IMA and its branches during surgical resections in conditions like colorectal malignancies at proper levels to prevent postoperative gangrenous changes in the leftover viable large gut. A thorough knowledge of the anatomy of the celiac, superior mesenteric, and inferior mesenteric arteries and their variants is necessary to accomplish a successful, uncomplicated abdominal operation.

Therefore, this paper is aimed to study the branching and distribution pattern of inferior mesenteric artery. The objectives of which include: To trace the origin of IMA and identify their branches, to study the course of inferior mesenteric artery, to observe the anatomical variations of IMA and to study the branching pattern of IMA.

MATERIALS AND METHODS

A total of seventy five human cadavers with age ranging between 40 to 70 years (52 male and 23 female cadavers) and 25 fetuses within the range of 28 – 38 weeks were used in the study. Dead and unclaimed fetuses were obtained mainly from the maternity wing of Gandhi Hospital, Musheerabad, Secunderabad, Telangana, India. The dissection was conducted as per Cunningham's manual of practical anatomy [11]. The peritoneum and the visceras were separated carefully and cleaned from the field of view.

Approval of the ethical committee from Osmania Medical College, Koti, Hyderabad, and Mediciti Medical College, Hyderabad and including

parent institution Gandhi Medical College, Musheerabad, Secunderabad was taken and the observations were made over the selected 75 cadavers and 25 fetuses. The whole dissection was carried out meticulously to locate the abdominal aorta which lies in the deeper plane from which the inferior mesenteric artery takes origin above the level of its bifurcation. After locating the abdominal aorta along with the origin of IMA, the branching pattern of IMA was neatly explored in all the fetuses.

RESULTS

Inferior mesenteric artery and its branches that originated from abdominal aorta were traced and identified in all the cadavers of the present study.

Origin: In all the 75 cadavers and 25 fetuses studied, IMA was found to spring from abdominal aorta (Table 1) a few cm proximal to the bifurcation of aorta (Table 2). The origin and course of IMA has great surgical significance. In the present study IMA showed normal pattern in 56 (75%) cases. The abdominal aorta gave off IMA at the level of the third lumbar vertebra (L3). IMA took origin from the aorta 2-5.2cm proximal to its bifurcation (Table 2).

Table 1: Origin of Inferior Mesenteric Artery from aorta in adult cadavers and fetuses.

Origin	Adult		Fetus	
	Aorta	Other	Aorta	Other
Number of cadavers	75	0	25	0
Percentage (%)	100	0	100	0

Table 2: Distance from origin of aorta to the bifurcation of inferior mesenteric artery.

Number of cadavers	Mean (cm)	Median (cm)	SD	Min (cm)	Max (cm)
75	3.68	3.73	0.804	2	5.2

Branches of IMA: In most of our cadavers studied IMA gave off three branches (Table 3 and Fig. 1). The most common branching pattern of inferior mesenteric artery was into LCA in 74 (98.66%) cadavers and common sigmoid trunk which gave off 3 - 4 sigmoid arteries. LCA was absent in only one single (1.33%) cadaver out of 75 adult cadavers (Fig. 2A) and one (4.00%) case out of 25 fetuses and two sigmoid vessels were found to be arising from IMA (Fig. 2B) giving origin to two small branches and continued as superior rectal artery (SRA).

Fig. 1: Branches of inferior mesenteric artery in the cadavers studied.

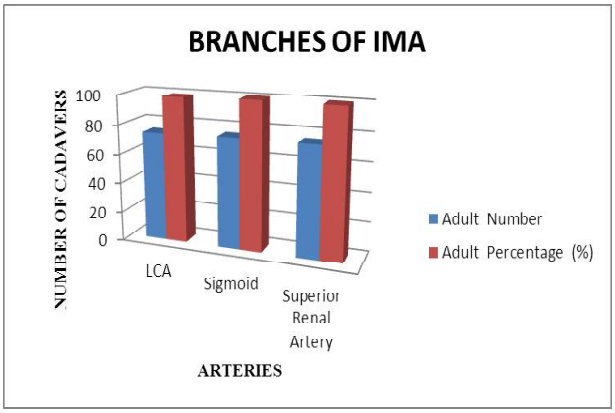

Table 3: Branches given by inferior mesenteric artery.

Branch	Adult		Fetus	
	Number	Percentage (%)	Number	Percentage (%)
LCA	74	98.66	24	96
Sigmoid	75	100	25	100
Superior Renal Artery	75	100	25	100

Left Colic Artery: The left colic artery (LCA) is the first branch of the inferior mesenteric artery, and the normal pattern was seen in 70% of the present series. The LCA crosses the psoas major and then divides into terminal branches the ascending and descending branches. The ascending branch travels in the transverse mesocolon and anastomoses with the left branch of middle colic. The ascending branch reached the splenic flexure where it bifurcated into two rami, the right and left. This normal pattern of branching was observed in 80% of the cases studied.

In the present study bifurcation of LCA has taken place close to its origin and only one sigmoid vessel was found arising from IMA (Fig. 2C) in 20% of cases. In other 80% of cases bifurcation was observed to take place close to splenic flexure and two sigmoid vessels arising from IMA (Fig 2D) similar to the observation reported in 89% of his cases [7]. The point of bifurcation is named after Griffith as Griffith point which has lot of surgical significance. During surgical intervention of colorectal malignancies, ligation of LCA is advised close to the level of bifurcation by many surgeons.

In two out of 100 cases i.e., one each in 75 adult cadavers and 25 fetuses LCA was found to be absent. In such cases 1st sigmoid may anastomose with middle colic to fulfill the role of LCA. In about 30% of cases in the present study 1st sigmoid has taken origin from LCA (Fig. 2E) which formed a loop of anastomosis with ascending branch of LCA (Fig 2F). In 2 (2.67%) cadavers out of 75 cases in the present study LCA has shown only ascending branch. No bifurcation of LCA was seen neither close to its origin nor to splenic flexure in the above cases as observed by Griffith [7].

There was an anastomosis loop connecting both the rami which complete the 'marginal artery of Drummond'. The point of bifurcation of the rami constitutes the Griffith's point and the anastomotic arc between the two rami observed in 89% of the cases by Griffith [7].

The inferior mesenteric artery supplies the terminal part of the transverse colon, left colic flexure, descending colon, pelvic colon and greater part of the rectum. It arises from the aorta 1.5" above its bifurcation and close to the lower border of the third part of the duodenum at the level of the third lumbar vertebra. It lies on the left side of the aorta, crosses the left common iliac near the medial side of the left ureter and is continued in the pelvic mesocolon as the superior rectal artery. The inferior mesenteric vein lies on its lateral side. This normal pattern was observed in 75% of the cases studied.

Congenital anomalies of the various structures belonging to the urinary system are not uncommon. The embryological interaction of nephrogenic tissue and IMA is a rare developmental anamoly and draws a dramatic clinical application in the field of Nephrology. In a male cadaver of 60yrs age multiple lobulated fused renal masses were observed, giving a single 'J' shaped appearance, located in the midline at the level between the L4 and L5 vertebrae, on left side. Hilum was facing anteriorly and this fused nephrotic mass had two ureters. The kidney was observed to be absent on the right side. The trunk of inferior mesenteric artery taking origin from abdominal aorta has crossed the parenchyma of the fused mass of nephrotic tissue on the left side (Fig. 3A) which is one of the possible congenital anomalies.

In one cadaver, the middle colic artery takes over the area of LCA where it's left branch become very prominent, converge over the splenic flexure and forms the marginal artery with 1st sigmoid artery. There was no marked change observed in the formation and size of vasa recta of the marginal artery. In second cadaver both the arc of Riolan and the marginal arteries were continuous without any interruption. LCA is a major central linking segment of marginal artery of Drummond (Fig. 3B) and the arcade of Riolan. These anterior arcades are the part and parcel of SMA, IMA which are important pathways for potential collateral circulation of the gut.

Sigmoid arteries: The sigmoid arteries were 1-4 in number. They crossed in front of psoas major ureter, and testicular vessels. They supplied the pelvic colon and the lower part of the descending colon. The first sigmoid artery anastomosed with the descending branch of the left colic artery. In 70% of the cases, the sigmoid arteries presented this normal pattern.

The number of sigmoid arteries were variable between 1- 4. Variations of the sigmoid arteries were in the mode of origin and number of the sigmoid arteries. First sigmoid was found to be arising from LCA in 30% of cases. Sigmoid arteries were arising from IMA in 70% of the cases in present study (Fig. 3C & 3D). In few cases only ascending branch of LCA was found to be arising from IMA distinctly and rest of the four sigmoid arteries were seen to take origin from IMA in the form of cluster (Fig. 3E). In one interesting case in addition to the absence of LCA only one sigmoid has taken origin from IMA and which in turn has given origin to 2 – 3 small branches. In one fetal specimen also such presentation was observed. In about 20% of the present cases only one sigmoid has taken origin directly from IMA which later continued as superior rectal artery (Fig 3F).

Superior rectal artery: The superior rectal is the direct continuation of the inferior mesenteric artery. It descends between the layers of the pelvic mesocolon and crosses the left common iliac vessels. It divides into two branches which supply the rectum and anastomose with the

Fig. 2: A- Absence of left colic artery, B- absence of LCA and 2 sigmoid vessels arising from IMA in fetus, C- bifurcation of LCA close to its origin and only one sigmoid vessel arising from IMA, D- bifurcation of LCA close to splenic flexure and 2 sigmoid vessels from IMA, E- 1st sigmoid arising from LCA, F- 1st sigmoid vessel anastomosing with ascending branch of LCA.

Fig. 3: A- trunk of IMA crossing parenchyma of fused mass of nephrotic tissue, B- marginal artery of Drummond, C- sigmoid vessels arising from IMA, D- 3 – 4 sigmoid vessels arising from IMA, E- only ascending branch of LCA arising from IMA and 4 sigmoid vessels arising from IMA in the form of cluster, F- one sigmoid vessel taken origin from IMA and continuation of superior rectal artery.

middle rectal arteries. In all the specimens of the present study rectal artery showed the above mentioned pattern.

DISCUSSION

According to Simeon, Philip, Johnstone and Hassan [12], the inferior mesenteric artery most commonly divides into LCA and common sigmoid trunk. According to Hamilton and Boyd Mossman [13] the inferior mesenteric artery supplies the derivatives of the hind gut. In the present study, 70 - 80% of the cadavers showed normal branching pattern with some variations. IMA gave three branches namely LCA in 74 (98.66%) cadavers, sigmoid and superior rectal artery (100%). According to a study, the inferior mesenteric artery most commonly divides into LCA and common sigmoid trunk [12]. Decker GAG et al. and Rekha M et al. reported absence of LCA in 6% and 1.34% of the cases respectively [2,14]. The absence of the left colic branch has been reported by Sonneland, Anson and Beaton [15]. Griffiths [7] noted absence of LCA in 6 cases and in all these cases the first sigmoid artery only was well developed reached up to splenic flexure to anastomose with the middle colic artery. Similar findings were observed in the present study with the absence of LCA in two cases, one (1.33%) out of 75 in adult cadavers and one (4%) out of 25 in the fetuses studied. In such cases 1st sigmoid may anastomose with middle colic to fulfill the role of LCA. In about 8

(10.67%) of the cases in the present study, 1st sigmoid has taken origin from LCA which formed a loop of anastomoses with ascending branch of LCA. In 61% of the cases observed by Michels, Siddharth, Kornblith and Parke [9] anastomotic arc connecting with rami of the ascending branch of left colic was observed.

In addition to absence of LCA only one sigmoid was observed to arise from IMA giving origin to two small branches and continued as superior rectal artery. Greenbergh and Brookyln [16] based on their observations in 74 autopsy specimens stated that in 54 cases the left colic was arising from the inferior mesenteric separately, whereas in 20 cases it was arising in common with sigmoid vessels. In the present study we have observed first sigmoid taking origin from LCA in 30% of cases and in rest of 70% of cases first sigmoid along with other sigmoid branches has taken origin from IMA directly. Griffiths [7] stressed the importance of preserving the point of bifurcation in those cases where the arcade was absent, the rami act as marginal artery in maintaining the collateral circulation. Hence, the point of bifurcation of the rami was named after Griffith as "Griffith's point". He stated that care has to be taken to ligate the left artery proximal to its bifurcation, in order to ensure adequate blood supply to the distal colon. In the present study, the origin of sigmoid arteries from IMA was observed in 70% of the cases.

Marginal artery of Drummond plays a vital role in maintaining the viability of large gut during surgical resections of large part of large bowel which includes ligation of IMA which is the main vessel of hind gut at the level of its origin from abdominal aorta. Inspite of ligation of IMA at root level from abdominal aorta during resection of colon and rectum in surgical interventions of colorectal malignancies, the left over large bowel after resection will survive but for the presence of potential blood flow through paracolic arcade formed by marginal artery of Drummond. In the present study normal pattern of paracolic vascular arcade of marginal artery of Drummond was observed.

The number of sigmoid arteries was variable as the observations made by [7,9,17,18] the arteries were between 2-3 in 85% cases.

In the present study the picture is as follows:

1. Four sigmoid arteries – 20%
2. Three sigmoid arteries – 40%
3. Two sigmoid arteries – 20%
4. One sigmoid artery – 20%.

There is a lot of controversy regarding the mode of origin of the sigmoid arteries by various workers. The definition of these vessels was very vague which led to much confusion in naming these arteries. The sigmoid vessels however, were described aptly by Griffiths [7] as those vessels which travel in the sigmoid mesocolon at least in part of their course, irrespective of their origin. In the present study the sigmoid arteries were seen arising from the inferior mesenteric except, in 10.67% cases the first sigmoid vessel has taken origin from LCA directly. Griffiths [7] described the origin of these vessels from inferior mesenteric in 36% out of 100 cases and from left colic in 30% cases. However, Greenberg and Brookyln [16] believed that these vessels arise more commonly from the left colic than inferior mesenteric directly. The findings in the present study approximate more closely to those of Griffiths [7] rather than of Greenberg and Brookyln [16]. Griffiths [7] described other modes of origin which were not observed in the present study.

The trunk of inferior mesenteric artery taking origin from abdominal aorta has crossed the parenchyma of the fused mass of nephrotic tissue on the left side, which is one of the possible congenital anomalies. As per the information provided by Decker and du Plessis [2], possibility of two kidneys ascending towards one side is possible where the parenchyma of two kidneys may be presenting in the form of fused lobular masses with double ureter. On the other side the kidney was observed to be absent. This may be correlated to the interpretation of Decker and du Plessis [2] as a possible congenital anamoly. Such embryological picture of interaction of nephrogenic tissue and IMA is a rare developmental anamoly and draws a dramatic clinical interest in the field of Nephrology. In the present study the normal pattern of paracolic vascular arcade of marginal artery of Drummond was observed.

CONCLUSION

The detailed knowledge of anomalous branching pattern of IMA and its distribution is of immense significance for surgeons particularly, when performing laparoscopic abdominal surgery. Knowledge of the arterial supply of the gut is essential for anatomists and surgeons for the safety and survival of patients in standard operative procedures.

Conflicts of Interests: None

REFERENCES

[1]. Standring S. Gray's Anatomy, The Anatomical Basis of Clinical Practice. 40th Ed. Philadelphia, Elsevier, Churchill Livingstone, 2008; ch. 66,67:1125-1137.
[2]. Decker GAG, du Plessis DJ. Lee McGregor's Synopsis of Surgical Anatomy. 12th ed., Bristol, John Wright and Sons Ltd. 1986; pp. 250-251.
[3]. Ufl acker R, Selby JB. Atlas of vascular anatomy: an angiographic approach. 2nd ed. Philadelphia: Lippincott Williams and Wilkins. 2007;16:p. 95.
[4]. Longo WE, Ballantyne GH, Gusberg RJ. Ischemic colitis: patterns and prognosis. Diseases of the Colon and Rectum. 1992;35(8):726-730.
[5]. Bower TC. Ischemic colitis. Surgical Clinics of North America. 1993; 3 (5): 1037 – 1053.
[6]. Farman J. Ischemic colitis. Abdominal Imaging. 1995; 20 (1): 85 – 86.
[7]. Griffiths JD. Surgical anatomy of the blood supply of the distal colon. Annals of the Royal College of Surgeons of England. 1956;19(4):241-256.
[8]. Yamazaki T, Shirai Y, Sakai Y, Hatakeyama K. Ischemic stricture of the rectosigmoid colon caused by division of the superior rectal artery below Sudeck's point during sigmoidectomy: report of a case. Surgery Today. 1997;27(3):254-256.
[9]. Michels NA, Siddharth P, Kornblith PL, Parke WW. The variant blood supply to the descending colon, rectosigmoid and rectum based on 400 dissections. Its importance in regional resections—a review of medical literature. Diseases of the Colon and Rectum. 1965;8(4):251-278.
[10]. Sudeck P. Über die Gefässversorgung des Mastdarmes in Hinsicht auf die operative Gangrän. Münchener Medizinische Wochenschr. 1907;54:1314-1317.
[11]. Cunningham DJ. Cunninghan's manual of practical anatomy Cunningham. 2nd Edition, Volume 1. Humphrey Milford, Oxford University Press, London. 1896;pp. 1414.
[12]. Simeon S, Philip M, Johnstone M, Hassan S. Branching Pattern of inferior mesenteric artery in a Black African population: A dissection study. Int Sch Res Notices Anat. 2013;1-4.
[13]. Hamilton WJ, Mossman HW. Human embryology. Baltimore: Williams and Wilkins. 1976;p. 646.
[14]. Rekha M, Charushila DS. Morphometric Study of Inferior Mesenteric Artery and its Branches. Indian Journal of Applied Research. 2015;5(4):580-582.
[15]. Sonneland J, Anson BJ, Beaton LE. Surgical anatomy of the arterial supply to the colon from the superior mesenteric artery based upon a study of 600 specimens. Surg Gynecol Obstet. 1958;106:385-398.
[16]. Greenberg MW, Brooklyn NY. Blood supply of the rectosigmoid and rectum. Ann. Surg. 1950;131:100-108.
[17]. Steward JA, Rankin FW. Blood supply of the large intestine. Its surgical considerations. Arch. Surg. 1933;26:843-891.
[18]. Drummond H. The arterial supply of the rectum and pelvic colon. Br. J. Surg. 1913; 1:677-685.

How to cite this article:

Raja Reddy Gangam, Sindhura Sadanandam Sharon. SURGICAL SIGNIFICANCE OF INFERIOR MESENTERIC ARTERY AND ITS BRANCHING PATTERN. Int J Anat Res 2016;4(1):2062-2068.
DOI: 10.16965/ijar.2016.141