

ORIGIN AND MORPHOMETRY OF THE INFERIOR MESENTERIC ARTERY

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ABSTRACT

Introduction

The inferior mesenteric artery (IMA) represents a key vessel supplying the left colon and rectum. Its anatomical variability, including the site of origin, caliber, and relationship to the abdominal aorta, is clinically important for surgery and interventional radiology. A precise understanding of these parameters reduces intraoperative risks and improves surgical outcomes.

The origin, topography, course, anastomoses, and distribution of the colic arteries show high variability. As Mayo stated, “no two individuals have identical colonic blood vessels.”

A precise anatomical understanding of these variations is essential in vascular and colorectal surgery, as well as in accurate radiological interpretation.

Material and methods

The inferior mesenteric artery (IMA) was studied in 209 cases using multiple anatomical and imaging approaches: 49 dissected adult cadavers, 7 eviscerated infradiaphragmatic organ blocks, 69 simple aortic angiographies, and 94 angio-CT scans.

Results

The IMA most frequently originated from the anterior aspect of the abdominal aorta at the level of L3 (62% of cases), but variations were observed from L2 to L4. The artery’s caliber at its origin ranged from 2.1 to 4.9 mm, with a mean of 3.2 mm. The distance from the superior mesenteric artery varied between 22 and 65 mm. Multiple branching patterns were noted, including common trunks with the left colic artery in 11% of cases.

The origin of the IMA was located between the upper half of the L2 vertebra and the lower edge of L4. Its distance from the renal arteries ranged from 43.9 to 73.3 mm. The distance to the aortic bifurcation was 30–40 mm.

The IMA originated most frequently on the left anterior surface of the abdominal aorta. Its diameter varied from 2.7 to 4.0 mm, and its length ranged from 0.5 to 5.0 cm, depending on the point of origin of its first collateral branch.

Conclusions

The IMA shows significant anatomical variability in its origin and morphometry. Awareness of these variations is crucial for surgical planning, vascular interventions, and accurate imaging diagnosis. Our results provide additional data supporting the integration of anatomical and radiological methods in preoperative evaluation.

Significant anatomical variability of the IMA exists. Differences in findings among authors are attributed to the number of cases studied, measurement methods, and potential geographic or ethnic vascular characteristics.

Key words: Inferior mesenteric artery, origin, morphometry, anatomical variability, aortic branches

INTRODUCTION

Interest in the vascular anatomy of the intestines has increased significantly with the evolution of vascular surgery, which now allows for revascularization procedures in compromised territories.

Accurate interpretation of imaging studies, the selection of appropriate therapeutic strategies, and the successful execution of surgical interventions all rely on a thorough understanding of both normal and variant anatomy of the intestinal arterial supply.

The number, topography, origin, course, anastomoses, and distribution of the colic arteries are subject to such variability that one may question the existence of a true “normal” pattern.

As Mayo [1] stated, “no two individuals have identical colonic blood vessels.” This anatomical diversity has led to significant contradictions in the literature regarding the origin, distribution, number, and even the nomenclature of the inferior mesenteric artery (IMA) branches.

The IMA—also referred to as the “small mesenteric artery” is the most inferior visceral branch of the abdominal aorta and is responsible for supplying the left side of the colon and the rectum [2, 3, 4, 5, 6, 7, 8].

AIM OF THE STUDY

To determine the vertebral level of the origin of the inferior mesenteric artery (IMA) in relation to the abdominal aorta, renal arteries, and aortic bifurcation, and to evaluate its morphometry, including diameter and length.

MATERIAL AND METHODS

This study on the inferior mesenteric artery (IMA) was conducted on a total of 209 cases using both anatomical dissection and imaging techniques:

- 49 adult human cadavers were dissected over an 8-year period in the dissection halls of the Anatomy Department, Faculty of Medicine, “Ovidius” University of Constanța;

- 7 infradiaphragmatic eviscerated organ blocks (including the digestive tract, liver, spleen, kidneys, abdominal aorta, and inferior vena cava) were examined in the Forensic Medicine Laboratory in Constanța. Of these, 3 were dissected, while 4 were injected with Technovit 7143 resin and then processed via corrosion using sodium hydroxide;

- additionally, 69 plain abdominal aortograms and 94 angio-CT scans were analyzed. The angiographic images were sourced from the Radiology Clinic of the Emergency Clinical Hospital “St. Apostle Andrew” in Constanța and acquired using a GE LightSpeed 16-slice CT scanner.

This multimodal approach allowed for a comprehensive evaluation of the origin, trajectory, and morphometric characteristics of the IMA in relation to surrounding anatomical structures.

RESULTS

The origin of the inferior mesenteric artery (IMA) was examined in 161 cases. Its vertebral level of origin was assessed in 124 of these cases, with the artery arising between the upper half of the L2 vertebra and the lower edge of L4. Specifically, 16 arteries (12.90%) originated at the level of L2, with 2 arteries (1.61%) each originating from the upper half or middle of the vertebra. Twelve arteries (9.68%) arose from the lower half of L2, and in 8 of these cases (6.45%) the origin was at the lower edge.

Additionally, 16 arteries (12.90%) arose at the L2-L3 intervertebral disc level.

Figure 1 illustrates representative cases of L2 and L3 vertebral origins.

The most frequent origin was at the L3 vertebra (70 cases, 56.45%), including: 32 cases (25.81%) from the upper half of L3, with 4 of these (3.23%) from the upper edge; 10 cases (8.06%) from the mid-body; and 28 cases (22.58%) from the lower half, of which 14 (11.29%) were at the lower edge.

The L3-L4 disc level was the origin in 18 cases (14.52%), and L4 in 4 cases (3.23%).

The relationship between the origin of the inferior mesenteric artery (IMA) and the right renal artery (RRA) was assessed in 54 cases.

The distance between them ranged from 53.2 to 73.3 mm. In 26 cases (48.15%), the separation included one vertebral body and 1-2 intervertebral discs. Only in 2 cases (3.70%) was the separation strictly one vertebral body and one disc. In the remaining 24 cases (44.44%), there was also a segment (half or less) of an adjacent vertebral body and one or two discs.

The vertebral body most frequently involved in these separations was L2 (20 cases, 37.04%), followed by L1 and L3 (2 cases each, 3.70%).

A distance of two vertebral bodies and 1-2 intervertebral discs between the IMA and RRA was also found in 26 cases (48.15%). Among these, L2-L3 was the most common pair (22 cases, 40.74%).

The intervertebral discs most frequently involved were L1-L2 and L2-L3. In 28 cases (51.85%), only one disc separated the arteries (L2-L3 in 16 cases, L1-L2 in 12 cases).

In 2 cases, the distance involved segments of two adjacent vertebrae (less than one full vertebral body) and one intervertebral disc.

As for the left renal artery (LRA), the IMA-LRA relationship was examined in 58 cases. The distance ranged from 43.9 to 57.1 mm.

In 42 cases (72.41%), a single vertebral body separated their origins—most commonly L2 (36 cases, 62.07%) and in 6 cases, L3 (10.34%).

In 14 cases (24.14%), two vertebral bodies separated them most often L2 and L3 (12 cases).

A single intervertebral disc was found between them in 46 cases (79.31%): L2-L3 in 26 cases, and L1-L2 in 20.

In 12 cases (20.69%), two discs were present L1-L2 and L2-L3 in 10 cases, L2-L3 and L3-L4 in 2.

In 2 cases (3.45%), the distance was formed by partial segments of two adjacent vertebrae and their corresponding disc.

Regarding the aortic bifurcation, the origin of the IMA was studied in 80 cases. The distance between them ranged from 30 to 40 mm.

Figure 2 shows a typical relationship between the IMA, renal arteries, and aortic bifurcation.

In 48 cases (60%), this distance corresponded to one vertebral body most often L4 (28 cases), followed by L3 (20 cases).

In 30 cases (37.5%), the separation was shorter than a full vertebral body and consisted of partial segments from two adjacent vertebrae plus one intervertebral disc (26 cases), or a partial segment of a single vertebra (2 cases).

Only 2 cases (2.5%) had two full vertebrae (L2 and L3) between the IMA and the bifurcation.

In 18 cases (22.5%), there was no intervertebral disc between the two origins.

The origin of the IMA in relation to the anterior surface of the aorta was analyzed in 130 cases.

Most frequently (86.15%, 112 cases), the origin was to the left of the aortic midline, including: near the midline in 48 cases, on the anterolateral surface in 52, and on the lateral surface in 12. In 14 cases (10.77%), the artery arose on the midline, and in 4 cases (3.08%) to the right of it.

Figure 3 displays a rare right-sided origin of the IMA.

The course and direction of the IMA trunk were analyzed in 130 cases. In 25 cases (19.23%), the artery had a vertical trajectory, either rectilinear down the anterior surface of the aorta (in 11 cases), or descending to the aortic bifurcation – 7 on the midline, and 4 on the anterolateral face.

In the remaining 105 cases (80.77%), the artery followed an oblique inferolateral path to the left, showing either a straight (33 cases) or wavy course (72 cases).

Of the latter, 46 had a right-concave curve, 12 had an S-shaped double curve, 8 had a left-concave curve, and 6 showed double right-concave curves.

In 102 cases, the level at which the IMA left the anterior aortic wall was also assessed: in 64 cases (62.75%), it departed at the vertebral level of origin; in 38 cases (37.25%), it became latero-aortic at a lower level.

The diameter of the IMA ranged from 2.7 to 4.0 mm, and was always smaller than that of the celiac trunk, superior mesenteric artery, or single renal arteries.

IMA length was highly variable.

The artery sometimes gave off its first branch within 0.5–1 cm from its origin (short trunk), or more distally at 1.5–2.5 cm (medium/long trunk). Overall length before issuing the final sigmoid branches ranged between 2.0 and 5.0 cm.

Finally, the angle formed between the IMA and the anterior aortic wall was relatively narrow (2° - 5°) in vertical trajectories, and larger (15° - 84°) in oblique courses.

Figure 4 illustrates the oblique course and angle of the IMA.

DISCUSSION

Our results regarding the origin of the inferior mesenteric artery (IMA) are consistent with the data presented by [8], with most authors locating the artery's origin at the level of the L3 vertebra [2, 6, 8, 10, 11].

Only [5] mentioned the L3 and L4 vertebrae with the intervertebral disc between them, while [7, 12] specified the L3–L4 disc itself. In our study, we classified origins at the L2 vertebra and L2–L3 disc as high origin (25.81% of cases), and those at L4 as low origin (3.23%).

The majority of origins – 88 arteries (70.97%) – were located between these two extremes, at the L3 vertebra or the L3–L4 disc.

Table 1. Origin of the IMA relative to the vertebral column – comparison of our findings with literature data.

Author	Level of origin
Adachi	Inferior third of L2 – inferior third of L4
Paturet	Lower edge of L3
Rouvière	L3, L3–L4 disc, L4
Pillet	L3
Gray	L3
Lippert-Pabst	Inferior third of L3
Pennington	Inferior third of L3
Kamina	L3–L4 disc
Dahmani	L3–L4 disc
Current study	Upper half of L2 – lower edge of L4

In most cases, the IMA originated on the left side of the vertebral body and the anterior surface of the aorta.

Rarely, the artery originated centrally, and in very few cases laterally to the vertebral column. According to the literature, most authors describe the IMA origin as left of the midline.

Only [2, 8] mention that midline or right-sided origins are possible but uncommon.

Table 2. IMA origin relative to the aortic midline.

Author	IMA Position Relative to Midline
Testut	Left of midline
Paturet	Left of midline (occasionally)
Rouvière	Left of midline
Pillet	Left of midline
Gray	Left of midline
Dahmani	Left of midline
Current study	Left: 86.15% Midline: 10.77% Right: 3.08%

In terms of distance from the renal arteries, [11] reported a shorter distance compared to ours by approximately 7 mm for the right renal artery and for the maximum distance to the left renal artery.

For the minimum distance to the left renal artery, our findings were about 2 mm shorter.

Regarding the distance between the IMA and the aortic bifurcation, [2, 5, 12] reported values of 40–50 mm, 10 mm more than our findings. [3, 4] reported even greater distances, 50–60 mm.

Our results were closer to those of [Okinczyc, 6, 7, 8], who found distances between 30 and 40 mm.

Table 3. Distance of IMA from renal arteries and aortic bifurcation.

Author	Distance to Renal Arteries	Distance to Aortic Bifurcation
Paturet	—	40–50 mm
Rouvière	—	40–50 mm
Okinczyc	—	30–40 mm
Testut	—	50–60 mm
Gray	—	30–40 mm
Pennington	56 ± 10 mm	—

Pillet	56.8 ± 10 mm	30–40 mm
Kamina	—	40 mm
Dahmani	—	50 mm
Current study	RRA: 53.2–73.3 mm LRA: 43.9–73.3 mm	30–40 mm

In relation to the third portion of the duodenum, [2, 5, 8, 9] frequently observed that the IMA originated posterior to it.

[6] described the origin below this segment as less common. Our data confirm that the most frequent positioning is posterior to the third part of the duodenum, followed by a higher origin (retropancreatic), and rarely a lower origin.

Regarding diameter, the IMA was consistently smaller than the celiac trunk (5–12.5 mm), the superior mesenteric artery (5.7–10.2 mm), and both right and left renal arteries.

Our findings showed a diameter between 2.7–4.0 mm, which is:

- 1–1.3 mm smaller than [2],
- 0.5–1.8 mm smaller than [6],
- 1–2.3 mm smaller than [7],
- and equal to or up to 1.3 mm smaller than [12].

Table 4. Diameter of the IMA – our results compared to the literature.

Author	IMA Diameter
Paturet	4–5 mm
Gray	4.5 mm
Pennington	4.5 ± 1 mm
Kamina	5 mm
Dahmani	4 mm
Current study	2.7–4.0 mm

The **true length** of the IMA is difficult to establish due to discrepancies in the literature regarding its point of termination. This may explain why many authors either omit this detail or mention it only briefly.

CONCLUSIONS

The present study on the morphology of the inferior mesenteric artery (IMA) confirms its high anatomical variability in terms of both origin and morphometry.

The significant differences reported in the literature concerning the spatial relationships and dimensions of the IMA can be attributed to several factors: the number of cases examined, the diversity of investigative methods (e.g., dissection, ultrasound, CT), and the precision of measurement tools employed.

Classical anatomical descriptions are often based on small sample sizes—sometimes fewer than ten cases which limits the reliability and comparability of results.

Moreover, discrepancies between findings from the same author at different time points suggest that cumulative case volume influences reported patterns.

Such variability also suggests the existence of regional or population-specific vascular characteristics, potentially linked to ethnic, environmental, or developmental factors.

These influences, acting during embryogenesis, may account for morphological differences observed even within the same geographical area over time.

REFERENCES

1. Mayo CW. Blood supply of the colon: surgical considerations. *Surg Clin North Am.* 1955;35:1117–1121.
2. Paturet G. *Traité d'Anatomie Humaine*. Paris: Masson; 1964. p. 489–510.
3. Testut L. *Traité d'Anatomie Humaine*. Livre IV. Angéiologie. Paris: Gaston Doin; 1921. p. 204–206.

4. Testut L. Traité d'Anatomie Humaine. Tome deuxième. Angéiologie. Paris: Gaston Doin; 1924. p. 524–526.
5. Rouvière H, Delmas A. Anatomie humaine. Tome 2: Tronc. Paris: Masson; 1997. p. 192-195.
6. Standring S. Gray's Anatomy. 39th ed. Edinburgh: Elsevier Churchill Livingstone; 2005. p. 1117–1120.
7. Kamina P. Anatomie Clinique. Tome 3. Paris: Maloine; 2007. p. 138-148.
8. Pillet J. In: Chevrel JP. Anatomie Clinique. Paris: Springer-Verlag; 1994. p. 421-440.
9. Adachi B. Das Fehlen der Arteria Mesenterica Inferior bei einem Japaner. Anat Anz. 1930; 69:431-433B.
10. Lippert H, Pabst R. Arterial Variations in Man. Munich: JF Bergmann Verlag; 1985. p. 48-53.
11. Pennington N, Soames R. The anterior visceral branches of the abdominal aorta. Surg Radiol Anat. 2005;27:395-403.
12. Dahmani O et al. L'Artère Mésentérique Inférieure. Wikipedia. Available at: https://fr.wikipedia.org/wiki/Art%C3%A8re_m%C3%A9sent%C3%A9rique_inf%C3%A9rieure.

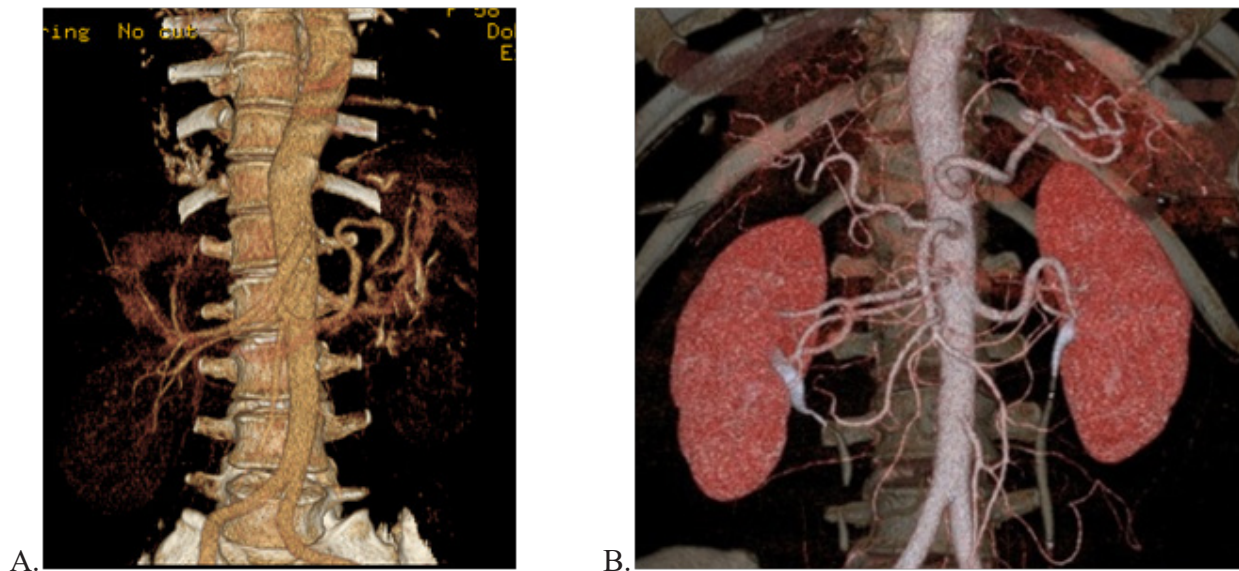


Figure 1. A. Origin of the IMA at the lower half of the L2 vertebra.
B. Origin of the IMA at the mid-body of the L3 vertebra.

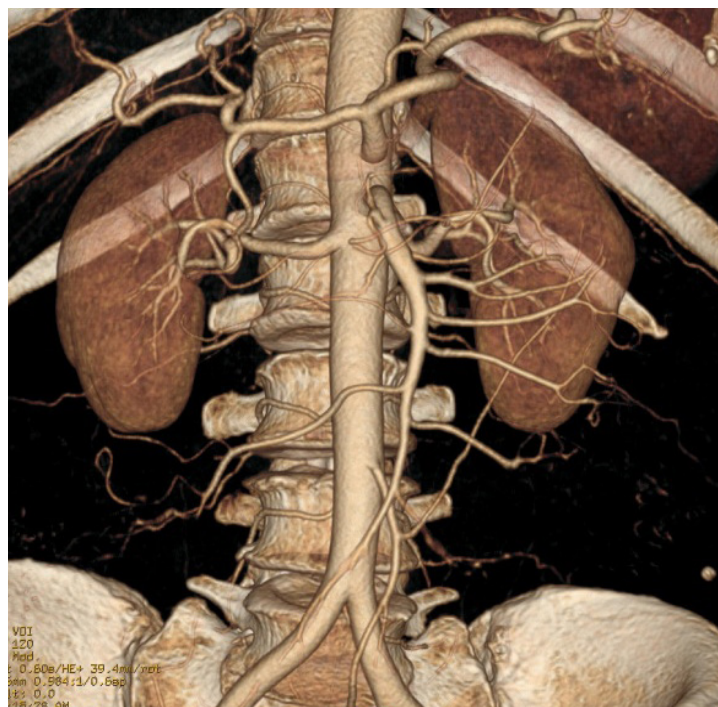


Figure 2. The origin of the inferior mesenteric artery (IMA), located on the anterolateral surface of the abdominal aorta (AoA), at the inferior half of the L3-L4 intervertebral disc level, is positioned: 2 vertebral bodies, 1 intervertebral disc (L3-L4), and the upper half of the L4-L5 disc above the origin of the renal arteries (AaR), and 1 vertebral body plus 2 disc halves (inferior half of L3-L4 and L4-L5) above the terminal bifurcation of the aorta. The IMA follows a curved trajectory with rightward concavity.

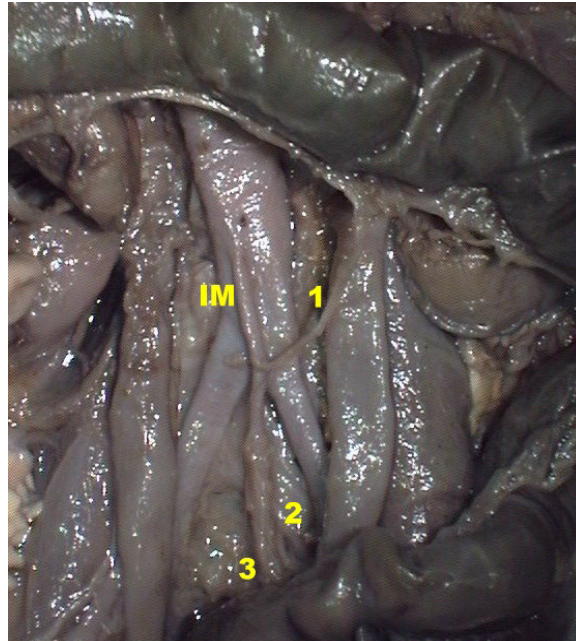


Figure 3. The origin of the inferior mesenteric artery (IMA) is located to the right of the midline on the anterior surface of the abdominal aorta (AoA), following its course along the aorta down to the terminal bifurcation.
IM – inferior mesenteric artery; 1 – left colic artery; 2 – sigmoid trunk; 3 – superior rectal artery.

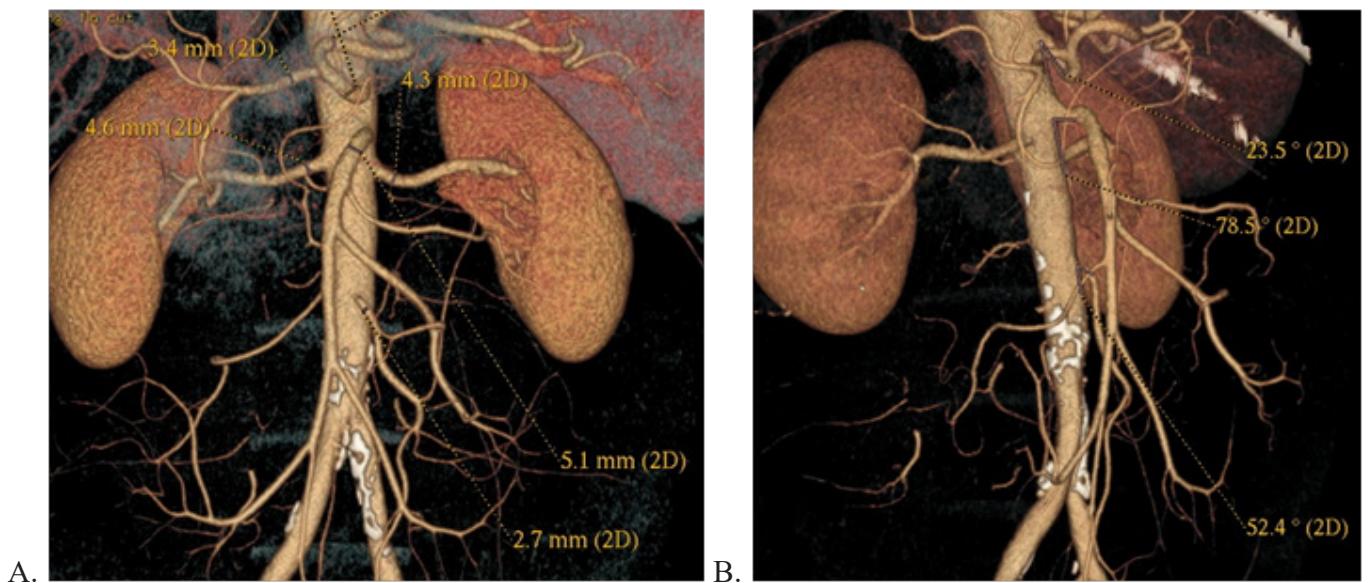


Figure 4. A. IMA originating from the left anterolateral aortic wall; oblique inferolateral course; 2.7 mm diameter. B. The IMA forms an angle of 52.4° with the anterior aortic wall.