# A study on anatomical variations of celiac trunk and superior mesenteric artery: a computed tomography study

**Sunima Maskey[1], Subindra Karki[2], Dil Islam Mansur[1], Sheprala Shrestha[1], Pragya Shrestha[1], Nilima Shrestha[3]**

[1]Department of Anatomy, Kathmandu University School of Medical Sciences, Dhulikhel, Kavre, Nepal

[2]Department of Radiodiagnosis, Dhulikhel Hospital, Kathmandu University School of Medical Sciences, Dhulikhel, Kavre, Nepal

[3]Research and Development Division, Dhulikhel Hospital, Dhulikhel, Kavre, Nepal



## ABSTRACT

### BACKGROUND

The abdominal aorta and its major anterior branches—the celiac trunk and superior mesenteric artery—exhibit considerable variation in origin and angulation. Understanding these variations is essential for radiologists and surgeons, as they directly influence abdominal interventions, vascular reconstructions, and transplant outcomes. Spiral computed tomography angiography provides a reliable, non-invasive modality for studying such vascular anatomy.

### METHODS

A descriptive cross-sectional study was conducted using 385 contrast-enhanced abdominal CT scans from individuals aged 7–87 years. Origin levels of the celiac trunk and SMA were classified relative to vertebral levels, and the aorta–SMA angle was measured. Data were stratified by age and sex and analyzed using SPSS (v16). Chi-square tests were applied to assess associations between demographic factors and arterial variation.

### RESULTS

The celiac trunk most frequently originated at the T12–L1 level (49.1%), followed by the T12 lower level (22.9%). The SMA most commonly arose from mid-L1 (35.8%) and upper-L1 (30.4%). A clear cranio-caudal shift in SMA origin was observed with advancing age. The mean aorta–SMA angle was 52.68°±20.72°, significantly wider in males (56.64°) than females (49.06°, $p < 0.001$). Across age groups, the angle showed a non-linear pattern—widest in childhood, narrowing in adulthood, and widening again in older age.

### CONCLUSIONS

This study confirms that the celiac trunk most often arises at T12–L1 and the SMA at L1 levels. The aorta–SMA angle demonstrates both sex-and age-related variation. These findings underscore the importance of population-specific vascular data for safe surgical planning and accurate radiological interpretation.

### KEY WORDS

Anatomical variation, Aorta, Celiac artery, Computed tomography, Mesenteric arteries

*Corresponding Author |
Dr. Sunima Maskey, M.S. (Anatomy)
Assistant Professor
Department of Anatomy, Kathmandu University School of Medical Sciences, Dhulikhel, Kavre, Nepal
Email: sunima.maskey@gmail.com

## BACKGROUND

The abdominal aorta, the direct continuation of the thoracic aorta, begins at the median aortic hiatus of the diaphragm, anterior to the lower border of the twelfth thoracic vertebra. It descends anterior to the lumbar vertebrae and terminates at the lower border of the fourth lumbar vertebra by dividing into the right and left common iliac arteries.1 Anatomical relations are complex, with the pancreas, duodenum, renal vessels, and mesentery lying anteriorly, and the vertebral column posteriorly. The aorta gives rise to anterior branches (celiac trunk, superior mesenteric artery, inferior mesenteric artery), lateral visceral branches, and dorsal branches supplying the abdominal wall.1 An in-depth understanding of the morphology and variation in these arteries is essential for clinicians and radiologists, particularly in planning and executing abdominal surgeries, interventional procedures, and transplantations.2,3

Among these, the superior mesenteric artery (SMA) is of particular importance, supplying the midgut from the distal duodenum to the proximal two-thirds of the transverse colon. Variations in its origin and branching pattern are well-documented, including common trunks with the celiac trunk or anomalous colic branches.3,4 Such variations hold immense surgical relevance, especially in procedures involving bowel resections, liver transplantation, and oncologic resections.

Spiral Computed Tomography Angiography (CTA) has revolutionized the non-invasive evaluation of abdominal vascular anatomy. With rapid volume acquisition and high-resolution image reconstruction, CTA allows multiplanar and three-dimensional assessment of the aorta and its branches.5,6 CTA not only accurately identifies vascular pathologies like aneurysms or stenosis but also delineates anatomical variants with remarkable clarity. These include uncommon branching patterns such as celiacomesenteric trunks, accessory renal arteries, or hepatic arteries originating from the SMA.2,7,8

Given the clinical relevance and technological advances in imaging, this study aims to analyze the abdominal aorta and its major branches (celiac trunk and SMA) using spiral CT angiography. The objective is to document the morphometric data with range of anatomical variations and emphasize their importance in surgical planning and radiological interpretation.

## METHODS

A descriptive cross-sectional study was conducted in the Department of Anatomy and data was collected from the Department of Radio-diagnosis, Dhulikhel Hospital, Dhulikhel, Nepal by using images of Siemens Somatome Perspective 128 slice MD - CT scan. The ethical clearance was obtained from IRC-KUSMS (Ref. no. 52/23). The convenient sampling technique was used for data collection.

The sample size was calculated as:

n= Z2 x p x q/ e2

= 1.962 x 0.5 x 0.5/ 0.052

= 384.16

Where,

n= minimum required sample size

Z= 1.96 at 95% Confidence Interval (CI)

p= prevalence taken as 50% for maximum sample size calculation

q= 1-p

e= margin of error, 5%

Total number of 385 images of individuals (184 male and 201 female) of various age from 7 to 87 years were taken during the period of seven months (July 2024- February 2025). The obtained data were studied under different age groups and each ten years were grouped as an age group. The images of individuals with routine CT scan images with an arterial phase covering the abdominal aorta were included for the study. The images with incomplete demographic data or without adequate arterial phases were excluded. The aorta superior mesenteric artery angle (aorta-SMA angle) were measured by using options provided in the Digital Imaging and Communications in Medicine software and the values were directly recorded from the monitor screen. Data was collected and entered in Microsoft excel and analyzed using the Statistical Package for the Social Sciences version 16 (SPSS 16.0) for descriptive statistical analysis.

The variations were classified as

Type 1= origin at vertebral level T11-T12

Type 2= origin at vertebral level T12 Upper

Type 3= origin at vertebral level T12 Mid

Type 4= origin at vertebral level T12 Lower

Type 5= origin at vertebral level T12-L1

Type 6= origin at vertebral level L1 Upper

Type 7= origin at vertebral level L1 Mid

Type 8= origin at vertebral level L1 Lower

Type 9= origin at vertebral level L1–L2

## RESULTS

Table 1 shows the demographic characteristics of the study participants. A total of 385 individuals were included in this study. The age distribution ranged from 7 years to 87 years, with the largest representation in the 51–60 year group (19.7%), followed by 41–50 years (19.2%) and 31–40 years (18.4%). The youngest (0–10 years) and oldest (81–90 years) groups were the least represented, comprising only 0.3% and 1.6% of the sample, respectively. Sex distribution showed a slight female predominance, with females accounting for 52.2% compared to 47.8% males (Table 1).

Table 2 shows the distribution of celiac trunk origin by sex. The most frequent origin overall was Type 5 (T12–L1), found in 49.1% of individuals, and remained the dominant pattern in both males (52.7%) and females (45.8%). The second most common was Type 4 (T12 Lower), present in 22.9% of cases, with a notably higher frequency in females (29.4%) than males (15.8%), indicating a possible sex-related tendency toward lower origins. Type 6 (L1 Upper, 9.6%) was more frequent in males (13.6%) than females (6.0%), while Type 3 (T12 Mid, 5.5%) occurred slightly more in females (6.5%) than males (4.3%). Rare patterns included Type 1 (3.1%), Type 2 (5.2%), and Type 7 (3.6%), while Type 8 (1.0%) was the least common, seen only in males. Statistical analysis confirmed a significant association between sex and celiac trunk origin ($\chi^2 = 21.227$, $p < 0.001$).

Table 3 illustrates the distribution of celiac trunk origin across different age groups (0–10 to 81–90 years). The most frequent origin was Type 5 (T12–L1), present in 49.1% of cases, consistently observed across all age ranges and increasing with age, reaching 100% in the 81–90 years group. The second most common was Type 4 (T12 Lower) (22.9%), especially frequent in middle-aged adults, peaking in the 51–60 years group (36.8%) and also high in the 71–80 years group (28.0%). Type 6 (L1 Upper) ranked third (9.6%), with notable clustering in 31–40 years (19.7%) and 71–80 years (18.0%). Less frequent types included Type 2 (5.2%), Type 3 (5.5%), and Type 7 (3.6%), generally limited to younger and middle adulthood. The rarest variant was Type 8 (1.0%), seen only in older individuals (51–70 years).

Age-related trends were evident: younger groups (≤30 years) had higher proportions of Types 3, 4, and 5, while middle-aged groups showed a redistribution favoring Types 4 and 5. In older adults (≥61 years), Type 5 progressively dominated, culminating in universal prevalence among the oldest participants. Statistical analysis confirmed a highly significant association between celiac trunk origin and age ($\chi^2 = 151.023$, $p < 0.001$).

Table 4 summarizes the origin of the SMA by sex. The most frequent type was Type 7 (L1 Mid), observed in 35.8% of cases, more common in males (40.2%) than females (31.8%). The second most frequent was Type 6 (L1 Upper) (30.4%), with nearly equal distribution between males (31.0%) and females (29.9%). Type 8 (L1 Lower) accounted for 12.5%, slightly higher in males (13.6%) than females (11.4%). Less common variants included Type 4 (4.4%), Type 3 (3.1%), and Type 9 (2.1%), occurring at similar rates across sexes. Type 1 (0.3%) was the rarest, seen only in a single male. Interestingly, males showed higher prevalence of Types 7, 6, and 8, whereas females had greater representation of Type 5 (15.9%). Statistical analysis revealed a significant association between SMA origin and sex ($\chi^2 = 15.648$, $p = 0.029$), indicating sex-specific variation in less frequent branching patterns despite dominance of Types 6 and 7 in both groups.

Table 5 illustrates the distribution of SMA origin across age groups. The most frequent type was Type 7 (L1 Mid), seen in 35.8% of cases, increasing with age and peaking in the 31–40 years group (54.9%). It remained dominant in older adults, including half of the cases in the 81–90 years group. The second most common was Type 6 (L1 Upper) (30.4%), more frequent in early and middle adulthood (34–35% in 41–60 years), though still notable in later decades. Type 8 (L1 Lower) accounted for 12.5%, showing higher prevalence in older individuals, particularly 22% in the 71–80 years group and 50% in the oldest group. Type 5 (T12–L1) was present in 11.4%, more common in younger adults, while Types 3, 4, and 9 were infrequent, and Type 1 was rare (0.3%). A clear cranio-caudal shift was evident with age, confirmed statistically ($\chi^2 = 89.226$, $p = 0.003$).

Table 6 summarizes the aorta–SMA angle across the study cohort, stratified by sex and age. The overall mean angle was 52.68°±20.72°, with males showing a significantly wider angle (56.64°±19.84°) than females (49.06°±20.90°) ($p < 0.001$), indicating sex-related differences in this relationship. Age-wise analysis also revealed significant variation ($p < 0.001$). The widest angle occurred in the 0–10 years group (87°), though based on a single case. A narrowing trend was noted during adolescence and early adulthood (≈47–49°), followed by relative stability in midlife. The narrowest mean was in the 51–60 years group (46.16°±19.89°). In later decades, the angle widened again, averaging 58–63° in older adults, suggesting a non-linear age-related pattern.

## DISCUSSION

The present study aimed to analyze the anatomical origin of the celiac trunk and superior mesenteric artery, as well as the aorta–SMA angle, using CT scan in a Nepalese population. The findings revealed significan t variation in origin levels of celiac trunk and SMA, and demonstrated sex and age-related differences in the origin level as well as aorta–SMA angle. Our results demonstrate that the celiac trunk most frequently originates at the T12–L1 intervertebral level. This finding agrees with several anatomical and radiological studies that

place the celiac origin between the lower third of T12 and the upper third of L1.2,9-12 Pinal-Garcia et al. reported that in their cadaveric series, the celiac trunk originated between the T12 vertebral body and the L1 vertebral body in 90% of specimens.10 Salve and Ratanprabha described the celiac trunk as the chief arterial supply of the foregut, arising from the ventral aspect of the abdominal aorta at the T12–L1 level, consistent with our finding.13 Similarly, in their CT-based evaluation, Hazirolan et al. reported that the celiac trunk most frequently originated at the T12–L1 level and described classic branching patterns, but not vertebral level classification.14 Vougadiotis et al. and Farghadani et al. emphasized population variability in celiac origin, but their studies focused more on branching morphology rather than precise vertebral mapping.7,9 Our findings align closely with these results in terms of the predominant vertebral level of origin (T12–L1, 49.1% in our study). However, unlike their focus on branching patterns, our analysis emphasized vertebral level classification, revealing age and sex-related differences and significant association.

In present study, SMA was found to originate most commonly from mid and upper-L1 levels, accounting for approximately two-thirds of the sample. This is consistent with classical anatomical descriptions, which generally place the SMA origin at the level of the first lumbar vertebra.2,3,8,15-17 Songur et al. and Jain et al. observed that the SMA typically originates approximately 1 cm below the celiac trunk, at the level of the L1–L2 intervertebral disc.2,3 Hadi et al. reported that the SMA typically originates from the abdominal aorta at approximately the L1 level, 1.5–3 cm inferior to the celiac trunk.6 Silva et al., through a systematic review of original studies indexed in major medical databases, confirmed the presence of the superior mesenteric artery in 100% of cases, with over half arising at the L1 vertebral level.8 Their analysis highlighted the consistency of SMA origin and emphasized its morphological relevance for surgical procedures involving posterior abdominal organs. Prakash et al. reported that the SMA most commonly originated at the L1 vertebral level in 76% of cadavers, establishing L1 as the predominant site of origin.17 These findings of various studies are consistent with our study, where the majority of SMA origins were also clustered at the L1 level (Types 6 and 7 combined, 66.2%), reinforcing the notion that L1 represents the most frequent anatomical level for SMA emergence. Such consistency reinforces the view that the SMA origin is anatomically stable around the L1 region, although minor age and sex-related variations in its precise positioning were noted in present study.

The mean aorta-SMA angle of 52.68°±20.72° was observed in our cohort, the angle showed significant variation with both sex and age. Males generally exhibited a wider angle than females. Across age groups, the angle was highest in childhood, decreased during early adulthood, and gradually increased again in older age, indicating a non-linear age-related pattern. Comparable findings have been reported by Hadi et al., who observed a mean aorta–SMA angle of 67.1°±25.7° in an Iraqi population.6 In their cohort, males likewise had a significantly larger angle than females (77.5°+25.2° vs. 63.0°+24.4°, $p < 0.0001$), consistent with our sex-related trend.6 Their study also highlighted progressive age-related changes, with younger individuals (<20 years) showing the narrowest angle (21.5°±7.4°), followed by widening angles in older groups (68.3°±22.1° in those ≥60 years).6 While our results differ in absolute values—most notably the higher childhood (0-10 years) angle in our series—the overall pattern of sex dimorphism and age-related variation aligns with their observations. According to Mathenge et al., the normal aorta–SMA angle in humans ranges from 25° to 60°, with variations in this angle potentially contributing to SMA syndrome and associated gastrointestinal complications.16 The overall aorta–SMA angle observed in our study falls within the normal range reported by Mathenge et al., although variations related to sex and age were also evident.16 In current study, the mean aorta–SMA angle was slightly higher than that reported by Plesa et al., who described an average angle of around 45°.18 Nonetheless, our findings fall within the normal anatomical range, and the variations observed, particularly with age and sex, likely reflect normal population differences.

Strengths of this study include its large sample size (n=385), the use of CT scan, and detailed stratification by age and sex, which allowed us to detect distributional trends overlooked by many prior studies. Limitations include its single-center design and underrepresentation of extremes of age. Future research should focus on multi-ethnic, multicentric CT cohorts, and investigation of clinical correlations with vascular compression syndromes and surgical outcomes.

## CONCLUSIONS

This study confirms that the T12–L1 level is the predominant site of celiac trunk origin, the SMA arises most often from L1 mid and upper levels, and that the aorta–SMA angle varies systematically with sex and age. By comparing our findings with existing literature, we demonstrate both concordant patterns and novel differences. These results underscore the importance of population-specific anatomical data for guiding safe surgical practice and accurate radiological interpretation.

Table 1. Descriptive Demographic Characteristics

| Characteristics | Categories | n (%) |
|---|---|---|
| Age | 0-10 years | 1 (0.3%) |
| | 11-20 years | 11 (2.9%) |
| | 21-30 years | 41 (10.6%) |
| | 31-40 years | 71 (18.4%) |
| | 41-50 years | 74 (19.2%) |
| | 51-60 years | 76 (19.7%) |
| | 61-70 years | 55 (14.3%) |
| | 71-80 years | 50 (13.0%) |
| | 81-90 years | 6 (1.6%) |
| Sex | Male | 184 (47.8%) |
| | Female | 201 (52.2%) |

Table 2. Origin Type of Celiac Trunk in Males and Females

| Origin Type | Male | Female | Total |
|---|---|---|---|
| Type 1 (T11-T12) | 4 (2.2%) | 8 (4.0%) | 12 (3.1%) |
| Type 2 (T12 Upper) | 9 (4.9%) | 11 (5.5%) | 20 (5.2%) |
| Type 3 (T12 Mid) | 8 (4.3%) | 13 (6.5%) | 21 (5.5%) |
| Type 4 (T12 Lower) | 29 (15.8%) | 59 (29.4%) | 88 (22.9%) |
| Type 5 (T12-L1) | 97 (52.7%) | 92 (45.8%) | 189 (49.1%) |
| Type 6 (L1 Upper) | 25 (13.6%) | 12 (6.0%) | 37 (9.6%) |
| Type 7 (L1 Mid) | 8 (4.3%) | 6 (3.0%) | 14 (3.6%) |
| Type 8 (L1 Lower) | 4 (2.2%) | 0 | 4 (1.0%) |

Pearson's Chi-square: 21.227, p-value<0.00

Table 3. Origin Type of Celiac Trunk in Various Age Groups

| | Origin Type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age Group (In years) | Type 1 (T11- T12) | Type 2 (T12 Upper) | Type 3 (T12 Mid) | Type 4 (T12 Lower) | Type 5 (T12- L1) | Type 6 (L1 Upper) | Type 7 (L1 Mid) | Type 8 (L1 Lower) |
| 0-10 | 0 | 1 (100%) | 0 | 0 | 0 | 0 | 0 | 0 |
| 11-20 | 0 | 1 (9.1%) | 0 | 2 (18.2%) | 7 (63.6%) | 1 (9.1%) | 0 | 0 |
| 21-30 | 0 | 2 (4.9%) | 10 (24.4%) | 11 (26.8%) | 13 (31.7%) | 0 | 5 (12.2%) | 0 |
| 31-40 | 2 (2.8%) | 5 (7.0%) | 4 (5.6%) | 7 (9.9%) | 34 (47.9%) | 14 (19.7%) | 5 (7.0%) | 0 |
| 41-50 | 2 (2.7%) | 8 (10.8%) | 4 (5.4%) | 14 (18.9%) | 38 (51.4%) | 8 (10.8%) | 0 | 0 |
| 51-60 | 8 (10.5%) | 1 (1.3%) | 1 (1.3%) | 28 (36.8%) | 35 (46.1%) | 0 | 1 (1.3%) | 2 (2.6%) |
| 61-70 | 0 | 0 | 2 (3.6%) | 12 (21.8%) | 31 (56.4%) | 5 (9.1%) | 3 (5.5%) | 2 (3.6%) |
| 71-80 | 0 | 2 (4.0%) | 0 | 14 (28.0%) | 25 (50.0%) | 9 (18.0%) | 0 | 0 |
| 81-90 | 0 | 0 | 0 | 0 | 6 (100.0%) | 0 | 0 | 0 |
| Total | 12 (3.1%) | 20 (5.2%) | 21 (5.5%) | 88 (22.9%) | 189 (49.1%) | 37 (9.6%) | 14 (3.6%) | 4 (1.0%) |

Pearson's Chi-square: 151.023, p-value<0.001

**Table 4. Origin Type of SMA in Males and Females**

| Origin Type | Male n (%) | Female n (%) | Total n (%) |
|---|---|---|---|
| Type 1 (T11–T12) | 1 (0.5%) | 0 (0.0%) | 1 (0.3%) |
| Type 3 (T12 Mid) | 2 (1.1%) | 10 (5.0%) | 12 (3.1%) |
| Type 4 (T12 Lower) | 9 (4.9%) | 8 (4.0%) | 17 (4.4%) |
| Type 5 (T12–L1) | 12 (6.5%) | 32 (15.9%) | 44 (11.4%) |
| Type 6 (L1 Upper) | 57 (31.0%) | 60 (29.9%) | 117 (30.4%) |
| Type 7 (L1 Mid) | 74 (40.2%) | 64 (31.8%) | 138 (35.8%) |
| Type 8 (L1 Lower) | 25 (13.6%) | 23 (11.4%) | 48 (12.5%) |
| Type 9 (L1–L2) | 4 (2.2%) | 4 (2.0%) | 8 (2.1%) |

Pearson's Chi-square: 15.648, p-value=0.029

**Table 5. Origin Type of SMA in Various Age Groups**

| | Origin Type | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Age Group (In years) | Type 1 (T11–T12) | Type 3 (T12 Mid) | Type 4 (T12 Lower) | Type 5 (T12–L1) | Type 6 (L1 Upper) | Type 7 (L1 Mid) | Type 8 (L1 Lower) | Type 9 (L1–L2) |
| 0–10 | 0 | 0 | 0 | 1 (100.0%) | 0 | 0 | 0 | 0 |
| 11–20 | 0 | 0 | 1 (9.1%) | 1 (9.1%) | 4 (36.4%) | 2 (18.2%) | 3 (27.3%) | 0 |
| 21–30 | 0 | 0 | 1 (2.4%) | 10 (24.4%) | 14 (34.1%) | 12 (29.3%) | 2 (4.9%) | 2 (4.9%) |
| 31–40 | 0 | 2 (2.8%) | 2 (5.6%) | 10 (14.1%) | 11 (15.5%) | 39 (54.9%) | 4 (5.6%) | 1 (1.4%) |
| 41–50 | 1 (1.4%) | 2 (2.7%) | 5 (6.8%) | 9 (12.2%) | 26 (35.1%) | 22 (29.7%) | 8 (10.8%) | 1 (1.4%) |
| 51–60 | 0 | 7 (9.2%) | 6 (7.9%) | 8 (10.5%) | 26 (34.2%) | 19 (25.0%) | 8 (10.5%) | 2 (2.6%) |
| 61–70 | 0 | 1 (1.8%) | 0 | 3 (5.5%) | 17 (30.9%) | 23 (41.8%) | 9 (16.4%) | 2 (3.6%) |
| 71–80 | 0 | 0 | 0 | 2 (4.0%) | 19 (38.0%) | 18 (36.0%) | 11 (22.0%) | 0 |
| 81–90 | 0 | 0 | 0 | 0 | 0 | 3 (50.0%) | 3 (50.0%) | 0 |
| Total | 1 (0.3%) | 12 (3.1%) | 17 (4.4%) | 44 (11.4%) | 117 (30.4%) | 138 (35.8%) | 48 (12.5%) | 8 (2.1%) |

Pearson's Chi-square: 89.226, p-value = 0.003

**Table 6. Aorta-SMA Angle in Various Demographic Characteristics**

| | | Mean ± SD | Significance |
|---|---|---|---|
| **Age** | 0-10 years | 87 ± 0 | p < 0.001 |
| | 11-20 years | 47.45 ± 17.27 | |
| | 21-30 years | 49.20 ± 17.99 | |
| | 31-40 years | 50.77 ± 22.43 | |
| | 41-50 years | 51.74 ± 19.57 | |
| | 51-60 years | 46.16 ± 19.89 | |
| | 61-70 years | 58.31 ± 19.74 | |
| | 71-80 years | 62.86 ± 19.86 | |
| | 81-90 years | 60.83 ± 24.10 | |
| **Sex** | Male | 56.64 ± 19.84 | p < 0.001 |
| | Female | 49.06 ± 20.90 | |
| | Total | 52.68 ± 20.72 | |

## REFERENCES:


1. Standring S. Abdomen and pelvis. Gray's anatomy the anatomical basis of clinical practice, 39th edition. Churchill-Livingstone: Elsevier, London 2005:1116-9.
2. Songur A, Toktas M, Alkoc O, et al. Abdominal aorta and its branches: morphometry-variations in autopsy cases. Eur J Gen Med. 2010;7(3):321-5. LINK
3. Jain P, Motwani R. Morphological variations of superior mesenteric artery: a cadaveric study. Int J Anat Res. 2013;02:83–7. LINK
4. Deshpande SH, Thomas J, Chiranjeev R, et al. Superior mesenteric artery syndrome in a patient with celiacomesenteric trunk. BMJ Case Rep. 2021 Feb 23;14(2):e237132. LINK
5. Costello P, Gaa J. Spiral CT angiography of the abdominal aorta and its branches. Eur. Radiol. 1993;3:359-65. LINK
6. Hadi SS, Kareem TF, Kamal AM. Normal values of angle and distance between the superior mesenteric artery and aorta in Iraqi population: A single centre study. J Med Radiat Sci. 2022 Jun 1;69(2):191–7. LINK
7. Farghadani M, Momeni M, Hekmatnia A, et al. Anatomical variation of celiac axis, superior mesenteric artery, and hepatic artery: Evaluation with multidetector computed tomography angiography. J. Res. Med. Sci. 2016;21:129. LINK
8. Silva NGOD, Barbosa ABM, Silva NA, et al. Anatomical variations of the superior mesenteric artery and its clinical and surgical implications in humans. Arq Bras Cir Dig. 2020;33(2):e1508. LINK
9. Vougadiotis I, Karampelias V, Chrysikos D, et al. Anatomical variations in the celiac trunk: a short review. Acta Med Acad. 2023 Aug 31;52(2):134–41. LINK
10. Pinal-Garcia DF, Nuno-Guzman CM, Gonzalez-Gonzalez ME, et al. The celiac trunk and its anatomical variations: a cadaveric study. J Clin Med Res. 2018;10(4):321–9. LINK
11. Satheesha Nayak B, Shetty SD, Sirasanagandla SR, et al. Concurrent variations of celiac and superior mesenteric arteries. Kathmandu Univ Med J. 2018 Oct.-Dec.;16(64):345-7. LINK
12. Venieratos D, Panagouli E, Lolis E, et al. A morphometric study of the celiac trunk and review of the literature. Clin Anat. 2013 Sep;26(6):741-50. LINK
13. Salve V M, Ratanprabha C. Multiple variation of branches of abdominal aorta. Kathmandu Univ Med J. 2011;33(1)72-6. LINK
14. Hazirolan T, Metin Y, Karaosmanoglu AD, et al. Mesenteric arterial variations detected at MDCT angiography of abdominal aorta. Am. J. Roentgenol. 2009 Apr;192(4):1097–102. LINK
15. Sasani H, Ekmen N. Investigation of coeliac trunk and superior mesenteric artery variations and literature review. J Clin Med Kaz. 2021;18(4):81–6. LINK
16. Mathenge N, Osiro S, Rodriguez II, et al. Superior mesenteric artery syndrome and its associated gastrointestinal implications. Clinical Anatomy. 2014;27:1244–52. LINK
17. Prakash, Mokhasi V, Rajini T, et al. The abdominal aorta and its branches: anatomical variations and clinical implications. Folia Morphol [Internet]. 2011;70(4):282–6. LINK
18. Pleșa A, Constantinescu C, Crumpei F, et al. Superior mesenteric artery syndrome superior mesenteric artery syndrome: an unusual cause of intestinal obstruction. J Gastrointest Liver. 2006;15(1):69–72. LINK