

ORIGINAL ARTICLE

Anatomical Variations of Celiac Trunk Branching Pattern in Different Ethnic Groups in Population of Karachi by 3D MDCTAROSHEENA NABEEL KHAN¹, ABDUL REHMAN², FAUZIA PERVEEN³, MUHAMMAD HUSSAIN SIDDIQUI⁴, NAHEED AKHTAR⁵, NUZHAT HASSAN⁶¹Associate Professor, Department of Anatomy, United Medical & Dental College, Karachi.²Assistant Professor, Department of Anatomy, Liaquat College of Medicine & Dentistry, Karachi.³Assistant Professor, Department of Biochemistry, Liaquat College of Medicine & Dentistry, Karachi.⁴Senior Lecturer, Department of Anatomy, Dow Medical College, DUHS, Karachi.⁵Lecturer, Department of Anatomy, Karachi Institute of Medical Sciences, Malir Cantt, Karachi.⁶Professor, Nuzhat Hassan, Department of Anatomy, Ziauddin University, Karachi.Correspondence to: Rosheena Nabeel Khan, Email: rosheenakhan12@gmail.com, Cell: 0322-2822855**ABSTRACT****Objective:** To evaluate the frequency of branching pattern of celiac trunk variations in different ethnic group in population of Karachi.**Study Design:** Cross-sectional study**Duration:** March, 2017- August, 2017.**Place:** Ziauddin hospital Karachi, Clifton campus, Department of Radiology & Anatomy**Method:** Total 160 participants were selected with the age range between 20-60 years old male & female adults. The subjects who were recruited in present study were those who came for 3D MDCTA without any upper abdominal vascular or visceral pathologies. Participants were interviewed to collect their demographic particulars and categorize them in different ethnic groups. Variation of Celiac trunk was analysed by Uflacker's classification. Statistical analysis was completed on SPSS (version 20) and all the data has been presented in percentage and frequency.**Results:** Classical celiac trunk was found to be the highest in Urdu Speaking i.e. 52 (32.5%) individuals followed by Punjabi speaking 36(22.5%) and 28(17.5%) individuals in Sindhi speaking and least was found in pakhtoon speaking 18(11.25 %) individuals in our study participants. Variant of Celiac trunk was found to be highest in Urdu speaking exhibiting a frequency of 13(8.125 %) individuals. It was followed by Pakhtoon, Sindhi and Punjabi speaking with the frequency of 7(4.375%), 4 (2.5%) and 2(1.25%) individuals respectively.**Practical Implication:** Present study reports celiac trunk variations in Pakistani population in different ethnic groups. The prevalence of celiac trunk variations in different ethnic groups found in our study was low but these variations may cause catastrophic injuries while doing laproscopic surgeries or Chemoembolization for liver cancer. Vascular anatomical variations of celiac trunk mostly found accidentally during interventional or radiological procedures so it should be reported routinely to create awareness regarding vascular variations specifically in different ethnic groups. This data may be utilized by the radiologists and surgeon to reduce catastrophic injuries for patient well being.**Conclusion:** It has been concluded that vascular anatomical variations of celiac trunk found accidentally during interventional or radiological procedures so it is essential to have a knowledge of vascular variations and their presence in different ethnic groups. This data may be utilized by the radiologists and surgeon to avoid injuries specific to Pakistani population.**Keywords:** Anastomosis, Celiac Trunk, Variations, Multidetector Computer Tomographic Angiography, Laproscopic**INTRODUCTION**

The 1st anterior branch of abdominal aorta is Celiac trunk (CT) ⁽¹⁾. This trunk arises just below the aortic hiatus at the level of T12/ L1 vertebra^(2, 3). Celiac trunk has 3 main branches which named as left gastric artery, common hepatic artery and splenic artery^(4, 5). Vascular aberrations and anatomical variations of the celiac trunk are quite frequent⁽⁶⁾. Anatomical variation of celiac trunk have been well documented in previous studies while vascular variations are embryological in origin^(7, 8).

There is a longitudinal anastomosis of 4 roots of omphalomesenteric or vitelline arteries. 1st and 4th roots of vitelline arteries join longitudinally while central 2 roots of arteries disintegrates. The CT has Left gastric artery, Common Hepatic artery and Splenic artery that arise from longitudinal anastomosis ⁽⁹⁻¹¹⁾. The future superior mesenteric artery originates from 4th root which usually separated from longitudinal anastomosis and if the separation of 4th root occurs proximally then one of its branch become displace to superior mesenteric artery (SMA). Celiacomesenteric trunk formed when there is 1st and 4th roots disappear ^(3, 7-9). Any defective fusion of vitelline arteries may cause arterial variations during embryonic period ⁽¹²⁾.

Commonly before performing any laproscopic procedures CT scans are usually performed for further diagnosis of any visceral pathologies or vascular variations. Serious complications may also occur if there is a lack of knowledge of these variations.

Complete understanding of anatomy of celiac trunk and its vascular variations before any upper abdominal procedures is important. Variations of Celiac trunk may increase the difficulty and risk of various surgical procedures, especially laparoscopic

cholecystectomy, liver & gastric resections or transplant surgeries ^(13, 14).

In recent study Uflacker's classification was used to analyze the celiac trunk vascular variants⁽¹⁵⁻¹⁷⁾. He categorized the pattern of vascular variation of celiac trunk into 8 different types as shown in (Table 1).

METHODOLOGY

This cross-sectional study was executed in March, 2017 to August, 2017, total 160 subjects were enrolled in this study with the age range 20- 60 years old. The subjects who were recruited in present study were referred to radiology department for abdominal CT with no abdominal pathologies. Data was collected in this study through convenience sampling technique. Sample size of present study was calculated through WHO sample size calculator that was 138 with the frequency of 10%, bound of error 5% & confidence level 95% was taken^{3, 17, 18}. Subjects who were enrolled in this study was male and female with different ethnic groups having serum creatinine levels with < 1.4mg/dl. Those patients who had allergy with contrast, any vascular lesion or pathology in abdomen or liver transplants, also female who were pregnant excluded from the study. Informed consent was taken & questionnaire was filled which was based on demographic profile and their medical and surgical history was taken. CT scan of abdominal aorta was taken for each subject.

Toshiba 16 slicer CT scanner Alexion, Japan was used for analysis of celiac trunk and its vessels through the automatic dose modulation technique in arterial phase. Contrast material was administered before scan then ask subject to lie in a supine

position on a platform of CT scanners to hold her / his breath for 15 seconds.

Analysis of arterial pattern was done on Axial plane while reconstructed technique was used in sagittal and coronal plane in Multiplanar reformatting images (MPR). Images were also reconstructed for 3D reconstruction and volume rendered rendered (VR) techniques for celiac trunk variations. For the analysis of celiac trunk patterns, 5 mm thickness was taken. All the images were analysed cranio-caudally from diaphragm to pubic symphysis.

Statistical Analysis: Frequencies & percentages were calculated for Celiac Trunk branching patterns in different ethnic group through SPSS version 20.

RESULTS

Total 160 individuals were enrolled, classical celiac trunk was noted in 134 (83.9%) individuals (table 2) while the variations of celiac trunk was found in 26 (16.1%) individuals. Our sample was comprised of different ethnic backgrounds which includes, Urdu speaking, Sindhi, Punjabi and Pathan. In Present study celiac trunk variations were categorized by Uflacker's classification. Type I i.e classical celiac trunk was found to be the highest in Urdu Speaking i.e. 52 (32.5%) individuals followed by Punjabi speaking 36(22.5%) and 28(17.5%) individuals in Sindhi speaking and least was found in Pakhtoon speaking 18(11.25 %) individuals in our study participants. Also Non classical Celiac trunk was found to be highest in Urdu speaking exhibiting the frequency of 13(8.125 %) individuals. It was followed by Pakhtoon, Sindhi and Punjabi speaking with the frequency of 7(4.375%), 4 (2.5%) and 2(1.25%) individuals respectively Table 3.

In present study hepatosplenic trunk (Type II) was found to be highest in Urdu and Pakhtoon speaking in 7 (4.375 %) individuals and 2 (1.25 %) individuals respectively. Hepatogastric

trunk (TypeIII) was found to be present in only pakhtoon speaking 1 (0.625%) individual while hepatosplenomesenteric trunk (Type IV) was found to be present in 1 (0.625%) Urdu speaking individual. Type V was found to be highest in Urdu speaking 4 (2.5 %) individuals followed by pakhtoon speaking 3 (1.875 %) and least was found in sindhi speaking individuals 2 (1.25 %) individuals. Type VI was found to be present in 1 individual only i.e. in urdu speaking. Type VII was found to be present in pakhtoon speaking punjabi speaking and sindhi speaking with the frequency of 1 (0.625%), 2 (1.25%) and 2 (1.25%) individuals respectively. As shown in Table 2. Type VIII was not found in our studied population.

Tab1e 1: Uflacker's Classification

Types	Description
Types I	Classic celiac trunk
Types II	Hepatosplenic trunk
Types III	Hepatogastric trunk
Types IV	Hepatosplenomesenteric
Types V	Gastroplenic trunk
Types VI	Celiac-mesenteric
Types VII	Celiac-cloic trunk
Types VIII	No celiac trunk

Table 2: Showing frequency of Classical Celiac Trunk in different ethnicity

Ethnicity	Type I N (%)
Pathan	18 (11.25)
Punjabi	36 (22.5)
Sindhi	28 (17.5)
Urdu speaking	52 (32.5)
Grand Total	134

Table 3: Showing the frequencies of celiac trunk and its variations in different ethnicities in our studied population by Uflacker's classification.

Ethnicity	Type I N (%)	Type II N (%)	Type III N (%)	Type IV N (%)	Type V N (%)	Type VI N (%)	Type VII N (%)	Type VIII N (%)
Pathan	18 (11.25)	2 (1.25)	1 (0.625)	-	3 (1.875)	-	1 (0.625)	-
Punjabi	36 (22.5)	-	-	-	-	-	2 (1.25)	-
Sindhi	28 (17.5)	-	-	-	2 (1.25)	-	2(1.25)	-
Urdu speaking	52 (32.5)	7 (4.375)	-	1 (0.625)	4 (2.5)	1 (0.625)	-	-
Grand Total	134	9	1	1	9	1	5	-

DISCUSSION

A complete understanding of anatomy of celiac trunk and vascular supply of hepatobiliary system is important for various radiological interventional & surgical treatment of upper abdominal organ diseases.

Celiac trunk branching patters are embryological in origin. During 3rd week development of heart, a pair of dorsal aorta develop with bilateral ventral segmental arteries, which supply abdominal organs. During 4th and 5th week of development, dorsal aorta fuse to form abdominal aorta with the fusion of the dorsal mesentery during the development of intestine. Several splanchnic branches arising from each dorsal aorta which anastomose longitudinally in midline to form ventral anastomosis (6).

With the development of ventral anastomosis, there is a regression of number of splanchnic branches, only 3 major arteries persists, namely as Celiac Trunk, Superior Mesenteric Artery, and Inferior Mesenteric Artery (6). There are 9 lateral splanchnic arteries are present on right and left side of abdominal aorta. Lateral splanchnic arteries supplies Mesonephrons, Metanephrons, Gonads, and Adrenal gland, which are derived from intermediate mesenchyme of the mesonephric ridge. Various anatomical arterial variations are due to persistence, regression or fusion of various splanchnic arterial branches (6).

Only 1 study has been conducted in Pakistan which showed anatomic variations of celiac trunk with the frequency of 11.8% (18). Present study presented higher frequencies of celiac trunk variations i.e. 16.1%. It may be due to greater number of

participants recruited in present study while it is a first study documented in Pakistan which showed ethnic differences in celiac trunk variations.

Previous studies showed Frequency of celiac trunk variation in different regions of India which showed considerable differences between different regions. A study was done in Andhra region (India) which showed frequency of celiac trunk variation as low as 18.52 % (19) while another study showed frequency of celiac trunk variations in north Indian population was 55% (20).

Literature has showed considerable variation in prevalences of celiac trunk branching pattern ranging from as low as 18.52% in Andhra region of Indian population (19) to as high as 55% in north Indian population (20). Few other Indian studies showed a frequency of celiac trunk variation was 19.65% (21) & 14% respectively (12). Further Studies was done on Chinese & Korean population showed prevalence of celiac trunk variation to be 10.9% (22) and 10.2% respectively (23). Branches of celiac trunk shows diversity across different populations it may be due to ethnic or genetic differences.

In present study celiac trunk (Type I) was found to be present in 83.9% studied population & their anatomic variations were found to be present in only 16.1% individuals. Presence of normal anatomical pattern of celiac trunk may reduce various complications that occur during surgical procedure or endovascular embolization (16).

Literature suggests variations in branching pattern of Celiac trunk but their ethnic differences are not well documented. There

are number of studies conducted on different Indian population on celiac trunk branching patterns. A recent study conducted on north Indian population which depicts celiac trunk variations with the frequency of 69.09% and the most frequent variation was found to be (type II) hepatosplenic trunk with the frequency of 60%⁽²⁴⁾. In present study type II was also found to be the most frequent variations of celiac trunk branching pattern i.e. (5.6%) although the frequency of hepatosplenic trunk was highest in Urdu speaking individuals (4.375%). A study conducted in 2012 in population of bangaluru also showed highest frequency of hepatosplenic trunk with a frequency of 4.8%⁽²⁵⁾.

Similarly type V i.e. gastrosplenic trunk was also found to be highest in our study participants with the frequency of 9 (5.6%) individuals. A study was done on Pakistani population which also showed highest frequency of gastrosplenic trunk, (8.2%) individuals⁽¹⁸⁾ but their ethnic differences was not documented. In our study participants type V was most commonly seen in Urdu speaking population with the frequency of 4 (2.5%) individuals followed by Pathan speaking (1.875%) individuals and least was seen in Sindhi speaking with the frequency of (1.25%) in 2 individuals. A study published in 2021 on north Indian population which showed type V was 2nd most frequent variation found in their study participants i.e. 4.55% individuals⁽²⁶⁾. Another study conducted on south Indian population showed type V was found to be 2nd most frequent variation with frequency of 1.5%⁽²⁷⁾.

Type VII (celiac-colic trunk) was found to be 2nd most frequent variation in present studied population i.e. 3.1% individuals. Celiac-colic trunk is present when middle colic artery which is a branch of superior mesenteric artery arising from celiac trunk. This type of variation showed low frequency but it can lead to severe complications while performing transverse colon surgeries⁽²⁸⁾. Prevalence of celiac-colic trunk in an Indian population was found to be 4% (29) but their ethnic differences were not mentioned. We couldn't find more studies on frequencies of celiac-colic trunk. Type VII was seen in Sindhi & Punjabi speaking equally but less frequently found in Pathan speaking participants in our study.

Frequencies of (type III) hepato-gastric trunk, (type IV) hepato-spleno-mesenteric trunk and (type VI) celiac-mesenteric trunk was found in only 1 individual in each type with the frequency of 0.6% in present study.

Type III (hepatogastric trunk) incidentally found in a cadaveric Indian population which was done on 50 cadavers, reported the frequency of hepatogastric trunk was 2% (1 individual)⁽¹²⁾. Collection of cadavers & their ethnicity is not mentioned⁽¹²⁾. Frequency of hepatogastric trunk in Turkish population was reported to be 1% (16) while in Brazilians it was reported to be 1.7% i.e. 1 individual each⁽³⁰⁾. A study conducted on north Indian population published in 2021 showed Hepatogastric trunk with the frequency of 1.82% cases⁽²⁶⁾ while in south Indian population hepatogastric trunk was not present⁽²⁷⁾. Present study showed hepatogastric trunk was only present in Pathan speaking.

A recent study conducted in 2022 which showed hepatosplenomesenteric (type IV) trunk in Indian population with the frequency of 0.38% which is comparable to our studied population⁽⁶⁾.

Celiac mesenteric trunk (type VI) was also observed in north Indian population with the frequency of 0.91% individual. This type of variation was also found in our study participants in Urdu speaking individual with the frequency of 0.625% individual⁽²⁶⁾. Though in our study Type IV and type VI was only found in Urdu speaking individuals.

In our study participants type VIII was absent but this type of variation found only in Turkish and polish population^(15, 28) while it was also absent in Indian population⁽³¹⁾.

CONCLUSION

Celiac trunk arterial variations in different ethnic groups should analysed carefully preoperatively by CT Scan to avoid any catastrophic outcomes. Understanding of these variations in

different ethnicity would be helpful for surgeons and radiologists to minimise the chances of serious complications during interventional radiological and upper abdominal surgeries in our population.

REFERENCE

- Nayak S, Prabhu LV, Krishnamurthy A, Kumar CG, Ramanathan LA, Acharya A, et al. Additional branches of celiac trunk and its clinical significance. *Rom J Morphol Embryol*. 2008;49(2):247-9.
- Juszczak A, Mazurek A, Walocha J, Pasternak A. Coeliac trunk and its anatomic variations: a cadaveric study. *Folia Morphologica*. 2021;80(1):114-21.
- Sehgal G, Srivastava A, Sharma P, RANI A, Deewan R, AGA P, et al. Celiacomesenteric trunk: an unusual variation. *J Anat Sci*. 2013;21(December (2)):1-6.
- de Oliveira Botelho L, Castro LC, de Alvarenga Pires ML, Barroso RCV. Anatomical variation of the branching of the Celiac Trunk: case report: Variação anatômica da ramificação do Tronco Celiaco: relato de caso. *Brazilian Journal of Health Review*. 2022;5(6):22731-8.
- Kumar A, Khare S, Jain S, Gupta M, Sharma Y. A MDCT STUDY ON THE ANALYSIS OF COELIAC TRUNK AND ITS BRANCHING PATTERN IN THE NORTH INDIAN POPULATION. Dr Satyam Khare.24.
- Ethiraj D, Kalyanasundaram S, Indiran V, Varadan B, Subbiah K, Srinivas S, et al. Newly proposed classification of celiac artery variations based on embryology and correlation with computed tomography angiography. *Polish Journal of Radiology*. 2022;87(1):563-73.
- Rathod S, Kulus R, Kim B, Gurnani S, Kim A, Kim E, et al. A case of abnormally dilated and tortuous arc of Buhler and pancreaticoduodenal arteries in the absence of celiac trunk stenosis. *Surgical and Radiologic Anatomy*. 2022;44(10):1343-7.
- Nayak SR, Pai MM, Prabhu LV, D'Costa S, Shetty P. Anatomical organization of aortic arch variations in the India: embryological basis and review. *Jornal Vascular Brasileiro*. 2006;5:95-100.
- Tandler J. über die Varietäten der Arteria coeliaca und deren Entwicklung. *Anatomy and Embryology*. 1904;25(2):473-500.
- Farghadani M, Momeni M, Hekmatnia A, Momeni F, Mahdavi MMB. Anatomical variation of celiac axis, superior mesenteric artery, and hepatic artery: Evaluation with multidetector computed tomography angiography. *Journal of Research in Medical Sciences*. 2016;21(1):129.
- Kandavadivelu MVA, Govindarajan A, Saminathan S, Hepzibah DJ. Branching pattern of superior mesenteric artery and its variations: Cadaveric study. *National Journal of Clinical Anatomy*. 2022;11(4):187.
- Rajini T, Mokhasi V, Geethanjali B, Sivacharan P, Shashirekha M. Coeliac trunk and its branches: anatomical variations and clinical implications. *Singapore medical journal*. 2012;53(5):329-31.
- Covantev S, Mazuruc N, Drangoi I, Belic O. Unusual development of the celiac trunk and its clinical significance. *Jornal Vascular Brasileiro*. 2021;20.
- Sureka B, Mittal MK, Mittal A, Sinha M, Bhamberi NK, Thukral BB. Variations of celiac axis, common hepatic artery and its branches in 600 patients. *Indian Journal of Radiology and Imaging*. 2013;23(03):223-33.
- Ugurel M, Battal B, Bozlar U, Nural M, Tasar M, Ors F, et al. Anatomical variations of hepatic arterial system, coeliac trunk and renal arteries: an analysis with multidetector CT angiography. *The British journal of radiology*. 2010;83(992):661-7.
- Torres K, Staśkiewicz G, Denisow M, Torres A, Szukała M, Czekajka-Chehab E, et al. Anatomical variations of the coeliac trunk in the homogeneous Polish population. *Folia morphologica*. 2015;74(1):93-9.
- Purushothama Raju N. Variants of Coeliac Trunk, Hepatic Artery and Renal Arteries in Puducherry Population Yash Kumar Achantani, Purushothama Raju N, Ramesh Kumar R. 2018.
- Arifuzzaman M, Naqvi SSN, Adel H, Adil SO, Rasool M, Hussain M. ANATOMICAL VARIANTS OF COELIAC TRUNK, HEPATIC AND RENAL ARTERIES IN A POPULATION OF DEVELOPING COUNTRY USING MULTIDETECTOR COMPUTED TOMOGRAPHY ANGIOGRAPHY. *Journal of Ayub Medical College Abbottabad*. 2017;29(3).
- Manoharrao SV, Lakshmi BB, Narayanrao GR. A STUDY OF ARTERIAL DIAMETERS AND BRANCHING PATTERNS OF COELIAC TRUNK IN CADAVERS OF ANDHRA REGION.
- Sehgal G, Srivastava A, Sharma P, Kumar N, Singh R. Morphometry of the celiac trunk: a multidetector computed tomographic

- angiographic study. *Journal of the Anatomical Society of India.* 2013;62:23-7.
21. Babu CR, Joshi S, Gupta K, Gupta O. Celiacomesenteric trunk and its variants a multidetector row computed tomographic study. *Journal of the Anatomical Society of India.* 2015;64(1):32-41.
 22. Song S-Y, Chung JW, Yin YH, Jae HJ, Kim H-C, Jeon UB, et al. Celiac axis and common hepatic artery variations in 5002 patients: systematic analysis with spiral CT and DSA. *Radiology.* 2010;255(1):278-88.
 23. Wang Y, Cheng C, Wang L, Li R, Chen J-h, Gong S-g. Anatomical variations in the origins of the celiac axis and the superior mesenteric artery: MDCT angiographic findings and their probable embryological mechanisms. *European radiology.* 2014;24(8):1777-84.
 24. Malviya K, Verma A, Nayak A, Mishra A, More R. Unraveling Variations in Celiac Trunk and Hepatic Artery by CT Angiography to Aid in Surgeries of Upper Abdominal Region. *Diagnostics* 2021, 11, 2262. s Note: MDPI stays neutral with regard to jurisdictional claims in published ...; 2021.
 25. Sivacharan P, Shashirekha M. Coeliac trunk and its branches: anatomical variations and clinical implications. *Singapore Med J.* 2012;53(5):329-31.
 26. Malviya KK, Verma A, Nayak AK, Mishra A, More RS. Unraveling Variations in Celiac Trunk and Hepatic Artery by CT Angiography to Aid in Surgeries of Upper Abdominal Region. *Diagnostics.* 2021;11(12):2262.
 27. Thangarajah A, Parthasarathy R. Celiac axis, common hepatic and hepatic artery variants as evidenced on MDCT angiography in south indian population. *Journal of Clinical and Diagnostic Research: JCDR.* 2016;10(1):TC01.
 28. Czekajaska-Chehab E, Drop A. Anatomical variations of the coeliac trunk in the homogeneous Polish population. *Folia Morphol.* 2015;74(1):93-9.
 29. Chitra R. Clinically relevant variations of the coeliac trunk. *Singapore medical journal.* 2010;51(3):216.
 30. Araujo Neto SA, Franca HA, Mello Júnior CFd, Silva Neto EJ, Negromonte GRP, Duarte CMA, et al. Anatomical variations of the celiac trunk and hepatic arterial system: an analysis using multidetector computed tomography angiography. *Radiologia brasileira.* 2015;48(6):358-62.
 31. Wadhwa A, Sonia S. A Composite Study of Coeliac Trunk in 30 Adult Human Cadavers-its Clinical Implications. *Global Journal of Medical Research.* 2011;11(1).