ORIGINAL ARTICLE

Morphometric Analysis of Celiac Trunk in Male and Female Adults of Karachi by using 3D Multidetector Computed Tomography Angiography (MDCTA)

Rosheena Nabeel Khan[1], Nuzhat Hassan[2], Madeeha Sadiq[3], Muhammad Ali[4]

ABSTRACT:

Objective: To determine the length and diameter of celiac trunk by using Multidetector computed Tomography Angiography (MDCTA) and to find its association with gender.

Methodology: 160 individuals, 85 (53.1%) males and 75 (46.9 %) females) without any vascular or upper abdominal visceral disease who presented to Radiology Department, Ziauddin University Hospital, Clifton, Karachi, for abdominal 3D MDCTA from March, 2017 to August, 2017 were recruited in this study. Length and diameter of both classical and non-classical celiac trunk was measured. Statistical analysis was done on SPSS version 20. All variables were presented as mean and standard deviation. Independent T test was applied. Correlation analysis by using Pearson's correlation was applied to test the relationship between variables. P-value ≤ 0.05 was considered significant.

Result: The difference between mean length of classical celiac trunk and non- classical celiac trunk was significant (P = 0.005).The difference in mean length (P = 0.007), and mean diameter (P = 0.007) of classical celiac trunk between males and females was significant. A weak positive association (r = 0.247) was found between length and diameter of classical celiac trunk (P = 0.004). A moderate positive association (r = 0.401) was found between length and diameter of non-classical celiac trunk (P = 0.043).

Keywords: Artery, Stent, Transplant, Angiography, Gender, Classical Celiac trunk, Non- Classical Celiac trunk

INTRODUCTION:

With the introduction of abdominal angioplasty, catheterization and minimally invasive surgeries, the study of splanchnic vasculature has become increasingly important for better preoperative planning[1]. Celiac trunk is the first anterior visceral branch of abdominal aorta[2] arising just below the aortic hiatus at T12/L1 vertebral level[3, 4]. It measures 1.5-2 cm in length[3, 5] and provides arterial supply to the foregut derivatives [6, 7]. Classically, celiac trunk gives rise to three main branches namely common hepatic, left gastric and splenic artery[8, 9]. In 1997 Uflacker classified the celiac trunk into 8 branching patterns[10, 11]. According to Uflacker's classification, a classic celiac trunk is type I while type II to Type VIII are non-classical types having varying branching patterns[12]. The abdominal vessels, especially the celiac trunk are subject to diverse variations in their origin, course and dimensions[13]. Anatomical variations of celiac trunk are well explored in literature but information regarding the variability in its dimensions across different populations is still scanty[14]. However, the reported mean lengths from different populations vary from as low as 17 mm in Indians [15] to as high as 28.35 mm in Albanian popula-tion[16].

Knowledge of arterial diameters is important for stent placement procedures and for the designing of such stents to customize them according to the specific dimensions of a certain population. Arterial diameter of celiac trunk branches is of great importance for preoperative planning in organ transplant surgeries and also for precise radiological diagnosis of arterial aneurysms and stenosis[17, 18].

MDCTA has replaced conventional angiography for preoperative imaging as it is the emerging most accurate modality[15]. MDCTA has various advantages like increase in high spatial resolution, imaging acquisition speed and more coverage of the patient[19]. Multidetector computed tomography angiography (MDCTA) in association with digital images processing by software resources represents a useful tool, which is particularly attractive for its non- invasiveness[20].

Celiac trunk variations and pathologies are relatively common occurrences. With the advent of computed tomography (CT) technology, these conditions are being diagnosed with an increased frequency even among asymptomatic individuals. CT angiography is used noninvasively for preoperative staging and vascular mapping in patients with pancreatic and hepatobiliary neoplasms. MDCTA also allows the accurate depiction of the abdominal splanchnic vessels' stenosis, collateral vessels and atherosclerotic plaques[21].

✉ **Dr. Rosheena Nabeel Khan**
Senior Lecturer
Department of Anatomy
Ziauddin University
Email: rosheenanabeel@gmail.com
✉ **Dr. Nuzhat Hassan**
Professor & Chairperson
Department of Anatomy
Ziauddin University
✉ **Dr. Madeeha Sadiq**
Assistant Professor
Department of Anatomy
Ziauddin University
✉ **Dr. Muhammad Ali**
Assistant Professor & Head
Department of Radiology
Ziauddin University Hospital
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METHODOLOGY:

Sample Collection: This cross-sectional study was carried out from March, 2017 to August, 2017. The study was performed on 160 individual aged 20-60 years of both genders having serum creatinine level of < 1.4mg/dl[22]. Recruitment of study participants was done from patients who were referred to Radiology Department of Ziauddin University Hospital for abdominal contrast MDCTA examination due to various indications such as abdominal pain, altered bowel habits, kidney and adrenal pathologies. Persons having hepatobilary pathologies, pancreatic or abdominal vascular lesions, abdominal malignancy distorting vascular anatomy, vasculitis and atherosclerosis were excluded from the study. Patients having history of liver transplant or upper abdominal surgeries or those having history of allergic reaction to contrast agents and pregnant ladies were also excluded from the study. The study was conducted after approval from Ethics Review Committee of Ziauddin University.

Data Collection: Informed consent was obtained from each participant.

1. **Questionnaire**: Based on demographic profile, including age, gender and medical/surgical history was filled.
2. **MDCTA** was performed

All CT examinations were performed on a 16-slice MDCT scanner (Toshiba 16 slicer Alexion, Japan) using the automatic dose modulation technique (Real Exposure Control, Toshiba Medical Systems) in the arterial phase. The subject was asked to lie in supine position on the platform of CT scanner. Contrast material was administered and the patient was instructed to hold his/her breath for 15 seconds.

Morphometric analysis was performed in axial plane with reconstruction techniques in the sagittal and coronal planes. Images were modified through Multiplanar reformatting (MPR), maximum intensity projection (MIP) reconstructions and volume rendered (VR) techniques. Through MDCTA, reconstruction programs, especially MIP and VR images are used to depict small calibre vessels[20] while MPR is the process of using the data from axial CT images to create non-axial two-dimensional images[23]. MPR program was used to reconstruct images in coronal, sagittal, axial or oblique planes for visualization of celiac trunk. A slice thickness of 5 mm was taken to evaluate the celiac trunk. Images were acquired from the dome of diaphragm to the pubic symphysis in craniocaudal fashion. In an axial plane, length of classical and non- classical celiac trunk was measured between two points, the first point was taken at the origin of celiac trunk from abdominal aorta and the second point was taken at its bifurcation. Diameter of the celiac trunk was measured 5 mm distal to its origin.

Data was analyzed on SPSS version 20. All variables were presented as mean and standard deviation. Independent T test was applied for the variables. Correlation analysis was done using Pearson's correlation to test the relationship between variables. P-value ≤ 0.05 was considered significant at 95% confidence interval.

RESULTS:

Out of 160 participants, the trifurcation of celiac trunk i.e. classical celiac trunk was observed in 72 males and 62 females (total 134 individuals, 83.9%), while variations were found in 26 individuals (16.1%, 13 males and females each) (Figure-1).

The difference between mean length of classical celiac trunk and non-classical celiac trunk was statistically significant (p = 0.005), whereas the difference between their mean diameter was insignificant (p = 0.586) (Table-1).

The difference between mean length as well as mean diameter of classical celiac trunk between genders was statistically significant (P = 0.007) (Table-2).

The difference between mean length of non-classical celiac trunk in males and females was insignificant (P = 0.965), and the difference between their mean diameter between genders was also insignificant (P= 0.832) (Table-3).

A weak positive association (r = 0.247) was observed between classical celiac trunk length and diameter with significant difference (P = 0.004) (Table-4).

A moderate positive association (r =0.401) was observed between length and diameter of nonclassical celiac trunk with a significant difference (P = 0.043) (Table-5).

Figure-1: Pie chart showing frequency of Classical and Non-Classical Celiac Trunk

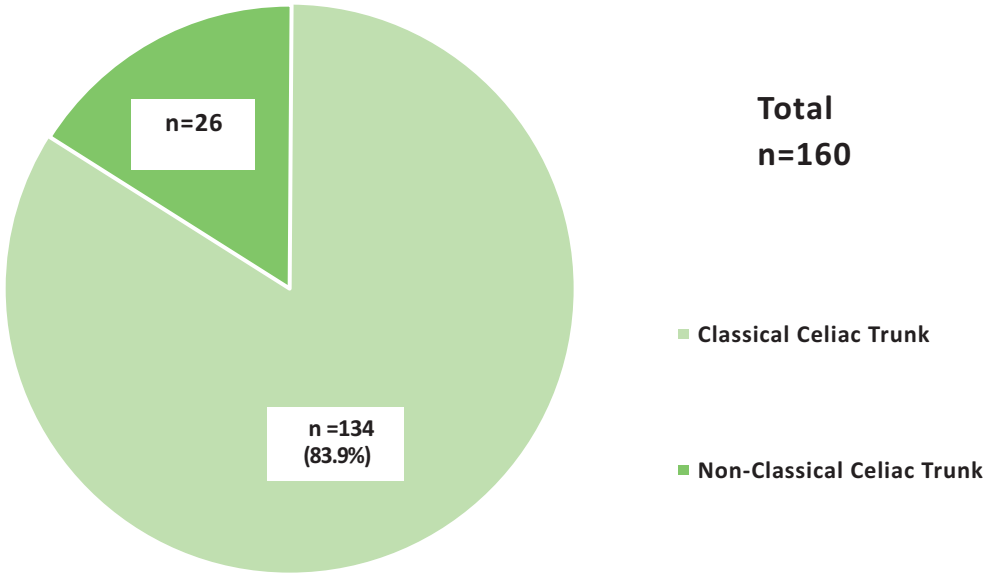

Table 1: Length and Diameter of Classical and Non-Classical Celiac Trunk

Variables	Classical CT (n=134)	Non-Classical CT (n=26)	P-value
Length *(Mean ± SD mm)*	27.5±7.9	22.7±7.5	0.005*
Diameter *(Mean ± SD mm)*	7.0±1.1	7.2±1.2	0.586

CT (Celiac Trunk). *p-value ≤ 0.05 was considered significant

Table 2: length and diameter of Classical Celiac Trunk with respect to gender

Variables	Gender		P-value
	Male (n=72)	Female (n=62)	
Length of Classical CT *(Mean ± SD mm)*	29.2±7.8	25.5±7.5	0.007*
Diameter of Classical CT *(Mean ± SD mm)*	7.3±1.1	6.7±1.1	0.007*

CT (Celiac Trunk). *p-value ≤ 0.05 was considered significant.

Table 3: Length and Diameter of Non-classical Celiac Trunk with respect to gender

Variables	Gender		P-value
	Male (n=13)	Female (n=13)	
Length of Classical CT *(Mean ± SD mm)*	22.7±7.6	22.8±7.6	0.965
Diameter of Classical CT *(Mean ± SD mm)*	7.2±1.3	7.1±1.0	0.832

CT (Celiac Trunk). *p-value ≤ 0.05 was considered significant.

Table 4: Correlation between length and diameter of Classical Celiac Trunk

Variables	(Mean ± SD mm)	P-value	R
Length of Classical CT	**27.5±7.9**	**0.004***	**0.247**
Diameter of Classical CT	**7.0±1.1**		

CT (Celiac Trunk). *p-value ≤ 0.05 was considered significant.

Table 5: Correlation between Length and Diameter of Non-Classical Celiac Trunk

Variables	Non classical CT Mean ±SD mm	P – Value	R
Length	**22.7±7.5**	**0.043***	**0.401**
Diameter	**7.2±1.2**		

CT (Celiac Trunk). *p-value ≤ 0.05 was considered significant.

DISCUSSION:

Celiac trunk is the main artery of the foregut and through its branches, namely splenic, left gastric and common hepatic arteries, it supplies the primary organs of supra-colic compartment of abdomen which includes the stomach, pancreas, duodenum, spleen, and liver[15, 24]. The knowledge of the diameter and length of the vessels is essential in surgeries, for placement of arterial stents and it is also useful for professionals who design and develop the stents[1].

In literature, very few studies were found regarding morphometry of celiac trunk by MDCTA. To the best of our knowledge the present study is the first morphometric analysis of celiac trunk by MDCTA on Pakistani population.

In order to make a precise and correct radiological diagnosis of arterial aneurysms, there is a need to have a complete knowledge of arterial diameter in a particular population. Previous anatomical knowledge of precise normal values for a particular artery might help in early diagnosis of an arterial stenosis through radiological examination, even before clinical signs of low arterial flow appear[25].

Our results showed that the mean length of classical celiac trunk was more than that of non-classical celiac trunk with a significant difference (p= 0.005). By using MDCTA in Indian population the mean length of celiac trunk was found to be 17 mm[15]**.** In Brazilian population mean length of celiac trunk was found to be 23.3±6.5 mm[1] while in Albania it was found to be 28.35 mm[16].

Our mean length of celiac trunk was close to that of Albanian population.

In our study the mean length of classical celiac trunk in males was significantly more than in females while the mean length of non-classical celiac trunk between genders did not show any significant difference.

In an Indian study, the mean length of celiac trunk in males was found to be 17.2 mm, while in females, mean length was found to be 17 mm. No significant difference was observed between gender[26]. In a study conducted in Brazil the mean length of celiac trunk was found to be 17.4 mm, and it was equal in males and females[27].

Few cadaveric studies have also been conducted on morphometry of celiac trunk. In an Indian study mean length of celiac trunk was found to be 17.1 mm[26]. A study conducted in Croatia showed a mean length of celiac trunk to be19±0.8 mm[17]. Another study from Saudi Arabia on cadavers reported the mean celiac trunk length to be 15.5 mm[28]. Literature thus suggests that longer lengths were reported in studies conducted on living subjects by the most accurate modality MDCTA as compared to cadaveric studies. This is perhaps due to the loss of elasticity and stiffer vessels in cadavers.

A study conducted on Indian population reported that non-classical celiac trunk is associated with a shorter length[29]. It has been suggested by Gielecki et al that if celiac trunk length is greater than normal, the surrounding tissues could be more susceptible to disease. Patients who present with abdominal pain should be assessed for Celiac trunk compression syndrome arising from the probable existence of a congenitally formed extended celiac trunk[30].

In a cadaveric study from Greece, Venieratos et al denoted a classical celiac trunk as true tripod and variant branching pattern of celiac trunk as false tripod. The mean length of true tripod in males was 26±7.99 mm and in females it was 28±7.47 mm. The mean length of false tripod in males was 32±5.94 mm and in females was 31±11.66 mm. They could not find any significant difference between the length of true and false tripod in both the genders[31].

In our study the mean diameter of classical celiac trunk was less than that of non-classical celiac trunk but it was not statistically significant. So the diameter of classical or non-classical types did not vary significantly.

By using MDCTA in Indian population, Brazilian population and Albanian population the diameter of celiac trunk was found to be 6.5 mm[15], 8±1.3 mm[1] and 7.65 mm[16] respectively.

In our study, the mean diameter of classical celiac trunk in males was found to be more than in females with a significant difference (P = 0.007). In an Indian study, they found that in male cadavers the diameter of celiac trunk was found to be 6.5 mm while in female cadavers it was 6.7 mm with no significant difference in diameter between genders[26]. A study done in Brazil showed a mean diameter of celiac trunk to be 6.5 mm in males and 6.7 mm in females[27]. To the best of our knowledge non-classical celiac trunk diameter has not been studied in relation to gender.

In our study a weak positive correlation was found between length and diameter of classical celiac trunk. However, these dimensions of the non-classical celiac trunk showed moderate positive correlation. A Brazilian study has also reported a moderate positive correlation between celiac trunk length and diameter[1].

CONCLUSION:

It is concluded that the length of classical celiac trunk is more than that of non-classical celiac trunk. The length and diameter of classical celiac trunk is greater in males than in females. It is also concluded that with increasing length, the diameter also increases more for the non-classical celiac trunk as compared to the classical celiac trunk.

Considerable diversity has been observed internationally in length and diameter of celiac trunk among different population and ethnic groups. Data specific to Pakistani population presented in this study may be utilized by surgeons and radiologists to minimize complications during upper abdominal surgeries and interventional procedures. It can also be used for designing of stents or catheters, so that all information can be integrated and used for the patients' well-being.

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