Med. J. Cairo Univ., Vol. 92, No. 2, Accepted 4/3/2024
DOI: 10.22608/MJCU. 505-515, June 2024
www.medicaljournalofcairouniversity.net

Anatomical Variations of Celiac Trunk and Hepatic Arterial System Using Multidetector Computed Tomography in Egyptians

NOURA M. ABOELKHAIR, M.Sc.*; AHMED NABAWY AHMED, M.D.*;
MOHAMMED A. ELHAWARY, M.D.** and DALIA M. SALEH, M.D.*

The Departments of Anatomy & Embryology and Radiology**, Faculty of Medicine, Mansoura University.*

Abstract

Background: The classic anatomic pattern of the Celiac trunk is present in 86-89% of cases in several studies. Major variations of the celiac trunk are common and should be anticipated before radiological and surgical interventions such as: hepatopancreatobiliary surgery, liver transplant, and interventional radiology. Uflacker's classification system of variations of coeliac trunk is one of the commonly used systems.

The normal hepatic artery arises from celiac trunk and divides into three main branches; the right hepatic, left hepatic and middle hepatic. Many variations of the normal anatomy of hepatic artery exist. Michel's classification for hepatic artery variants describes nine arterial anatomical variations. Preoperative identification of hepatic artery variations reduces intraoperative bleeding complications and improve postoperative surgical outcomes in many surgeries such as liver tumor resection, liver transplantation, pancreatic tumor resection, pancreatoduodenectomy and biliary surgeries.

Multidetector computed tomography angiography has shown great ability in defining the vascular anatomy and detecting any anomalies and variants before the surgical interference with much less side effects.

Aim of Study: The aim of the work is to study the variations of the normal anatomy of the celiac trunk and the hepatic artery among Egyptians using MDCT.

Material and Methods: This Descriptive cross-sectional study was carried out on 380 patients who underwent MDCT scan by Toshiba Aquilion Prime Series CT Scanner -80 slice per rotation for abdominal and hepatic assessment.

Results: According to Uflacker's classification of celiac trunk variants, Type I (classic and non-classic patterns) was the most common variant in 91.07% of the cases. Followed by type V in 30 cases (7.89%). Other variants were type II in 4 cases (1.05%). Type III, VI, IV, VII and VIII weren't reported among the included cases.

According to Michel's classification for hepatic artery variants, Type I (Classic Anatomy) was the most common variant in 80.2% of the cases. Followed by Type III in 42 cases (11.05%). Type V in 15 cases (3.94%), Type II in 10 cases (2.63%), Type IXin 7 cases (1.84%) and Type VI in 1 case (0.26%). Type IV, VII, VIII and X weren't reported in the cases of the study.

Conclusions: Based on the results of the current study, it is concluded that Multidetector Computed Tomography could be used as an efficient diagnostic technique in assessment of variants of the celiac trunk and hepatic artery.

Key Words: *Celiac trunk – Hepatic artery – Multidetector computed tomography angiography – 3D image reconstruction – Uflacker's classification – Michel's classification.*

Introduction

CELIAC trunk is the first ventral branch from the abdominal aorta. It arises between the twelfth thoracic vertebra and the first lumbar vertebra below the aortic orifice of the diaphragm. It is a short trunk measuring 1.5-2cm **[1]**. It divides into three terminal branches: ,eft gastric, splenic, and common hepatic arteries **[2].**

This classic pattern represents 86-89% of cases in several studies and first described by Haller since 1756, so sometimes defined as Tripus Halleri **[3].**

The left gastric artery (LGA) is the smallest branch of the celiac trunk. It gives esophageal branches that reach the esophagus through the esophageal opening of the diaphragm. And along its course through lesser curvature supply both surfaces of the stomach and then ends by anastomosing with the right gastric artery at the region of angular incisure **[4].**

Correspondence to: Dr. Noura M. Aboelkhair,
E-Mail: Noura.magdy.94@gmail.com

The Splenic artery is the largest branch of the celiac trunk; it runs in a tortuous course. It ends by 5-6 terminal branches which enter the hilum of spleen. In its course, it gives off multiple branches to the pancreas, short gastric branches and left gastroepiploic branch to the stomach [4]. Common hepatic artery (CHA) is intermediate in size between the other two branches. It reaches the porta hepatis where it ends by dividing into right and left terminal branches [4].

The superior mesenteric artery (SMA) arises from the abdominal aorta opposite the lower border of L1 vertebra, 1cm below the celiac trunk. Then passes towards the right iliac fossa to enter the root of the mesentery of the small intestine where it divides to its terminal branches. It ends by anastomosing with ileal branches of ileocolic artery. Its branches include inferior pancreaticoduodenal artery, ileocolic artery, jejunal and ileal branches, right colic artery and middle colic artery [2].

Major variations of the celiac trunk are common and should be anticipated before radiological and surgical interventions. Various classification systems for the celiac trunk exist; the most concise and most frequently cited is that proposed by Adachi (1928), another system was proposed by Uflacker (1997) [5].

The hepatic artery is defined as typical 'normal' when it arises from celiac trunk and divides into three main branches; the right hepatic, left hepatic and middle hepatic. The term 'accessory' hepatics should be used only in those cases where the normal celiacal right or left hepatic is present, and there is an additional artery from other sources. When the normal celiacal right or left hepatic artery is missing the replacing vessel coming from another source supplying the right or left lobe is to be termed as a 'replaced' right or left hepatic artery [6].

In 1966, Michels published the results of 20 years of investigations into the blood supply of the liver using 200 cadavers. He proposed Michel's classification for hepatic artery variants describing nine arterial anatomical variations [7].

Precise knowledge of hepatic artery variations is helpful in the preoperative planning of surgeries such as liver tumor resection, liver transplantationand biliary surgeries, which can reduce intraoperative bleeding complications and improve postoperative surgical outcomes [8].

MDCTangiography has facilitated three-dimensional [3D] image reconstruction, maximum intensity projection [MIP], multiplanar reconstruction [MPR], and 3D volume rendering [VR] of vascular images. Therefore, it has been shown to have excellent correlation with defining the vascular anatomy and detecting any anomalies and variants before surgical interference. It has also reduced the burden of cost and radiation [9].

Aim of the study:

The aim of the work is to study the variations of the normal anatomy of the celiac trunk and the hepatic artery among Egyptians using MDCT.

Patients and Methods

Study design:

This Descriptive cross-sectional study was carried out on 380 patients (250 males and 130 females).

Target population:

All subjects presented to the Gastroenterology Center at Mansoura University Hospital underwent MDCT scan by Toshiba Aquilion Prime Series CT Scanner-80 slice per rotation for abdominal and hepatic assessment.

Permission for analysis of all CT data was obtained from our institution review board (IRB) prior to initiating this study.

Male and female patients from all age groups were included in the study. Patients with impaired renal function, pregnant female patients, patients with severe obesity, patients with bad general condition, and patients with conditions that may alter normal vascular anatomy were excluded from the study.

Procedure:

All subjects in this study underwent the following:

1- Laboratory investigations: Renal function.

2- Radiological examination:

- Computed Tomography is performed using Multidetector computed tomography (MDCT) Toshiba Aquilion Prime Series CT Scanner -80 slice per rotation.
- Precontrast and postcontrast triphasic studies together with post processing techniques: MPR, MIP and VR.

MDCTAngiography scanning protocol:

All cases were assessed using (Toshiba Aquilion Prime Series CT Scanner -80 slice per rotation) with the same protocol of arterial and venous phases. All cases were instructed to fast for at least 4 hours before scanning. First, an initial scout topography was obtained. Then, 100cc of non-ionic iodinated contrast agent was injected through a 16-18guage cannula inserted in an antecubital vein at a flow rate of 5ml/s using a power injector at pressure 300 psi.

Arterial phase scanning starts based on automatic bolus tracking. Scanning starts 5s after reaching threshold of 150 HU in the area of the abdominal aorta. The scanned area extended from diaphragm to level of S1. The arterial phase acquisition delay was 22s after the start of the contrast injection. The main acquisition thickness of 1.25mm, intersection spacing of 1.25mm, tube voltage of 120kv, tube current range 250-300mAs, with 0.5s gantry rotation time.

Image processing:

For 3D image reconstruction, the volumetric CT data sets were processed on a separate workstation with multiplanar reformatting (MPR), maximum intensity projection (MIP) and volume rendering (VR). Axial source images and the 3D data sets were evaluated by experienced radiologists. The celiac and hepatic arterial anatomy was assessed forthe presence of variants.

Statistical analysis of the data:

The collected data is coded and analyzed using SPSS program (version 21) for windows. Descriptive statistical analysis is performed. The appropriate statistical tests will be used when needed. *p*-value less than 0.05 (5%) will be considered statistically significant.

Results

The current study included total number of 380 cases who underwent hepatic and abdominal MDCT assessment. Among the cases, there were 250 males and 130 females.

According to Uflacker's classification of celiac trunk variants in the current study, Type I (classic and non-classic patterns) was the most common variant in 90% of the cases. The second common pattern was type V (gastro-splenic trunk) in 30 cases (7.89%). Other variants were type II (hepato-splenic trunk) in 4 cases (1.05%), Type III (hepatogastric trunk), Type VI (celiacomesenteric trunk), Type IV (hepatospleno-mesenteric trunk) and Type VII (celiaco-colic trunk) and Type VIII (no celiac trunk) weren't reported among the included cases (Table 1), (Figs. 1,2,3).

According to the Michel's classification for hepatic artery variants in the current study, Type I (Classic Anatomy) was the most common variant in 80.2% of the cases. The second common pattern was Type III (Replaced RHA arising from SMA) in 42 cases (11.05%). Other variants were Type V (Accessory LHA arising from LGA) in 15 cases (3.94%), Type II (Replaced LHA arising from LGA) in 10 cases (2.63%), Type IX (CHA arising from SMA) in 7 cases (1.84%) and Type VI (Accessory RHA arising from SMA) in 1 case (0.26%). Type IV (Replaced LHA and replaced RHA), type VII (Accessory LHA and RHA), type VIII (Replaced RHA and accessory LHA, or replaced LHA and accessory RHA) and type X (CHA arising from LGA) weren't reported in the cases of the study (Table 2) (Figs. 3-7).

Table (1): Celiac trunk variants according to The Uflacker's classification of celiac trunk anomalies.

Type	No. of patients	Incidence
Type I: Classic and non-classic patterns	346	91.05%
Type II: Hepato-splenic trunk	4	1.05%
Type III: Hepatogastric trunk	0	0%
Type IV: Hepatospleno-mesenteric trunk	0	0%
Type V: Gastro-splenic trunk	30	7.89%
Type VI: Celiacomesenteric trunk	0	0%
Type VII: Celiaco-colic trunk	0	0%
Type VIII: No celiac trunk	0	0%

Table (2): Hepatic artery variants according to Michel's classification for hepatic artery variants.

Type	No. of patients	Incidence
Type I: Classic anatomy	305	80.2%
Type II: Replaced LHA arising from LGA	10	2.63%
Type III: Replaced RHA arising from SMA	42	11.05%
Type IV: Replaced LHA and replaced RHA	0	0%
Type V: Accessory LHA arising from LGA	15	3.94%
Type VI: Accessory RHA arising from SMA	1	0.26%
Type VII: Accessory LHA and RHA	0	0%
Type VIII: Replaced RHA and accessory LHA, or replaced LHA and accessory RHA	0	0%
Type IX: CHA arising from SMA	7	1.84%
Type X: CHA arising from LGA	0	0%

Radiological findings

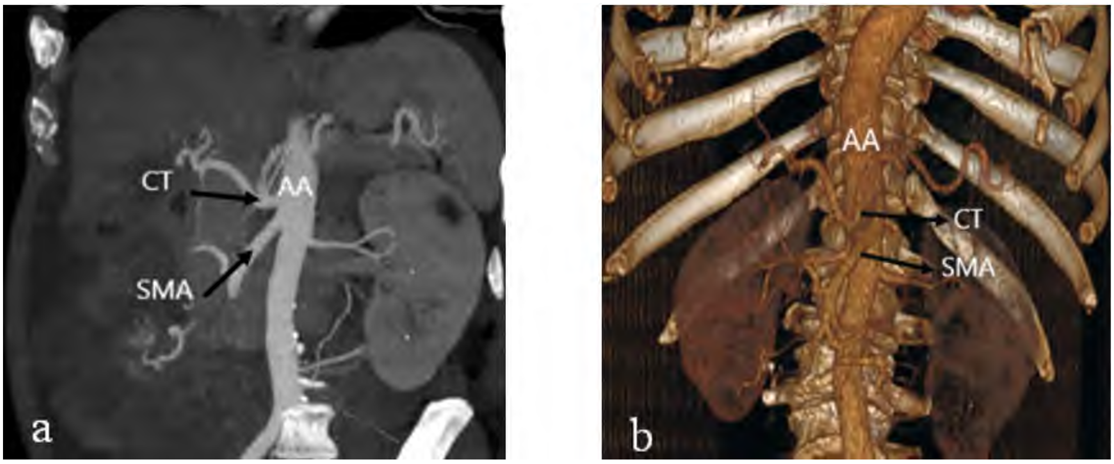

Fig. (1): (A) Maximum intensity projection (MIP) coronal image and (B) Volume rendered image of a male patient aged 34 years showing normal anatomy of Celiac Trunk (CT) and Superior Mesenteric Artery (SMA) arising together from the Abdominal Aorta (AA). Uflacker Type I.

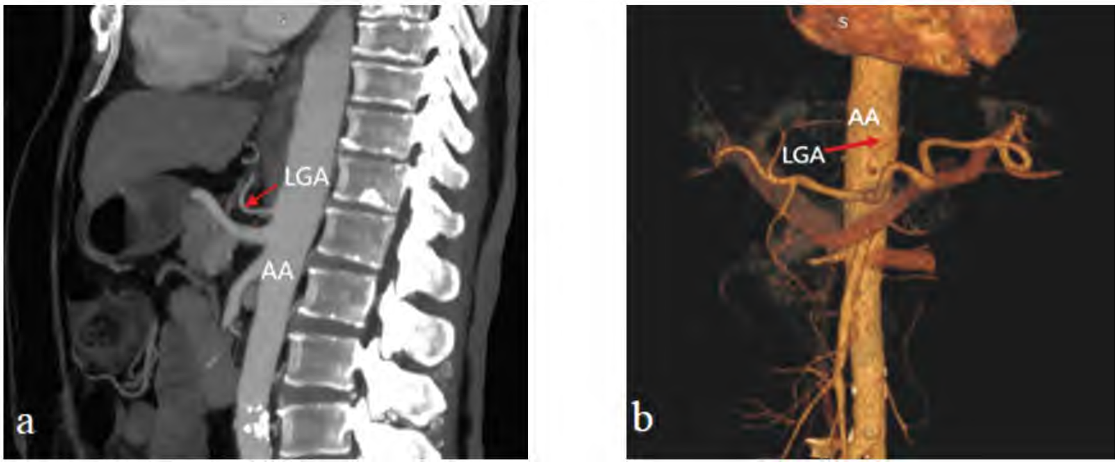

Fig. (2): (A) Maximum intensity projection (MIP) sagittal image and (B) Volume rendered image of a male patient aged 26 years showing the Left gastric artery (LGA) arising from the Abdominal Aorta (AA) Uflacker type II.

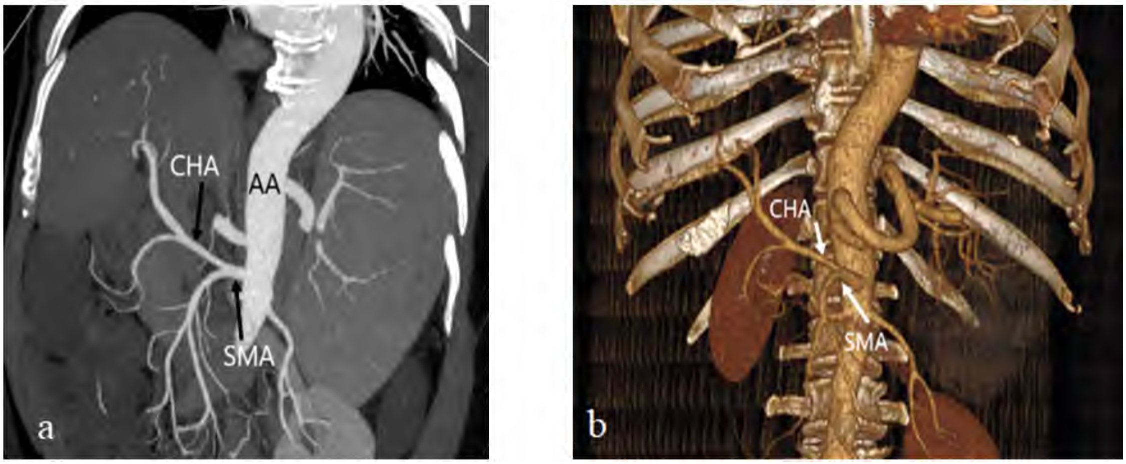

Fig. (3): (A) Maximum intensity projection (MIP) coronal image and (B) Volume rendered image of a male patient aged 37 years showing the Common Hepatic Artery (CHA) arising from the Superior Mesenteric Artery (SMA) Uflacker type V and Michel Type IX.

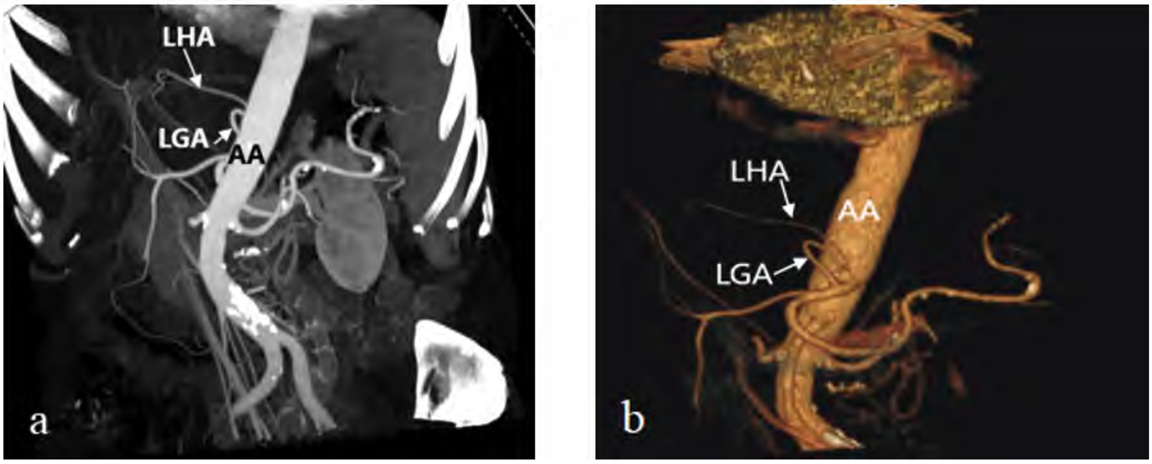

Fig. (4): (A) Maximum intensity projection (MIP) coronal image and (B) Volume rendered image of a female patient aged 47 years old showing replaced Left hepatic Artery (LHA) arising from Left Gastric Artery (LGA) Michel type II.

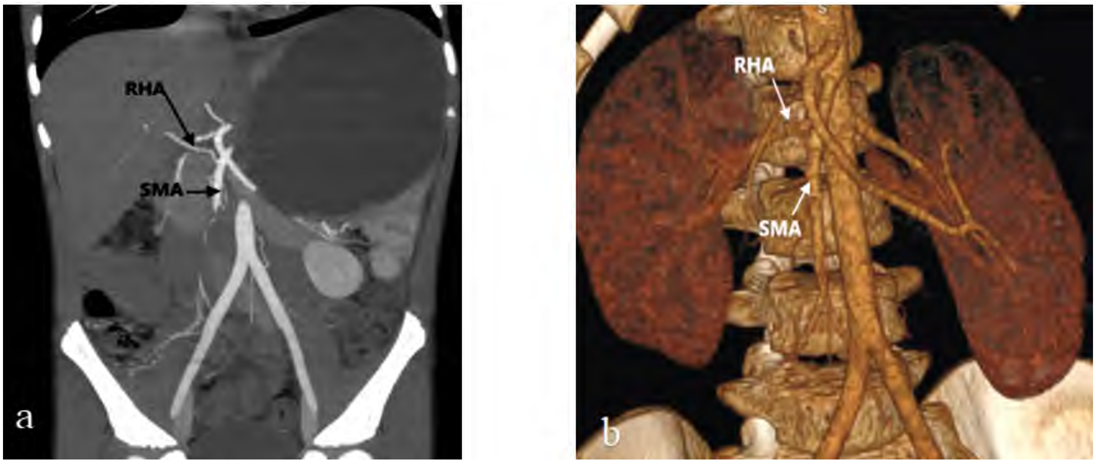

Fig. (5): (A) Maximum intensity projection (MIP) coronal image and (B) Volume rendered image of a female patient aged 27 years showing replaced Right hepatic Artery (RHA) from Superior Mesenteric Artery (SMA) Michel type III.

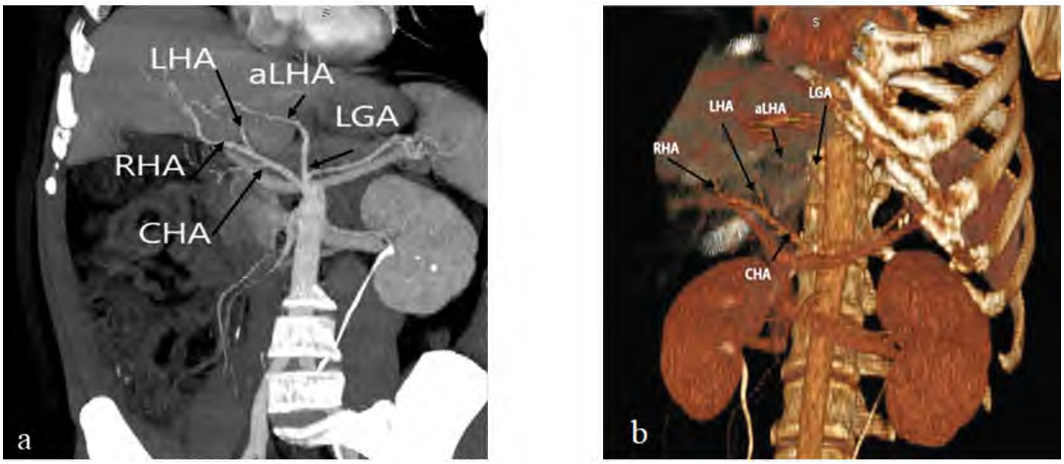

Fig. (6): (A) Maximum intensity projection coronal image and (B) Volume rendered image of a female patient aged 45 years showing accessory left hepatic artery (LHA) from left gastric artery (LGA) Michel Type V.

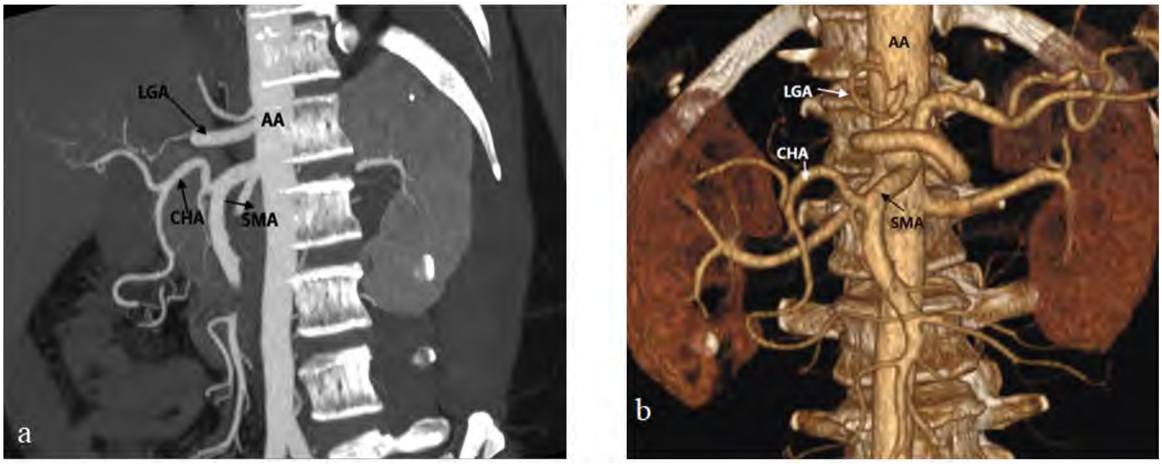

Fig. (7): (A) Maximum intensity projection coronal image and (B) Volume rendered image of a male patient aged 55 years showing Left Gastric artery (LGA) directly from Aorta Uflacker type II. and Common Hepatic Artery (CHA) from superior mesenteric artery (SMA) Michel Type IX.

Discussion

Regarding the Celiac trunk variants according to The Uflacker's classification of celiac trunk anomalies, the current results agreed with Osman and Abdrabou who included 1285 Egyptian patients were retrospectively analyzed in Radiology Department, Ain Shams University. They showed that 90.5% of the patients have normal trifurcation pattern of the celiac trunk (Uflacker type I) with the commonest variant was gastro-splenic trunk (Uflacker type V) with 4.3% incidence. The bifurcation pattern was representing 7.7% of cases **[10].**

The current results were also in accordance with Jalamneh et al., who reported that the anatomical variations in the celiac trunk pattern were observed in 54Palestinian cases (9.8%). Among the variants, type V was the most common (5.5%), which is a gastrosplenic trunk with the CHA originating directly from the abdominal aorta (AA) or SMA **[11].**

Similar results were obtained by Araujo Neto et al., who conducted a study based on the analysis of MDCT images of 60 Brazilian patients. The results showed that the celiac trunk anatomy was normal in 90% of cases. Type II (hepato-splenic trunk) was found in 8.3% of patients, and type III (hepatogastric trunk) in 1.7% **[12].**

Another study found 89.1% of Korean population with type I classification and 10.1% with other variations **[13].** Other researchers Ramanand et al., found 9% of his Indian patients with celiac trunk anatomical variants **[14].**

A previous study found 94.5% of Indian population with type I classification and 5.5% with other variations **[15].** Another study, found 90.2 % of Turkish population with type I classification and 9.8% with other variations **[16].**

A slightly higher prevalence of variant celiac trunk anatomy has been reported in cadaveric studies. The results from the classical cadaveric studies from the first half of the 20th century are summarized in Bergman's Illustrated Encyclopedia of Human Anatomic Variation **[17].**

Panagouli et al.published a systematic review including 36 studies and found a significantly lower incidence of variant celiac trunks in the radiological studies (10.5%, 675/6,501) compared with cadaveric studies (14.9%, 489/3,278) **[18].**

Another study found 83.9% of Palestinian population with type I classification and 16.1% with other variations **[19].**

The reason why the variation rates were higher in some cadaveric studies compared to radiological studies may be attributed to the insufficiency of opacification of very thin vessels **[20].**

In contrast, the current results disagreed with Reda et al. who included 30 Egyptian patients with signs and symptoms of various liver and other abdominal pathologies in which biphasic or triphasic contrast-enhanced CT was indicated. They reported that the commonest variant was Uflacker type II (hepato-splenic trunk) in which CHA and SA have common trunk and LGA arises separately from aorta representing 40% while Uflacker type V (gastro-splenic trunk) in which the origin of the CHA from either the SMA or the aorta was the second common variants representing 20%. Type I (no classic variant) was reported only in 10% **[21].**

According to the Michel's classification for hepatic artery variants, the results of the current study agreed with Ghenciu et al., who included 4192 Romanian patients. Using Michels' classification, the normal anatomy (type I) was present in 3392 (80.91%) cases, while abnormal hepatic arteries were observed in 800 (19.08%) cases. The variations were distributed as follows: Type II in 40 (0.95%) cases, type III in 442 (10.54%) cases, type IV in 13 (0.31%) cases, type V in 285 (6.79%) cases, type VI in 12 (0.28%) cases, type VII in 3 (0.07%) cases, type VIII in 108 (2.57%) cases, type IX in 6 (0.14%) cases and type X in one case (0.02%). 170 (4.05%) unclassified cases were observed. Using Hiatt's classification, the variations were: Type II in 325 (7.75%) cases, type III in 454 (10.83%) cases, type IV in 124 (2.95%) cases, type V in 6 cases (0.14%) and type VI in 69 (1.64%) cases. 102 (2.43%) unclassified cases were observed [22].

Higher incidence of hepatic artery variant was reported in other studies. Osman and Abdrabou who showed that regarding the hepatic artery, 74.3% of the cases showed normal origin of the hepatic arteries (Michel type I) with the commonest anomaly was Michel type III with 12.5% incidence [10].

Within the same line, Gkaragkounis et al., conducted a study among 1,520 Greek patients. They showed that 1,108 (72.89%) were classified as Michels Type I (normal anatomy). Type II and Type III were the commonly reported variants after type I in 9.01% and 7.11% respectively while 4.87% were non-classified [7].

A retrospective study done by Prabhasavat and HomgadestudyingMDCT of 200 Thais patients showed hepatic arterial anatomic variation in about 16% of population. Type III was most common variation in their study and prevalence of other variations were 2.5% [23].

Another MDCT based study done among 400 Chinese patients by Wang et al., showed variant anatomy in 24% of study population with type III being commonest variant [24].

In Araujo Neto et al.'s study, variation of the hepatic artery variant was observed in 21.7% of cases, including anomalous location of the right hepatic artery in 8.3% of cases, and of the left hepatic artery, in 5%. Also, cases of joint relocation of right and left hepatic arteries, and trifurcation of the proper hepatic artery were observed, respectively, in 3 (5%) and 2 (3.3%) patients [12].

Also, Zaki and his colleagues conducted a study on 500 Egyptian patients. They showed that according to Michel's classification, the normal anatomy (type I) was observed in 369 (73.8%) cases, while anomalous hepatic arterial pattern was detected in 131 (26.2%) cases. These anomalies were distributed as follows: Type II in 36 (7.2%) cases, type III in 60 (12%) cases, types IV and V in 5 cases for each (1% each), type VI in 14 (2.8%) and types VIII and IX in a single case for each (0.2% each). Neither type VII nor type X was detected. Nine (1.8%) unclassified cases were observed [25].

A study by Maharjan et al., in Nepal showed that the prevalence of variant anatomy was found to be higher (25.3%) and type III variant anatomy (replaced RHA from SMA) was the commonest variant anatomy (10.1%) [26].

On the other hand, much higher prevalence of variations were reported in other studies according to Ugurel et al., in a retrospective study of 100 computed tomography (CT) images of Turkish patients , hepatic artery with variations was found in 48% of the cases [27]. Sebben et al., in a study of 30 Brazilian cases, have reported variation in 40% of their cases [28].

In a study that included 350 patients from India, hepatic artery proper (right and left hepatic arteries arising from common hepatic artery) (Type I) was seen in 222 (63.4%) of cases. The most common variant replaced left Hepatic Artery (LHA) from the left gastric artery (Type II) with a prevalence of 46 (13.1%). A normal portal vein branching pattern (Type I) was seen in 201 (57.4%) of cases. The most common variation was trifurcation (Type II) with a prevalence of 68 (19.4%) [29].

The most common anatomical variants observed in our study was the replaced RHA arising from SMA (Michel's type III). It constituted 11.05% of our studied cases. This was in accordance with the findings of Michel (11%), Zaki (12%), Rygaard (13.4%), De Cecco et al. (9.2%), Saba and Mallarini (10.56%) [25,30,31,32]. A low percentage of this variation was found in the studies of Daly et al. (6%) [33], Chen et al. (5.2%) [34], Stemmler et al. (6.3%) [35].

The replaced RHA is a beneficial variant in right hepatic lobe living donors transplant, as the common postoperative complication in liver transplantation is hepatic artery thrombosis because of shorter and thinner hepatic artery graft. However, the replaced RHA in such cases provides a longer and larger graft, thus reducing chances of hepatic artery thrombosis [36].

In the current study, the second most common variant was Type V (accessory LHA arising from LGA) in 15 cases (3.94%). This agreed with Cankalet al.who showed that the accessory LHA was the second common anomaly reported in 10% of the included cases [37].

However, Thangarajah discovered that type V of Michels' classification, the presence of left accessory hepatic artery, as the most common abnormality (8.5% of all cases), followed by Type III (8%) and Type II (6%) [38].

The third most frequent variation in our study was the replaced LHA arising from the LGA (Michel's type II). It constituted 2.63% of the studied cases. This variant exists with different percentages in different studies as following Michels (10%), Chen et al. (7.8%), Saba and Mallarini (7.48%), De Cecco et al., (5.2%), Koops et al., (2.5%). Stemmler et al.,reported absence of such variant in their study **[30,31,32,34,35,39]**.

Type IV (LHA from LGA and RHA from SMA) type VII (accessory LHA from LGA and accessory RHA from SMA) and type X (CHA from LGA) are relatively rarer anatomical variants as their prevalence were 1%, 1% and 0.5%, respectively in the study by Michel, 1966 **[30]**. In our study, we also could not find a single case with type VII and type X variation. Other studies done by Duran, et al., and Keles, et al., also did not detect these variants in their study **[40,41]**.

This study recommends the utilization of MDCT as standard screening tool for detection of the anatomical variants of the abdominal vasculature. Also, further multiple centers studies with larger number of cases should be conducted.

Conclusion:

Based on the results of the current study, it could be concluded that Multidetector Computed Tomography could be used as an efficient diagnostic technique in assessment of vascular pattern variants of the celiac trunk and hepatic artery.

Among the included cases, the prevalence of celiac trunk anatomical variants (rather than the classic pattern) was 8.93% while the prevalence of hepatic artery variants (rather than the classic pattern) was 19.8%.

Declarations:

Ethics approval and consent to participate:

The study proposal was revised and approved by the Institutional Review Board, Medical Research Ethics Committee, approval code MS.21.07.1573 (28/03/2021).

Availability of data and material:

The datasets used and analyzed during the study are available from the corresponding author on reasonable request.

Competing interests:

The authors declare that they have no competing interests.

Funding:

This study had no funding from any source.

Authors' contributions:

- NM primary author.
- AN revising the parts of the thesis.
- ME access to the patients and taught me how to take sections of MDCT.
- DS revising the parts of thesis.

Acknowledgements:

The authors would like to acknowledge the study participants for their time and contributions to the study.

References

1- HEMAMALINI: Variations in the branching pattern of the celiac trunk and its clinical significance. Anatomy & Cell Biology, 51 (3): 143-149, 2018.

2- BLACKBURN S., MOFFAT D. and FAIZ O.: Anatomy at a Glance. John Wiley & Sons, 2011.

3- VENARA A., PITTET O., LU T. L., DEMARTINES N. and HALKIC N.: Aberrant Right Hepatic Artery with a Prepancreatic Course Visualized Prior to Pancreaticoduodenectomy. Journal of Gastrointestinal Surgery, 17 (5): 1024-1026, 2013.

4- STANDRING S. and STANDRING S.: Gray's anatomy: The anatomical basis of clinical practice (Forty-first edition (International edition) ed.). Elsevier Limited, 2016.

5- CH E., J C., O A., M C. and D T.: Case Report: Pancreaticoduodenectomy for Pancreatic Ductal Adenocarcinoma with a Rare Anomaly of Celiac Trunk Originating from Superior Mesenteric Artery. American Journal of Medical Case Reports, 7 (2): 29-32, 2019.

6- MALVIYA, K. K., VERMA A., NAYAK, A.K., MISHRA A. and MORE R.S.: Unraveling variations in celiac trunk and hepatic artery by CT angiography to aid in surgeries of upper abdominal region. Diagnostics, 11 (12): 2262, 2021.

7- GKARAGKOUNIS A., FANARIOTIS M., TEPETES K., FEZOULIDIS I. and VASSIOU K.: Celiac trunk and hepatic arteries: Anatomical variations of liver arterial supply as detected with multidetector computed tomography in 1,520 patients and its clinical importance. Clinical Anatomy, 33 (7): 1091-1101, 2020.

8- MALVIYA K.K. and VERMA A.: Importance of Anatomical Variation of the Hepatic Artery for Complicated Liver and Pancreatic Surgeries: A Review Emphasizing Origin and Branching. Diagnostics, 13 (7): 1233, 2023.

9- ANWAR A.S., SRIKALA J., PAPALKAR A.S., PARVEEZ M.Q. and SHARMA A.: Study of anatomical variations of hepatic vasculature using multidetector computed tomography angiography. Surgical and Radiologic Anatomy, 42 (12): 1449-1457, 2020.

[10]OSMAN A. M. and ABDRABOU A.: Celiac trunk and hepatic artery variants: A retrospective preliminary MSCT report among Egyptian patients. The Egyptian Journal of Radiology and Nuclear Medicine, 47 (4): 1451-1458, 2016.

11- JALAMNEH B., NASSAR I.J., SABBOOBA L., GHANEM R., NAZZAL Z., KIWAN R., et al.: Exploring Anatomical Variations of Abdominal Arteries Through Computed Tomography: Classification, Prevalence and Implications. Cureus, 15 (7), 2023.

12- ARAUJO NETO S.A., FRANCA H.A., MELLO JÚNIOR C.F.D., SILVA NETO E.J., NEGROMONTE G.R.P., DUARTE C.M.A., et al.: Anatomical variations of the celiac trunk and hepatic arterial system: An analysis using multidetector computed tomography angiography. Radiologia brasileira, 48: 358-362, 2015.

13- SONG S.-Y., CHUNG J.W., YIN Y.H., JAE H.J., KIM H.-C., JEON U.B., et al.: Celiac axis and common hepatic artery variations in 5002 patients: Systematic analysis with spiral CT and DSA. Radiology, 255 (1): 278-288, 2010.

14- RAMANAND G., SINGH C.A., RANA C.K., RAMESH K. and SINGH S.I.: 64 Slice CT Evaluation of Anatomical Variations of Main Arteries Arising from the Abdominal Aorta and their Branching Pattern. Journal of Medical Science And clinical Research, 6: 576-588, 2018.

15- SUREKA B., MITTAL M.K., MITTAL A., SINHA M., BHAMBRI N.K. and THUKRAL B.B.: Variations of celiac axis, common hepatic artery and its branches in 600 patients. Indian Journal of Radiology and Imaging, 23 (03): 223-233, 2013.

16- CALISKAN E., ACAR T., OZTURK M., BAYRAMOGLU Z., YILMAZ R., ELBUKEN F., et al.: Coeliac trunk and common hepatic artery variations in children: an analysis with computed tomography angiography. Folia Morphologica, 77 (4): 670-676, 2018.

17- BERGMAN R.A., AFIFI A.K. and MIYAUCHI R.: Illustrated Encyclopedia of Human Anatomic Variation: Opus IV: Organ Systems: Digestive System and Spleen. Дата последнего обращения, 30.01: 21, 2015.

18- PANAGOULI E., VENIERATOS D., LOLIS E. and SKANDALAKIS P.: Variations in the anatomy of the celiac trunk: A systematic review and clinical implications. Annals of Anatomy-Anatomischer Anzeiger, 195 (6): 501-511, 2013.

19- RAO A.H., THAHIM H. and KHAN R.: Variation assessment of coeliac trunk branching pattern in changed bowel habits, abdominal pain & kidney/adrenal pathologies patients. Indo American Journal of Pharmaceutical Sciences, 5 (8): 7280-7287, 2018.

20- WHITLEY A., OLIVERIUS M., KOCIÁN P., HAVLŮJ L., GÜRLICH R. and KACHLÍK D.: Variations of the celiac trunk investigated by multidetector computed tomography: systematic review and meta-analysis with clinical correlations. Clinical Anatomy, 33 (8): 1249-1262, 2020.

21- REDA M., REFAAT M. and ABDEL AZIZ S.Z.: Anatomical variations of the celiac artery detected by multidecteor computated tomography. Benha Medical Journal, 39 (Special issue (Radiology)), 98-106, 2022.

22- GHENCIU L.A.B., BOLINTINEANU S.L., IACOB R., STOICESCU E.R. and ZAHOI D.E.: Hepatic arterial variations detected at multidetector computer tomography angiography in the Romanian population. Folia Morphologica, 2023.

23- PRABHASAVAT K. and HOMGADE C.: Variation of hepatic artery by 3-D reconstruction MDCT scan of liver in Siriraj Hospital. Medical journal of the Medical Association of Thailand, 91 (11): 1748, 2008.

24- WANG Y., CHENG C., WANG L., LI R., CHEN J.-H. and 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, 24, 1777-1784, 2014.

25- ZAKI S.M., ABDELMAKSOUD A.H.K., KHALED B.E.A. and KADER I.A.A.: Anatomical variations of hepatic artery using the multidetector computed tomography angiography. Folia Morphologica, 79 (2): 247-254, 2020.

26- MAHARJAN D., SHERPA N.T., KHAREL A. and GYAWALI S.: Anatomic variation of celiac axis and hepatic artery as evidenced multidetector computed tomography in patients at tertiary care center in Nepal. Journal of Patan Academy of Health Sciences, 9 (3): 46-52, 2022.

27- UGUREL M.S., BATTAL B., BOZLAR U., NURAL M.S., 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, 83 (992): 661-667, 2010.

28- SEBBEN G.A., ROCHA S.L., SEBBEN M.A., PARUSSOLO FILHO P R. and GONÇALVES B.H.H.: Variações da artéria hepática: Estudo anatômico em cadáveres. Revista do Colégio Brasileiro de Cirurgiões, 40: 221-226, 2013.

29- SAMBATH P., PADMANABAN E., AMIRTHALINGAM U., ANAND A.M., SUDHAKAR, P., DHINADHAYALAN R., et al.: Hepatic Artery and Portal Vein Variations using Contrast Enhanced Computed Tomography Abdominal Angiography, 2022.

30- MICHELS N.A.: Newer anatomy of the liver and its variant blood supply and collateral circulation. The American Journal of Surgery, 112 (3): 337-347, 1966.

31- DE CECCO C.N., FERRARI R., RENGO M., PAOLANTONIO P., VECCHIETTI F. and LAGHI A.: Anatomic variations of the hepatic arteries in 250 patients studied with 64-row CT angiography. European radiology, 19: 2765-2770, 2009.

32- SABA, L. and MALLARINI, G.: Anatomic variations of arterial liver vascularization: An analysis by using MDCTA. Surgical and radiologic anatomy, 33: 559-568, 2011.

33- DALY J.M., KEMENY N., ODERMAN P. and BOTET J.: Long-term hepatic arterial infusion chemotherapy: Anatomic considerations, operative technique, and treatment morbidity. Archives of surgery, 119 (8): 936-941, 1984.

34- CHEN C.-Y., LEE R.C., TSENG H.S., CHIANG J.H., HWANG J.I. and TENG M.M.: Normal and variant anatomy of hepatic arteries: Angiographic experience. Zhonghua yi xue za zhi Chinese medical journal; Free China ed, 61 (1): 17-23, 1998.

35- STEMMLER B.J., PAULSON E.K., THORNTON F.J., WINTERS S.R., NELSON R.C. and CLARY B.M.: Dual-phase 3D MDCT angiography for evaluation of the liver before hepatic resection. American Journal of Roentgenology, 183 (6): 1551-1557, 2004.

36- MARCOS A., KILLACKEY, M., ORLOFF, M. S., MIELES, L., BOZORGZADEH A. and TAN H.P.: Hepatic arterial reconstruction in 95 adult right lobe living donor liver transplants: Evolution of anastomotic technique. Liver Transplantation, 9 (6): 570-574, 2003.

37- CANKAL F., KAYA M. and GUNER M.A.: Evaluation of Celiac Trunk, Hepatic Artery Variations, and Their Collateral Arteries by Multi-Slice Computed Tomography. Sisli. Etfal. Hastan. Tip. Bul, 55: 217-223, 2021.

38- THANGARAJAH A. and 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, 10 (1): TC01, 2016.

39- KOOPS A., WOJCIECHOWSKI B., BROERING D.C., ADAM G. and KRUPSKI-BERDIEN G.: Anatomic variations of the hepatic arteries in 604 selective celiac and superior mesenteric angiographies. Surgical and Radiologic Anatomy, 26 (3): 239-244, 2004.

40- DURAN C., URAZ S., KANTARCI M., OZTURK E., DOGANAY S., DAYANGAC M., et al.: Hepatic arterial mapping by multidetector computed tomographic angiography in living donor liver transplantation. Journal of computer assisted tomography, 33 (4): 618-625, 2009.

41- KELES P., YUCE I., KELES S. and KANTARCI M.: Evaluation of hepatic arterial anatomy by multidetector computed tomographic angiography in living donor liver transplantation. Biochemical genetics, 54: 283-290, 2016.

الاختلافات التشريحية للجذع البطنى والجهاز الشريانى الكبدى باستخدام التصوير المقطعى متعدد الكواشف فى المصريين

المقدمة: الجذع البطنى هو أول فرعمن الشريان الأورطى البطنى. ينشأ بين الفقرة الصدرية الثانية عشرة والفقرة القطنية الاولى مباشرة أسفل فتحة الأبهر للحجاب الحاجز. إنه جذع قصير بقياس ٥ , ١-٢ سم. يمر بشكل أفقى تقريبًا وباتجاه اليمين أعلى البنكرياس والوريد الطحالى، وينقسم إلى ثلاثة فروع كلاسيكية: الشريان المعدى الأيسر والشريان الكبدى المشترك وشريان الطحال.

ينقسم الكبد بواسطة الوريد الكبدى الأوسط إلى نصفين أيمن وأيسر. ثم ينقسم النصف الأيمن إلى الجزء الأمامى الأيمن والذى يحتوي على المقطعين الخامس والثامن والجزء الخلفى الأيمن والذى يحتوى على المقطعين السادس والسابع. وينقسم النصف الأيسر أيضًا إلى جزء جانبى يشتمل على المقطع الثانى والثالث وجزء وسطى يشتمل على المقطع الرابع.

ويتنوع التشريح الطبيعى للجذع البطنى والجهاز الشريانى الكبدى. عادة ما تكون هذه التنوعات بدون أعراض. معرفة هذا التباين يلعب دورًا هاما فى الإجراءات الجراحية بدءًا من جراحة الكبد الصفراوى وجراحات المعدة والمناورات بالمنظار والإجراءات الإشعاعية التداخلية لاستئصال الأورام الكبدية والانصمام الكيميائى عبر الشرايين وتمدد الأوعية الدموية الشريانية ورأب الأوعية الدموية ووضع الدعامة من أجل نقص تروية المساريق. يقلل التقييم قبل الجراحة لهذه الاختلافات من المضاعفات والتى قد تؤدى إلى الوفاة.

كان تصوير الأوعية بالطرح الرقمى هو الأسلوب القياسي فى تقييم هذه الاختلافات الوعائية، لكن دوره محدود فى الوقت الحاضر لأنه متوغل، وغير متوفر فى كل مكان، ويمكن تفويت بعض الاختلافات بسبب موضع طرف القسطرة وأيضًا عندما تكون الصور المطلوبة عالية الجودة أو حتى إذا كان المريض يعانى من السمنة.

تم استبدال تصوير الأوعية التشخيصى بالأشعة المقطعية والتصوير بالرنين المغناطيسى. ولقد تغير التصوير المقطعى المحوسب من كونه تصويرًا محوريًا إلى تقنية ثلاثية الأبعاد سريعة وقوية.

في السنوات الأخيرة أصبح التصوير المقطعى المحوسب متعدد الكواشف لتقييم كل من الشرايين الحشوية والاضطرابات الهضمية والشرايين المساريقية والكلوية العلوية وأمراض الجهاز الهضمى العلوى هى الطريقة الأساسية مقارنة بالطرق الأخرى.

يوفر التصوير المقطعى المحوسب متعدد الكواشف صورًا عالية الدقة ثلاثية الأبعاد عالية التباين ذات دقة عالية مع إسقاط أقصى كثافة وإعادة بناء. علاوة على ذلك، فإن هذه التقنية أقل توغلًا، وأقل فى التكلفة، وسريعة، ويتعرض فيها المريض لكمية أقل من الإشعاع.

الهـدف مـن الدراسـة: تهـدف الاطروحـة الـى دراسـة الاختلافـات فـي تشـريح الجـذع البطنـى والشـريان الكبـدى بـين المصريـين باسـتخدام التصويـر المقطعـي المحوسـب متعـدد الكواشـف.

المرضـى وطـرق البحـث: أجريت هـذه الدراسـة الوصفيـة المقطعيـة على ٣٨٠ مريضًـا (٢٥٠ ذكراً و١٣٠ أنثى) مـن المترددين على مركز أمـراض الجهـاز الهضمى بمستشـفيات جامعـة المنصـورة لتقييـم البطـن والكبـد.

بعـد موافقـة مجلـس المراجعـة المؤسسـية بجامعـة المنصـورة، تم إخضـاع جميـع الموضوعـات فـي هـذه الدراسـة للفحوصـات المعمليـة (لتقييـم وظائـف الكلـى) والفحـص الإشـعاعى بواسـطة الأشـعة المقطعيـة متعـددة الكاشـفات (بمـا فـى ذلك الدراسـات ثلاثيـة الأطـوار قبل وبعـد التبايـن مـع تقنيـات المعالجـة اللاحقـة: إسـقاط الحـد الأقصـى للكثافـة وإعـادة البنـاء متعـدد المخططـات وتقـديم الحجـم).

النتائج:

أظهرت نتائج الدراسة ما يلى:

وفقًـا لتصنيـف اوفلاكـر لمتغيـرات الجـذع البطنـى فـي الدراسـة الحاليـة، كان النـوع الأول (الأنمـاط الكلاسـيكية وغيـر الكلاسـيكية) هـو البديـل الأكثـر شـيوعًا فـى (٩١,٠٧٪) مـن الحـالات. النمـط الشـائع الثانـى كان النـوع الخامـس (الجـذع المعـدى الطحالـى) فـي ٣٠ حالـة (٧,٨٩٪). كانـت المتغيـرات الأخـرى هـى النـوع الثانـى (الجـذع الكبـدى الطحالـى) فـي اربـع حـالات (١,٠٥٪). لـم يتـم اكتشـاف النـوع الثالـث (الجـذع الكبـدى المعـدى) والنـوع السـادس (الجـذع الهضمـى البطنـى (والنـوع الرابـع (الجـذع الكبـدي الطحالـى المسـاريقى)، والنـوع السـابع (الجـذع البطنـى القولونـى) والنـوع الثامـن (لا يوجـد جـذع البطـن) مـن بـين الحـالات المشـمولة.

وفقـا لتصنيـف ميشـيل لمتغيـرات الشـريان الكبـدى فـي الدراسـة الحاليـة، كان النـوع الأول (التشـريح الكلاسـيكى) هـو المتغيـر الأكثـر شـيوعا فـى ٨٠,٢٪ مـن الحـالات. النمـط الشـائع الثانـى هـو النـوع الثالـث (الشـريان الكبـدى الأيمـن المسـتبدل الناشـئ عـن الشـريان المسـاريقى العلـوى) فـى ٤٢ حالـة (١١,٠٥٪). كانـت المتغيـرات الأخـرى هـى النـوع الخامـس (الشـريان الكبـدى الأيسـر الملحـق الناشـئ عـن الشـريان المعـدى الأيسـر) فـى ١٥ حالـة (٣,٩٤٪)، والنـوع الثانـى (الشـريان الكبـدى الأيسـر المسـتبدل الناشـئ مـن الشـريان المعدى الأيسـر) فـى ١٠ حـالات (٢,٦٣٪)، والنـوع التاسـع (الشـريان الكبـدى الشـائع) الشـريان الناشـئ عـن الشـريان المسـاريقى العلـوى) فـي سـبع حـالات (١,٨٤٪) والنـوع السـادس (الشـريان الكبـدي الأيمـن الملحـق الناشـئ عـن الشـريان المسـاريقي العلـوى) فـي حالـة واحـدة (٠,٢٦٪). النـوع الرابـع (اسـتبدال الشـريان الكبـدي الأيسـر واسـتبدال الشـريان الكبـدى الأيمـن)، النـوع السـابع (الشـريان الكبـدى الأيسـر الفرعـى والشـريان الكبـدى الأيمـن)، النـوع الثامـن (اسـتبدال الشـريان الكبـدى الأيمـن والشـريان الكبـدى الأيسـر الإضافـى أو اسـتبدال الشـريان الكبـدى الأيسـر والشـريان الكبـدى الأيمـن الإضافـى) والنـوع العاشـر (الشـريان الكبـدى المشـترك الناشـئ عـن الشـريان المعـدى الأيسـر) لـم يتـم الاسـتدلال عنـه فـى حـالات الدراسـة.

الاستنتاجات:

في ضوء نتائج الدراسة الحالية يمكن استنتاج ما يلي:

يمكـن اسـتخدام التصويـر المقطعـى المحوسـب متعـدد الكاشـفات كتقنيـة تشـخيصية فعالـة فـي تقييـم متغيـرات نمـط الأوعيـة الدمويـة فـي الجـذع البطنـى والشـريان الكبـدى.

مـن بـين الحـالات المشـمولة، كان معـدل انتشـار المتغيـرات التشـريحية للجـذع البطنـي٨,٩٣٪ (بـدلاً مـن النمـط الكلاسـيكى) بينمـا كان معـدل انتشـار متغيـرات الشـريان الكبـدى) ١٩,٨٪ (بـدلاً مـن النمـط الكلاسـيكى).