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ORIGINAL ARTICLE

Anatomical variants of the celiac trunk

Variantes anatomiques du tronc cœliaque



C.M. Laleye^{a,b,*}, P. Yekpe Ahouansou^c, S.E.D. Hounton^{a,c},
L.B. Videgla^{a,c}, A.A. Hadonou^a, A.C. Agossou^{a,c}, S.G. Attolou^a,
E. Dibert-Bekoy-Nouganga^d, O. Biauou^c, G.M. Hounnou^a,
Mehinto^b, A.K. Voyeme^a

^a Laboratory of Human Anatomy, Faculty of Health Sciences, Cotonou, Benin

^b University Clinic of Visceral Surgery, "Hubert_Koutoukou_Maga" University Teaching Hospital Center, Cotonou, Benin

^c Medical Imaging Department, "Hubert_Koutoukou_Maga" University Teaching Hospital Center, Cotonou, Benin

^d Department of Surgery, "Maman Elisabeth Domitien de Bimbo" University Hospital Center, Bimbo, Central African Republic

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KEYWORDS

Celiac trunk;
Anatomical variants;
CT scan.

Summary

Aim of the study. – Determine the anatomical variants of the celiac trunk and describe it in its modal form using a scanner.

Patients. – In total, 200 patients were included in this study.

Material and methods. – The study was carried out using a multi-detector scanner (SIEMENS Somatom Emotion Excel Edition, 16 bars). The two-dimensional and three-dimensional reconstructions by volume were made with the OSIRIX software. It was a retrospective study. The study had taken into account the result of the abdominal scanners injected carried out from December 15, 2018 to February 15, 2019 i.e. 14 months (1 year 2 months).

Results. – A predominance of type I of UFLACKER is 93.50% with a rate of change from normal of 6.50%. A vertebral projection of the origin of the celiac trunk at the level of the T12-L1 intervertebral disc was observed in 52.80%. An existence of collateral branches in 7.5% of cases. Other terminal branches apart from the three classics were found in 8.5% of the cases.

Conclusion. – These variants deserve special attention in the case of a pre-therapeutic vascular assessment for the surgical or interventional management of tumors and trauma of the supra-meso-colic viscera or even for organ transplantation.

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* Corresponding author.

E-mail address: laleyefor@yahoo.fr (C.M. Laleye).

Résumé

But de l'étude. – Déterminer les variantes anatomiques tronc cœliaque et de le décrire dans sa forme modale au scanner.

Patients. – Au total, 200 patients ont été inclus dans cette étude.

Matériel et méthodes. – L'étude a été réalisée grâce à un scanner multidétecteur. Les reconstructions en deux et trois dimensions ont été faites avec le logiciel OSIRIX. Il s'est agi d'une étude rétrospective. L'étude a pris en compte le résultat des scanners abdominaux injectés réalisés du 15 décembre 2018 au 15 février 2019, soit 14 mois (1 an 2 mois).

Résultats. – Une prédominance du type I de UFLACKER, soit 93,50 %, avec un taux de variation de la normale de 6,50 %. Une projection vertébrale de l'origine du tronc cœliaque à hauteur du disque intervertébral T12-L1 a été observée dans 52,80 %. L'existence de branches collatérales dans 7,5 % des cas. D'autres branches terminales en dehors des trois classiques ont été retrouvées dans 8,5 % des cas.

Conclusion. – Ces variantes méritent une attention particulière en cas de bilan vasculaire préthérapeutique pour la prise en charge chirurgicale ou interventionnelle des tumeurs et traumatismes des viscères supramésocolique, voire pour une transplantation d'organe.

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Introduction

The celiac trunk is the first ventral branch of the abdominal aorta. It ensures the vascularization of the viscera of the supra-mesocolic region through its terminal branches which are the left gastric artery, the splenic artery and the common hepatic artery [1]. These can arise in common or through a common hepatosplenic trunk for the common and splenic hepatic arteries. Several anatomical varieties of the modal distribution are reported in the literature, i.e. a rate of variation of 1.7 to 46% [2,3]. This can pose a diagnostic and therapeutic problem (pancreatic tumor, abdominal visceral trauma, intra-abdominal organ transplantation, etc...) during the interpretations of selective angiograms, the practice of selective interventional radiology and surgical interventions on the abdomen.

The literature abounds in data on the anatomical variations of the celiac trunk. However, if it is accepted that its variations are functions of several factors including ethnic factors [4,5]; very little data exists on the vascular anatomical variations of the celiac trunk in black Africans living south of the Saharra.

We set ourselves the objective of determining the anatomical variants of the celiac trunk and of describing it in its modal form on a CT scan within the Beninese population.

Framework, material and method

This study had taken into account the results of the abdominal scanners injected carried out from December 15, 2018 to February 15, 2019 (1 year 2 months).

The study included patients who had an abdominal scanner injected for a condition other than an abdominal vascular pathology or any other pathology which could modify the anatomy of the celiac trunk. All poor quality injected abdominal scanners were excluded. The exams were acquired using a multi-detector scanner (SIEMENS Somatom Emotion Excel Edition, 16 bars, Germany). The

acquisition parameters were a pitch between 0.4 and 1.5 with a maximum Pitch of 2.0. Rotation time per revolution: 0.6; 1.0 and 1.5 seconds; table feed speed: 3.84–28.2 mm/revolution (with conical beam reconstruction) and 3.84–38.4 mm/revolution (without conical beam reconstruction). Acquisition at arterial time obtained 20 to 25 s after the intravenous injection of the iodinated contrast agent with an injection flow rate of 2 to 3 mL/s depending on the quality of the patient's venous network. (2 mL/kg in adults and 4 mL/kg in children). Serial cuts of one mm thick have been made. The two-dimensional and three-dimensional reconstructions by volume were made with the OSIRIX software. Several classifications of variants of the celiac trunk have been proposed by authors, the most complete and most recent of which is that of Uflacker in 1997 (which distinguishes 8 types of celiac trunk. Among others we have the classifications of Lipshutz in 1917 which distinguishes 4 types of celiac trunk; from Adachi in 1928, 6 types; that of Morita in 1935, 5 types; that of Michels in 1942, that is to say 6 types [6–11]. The data collected was entered into CPro 6.2 software and then processed and analyzed using STATA13.0 software.

Results

The average age of the subjects was 51.44 ± 16.35 years with extremes of 13 and 87 years. The male sex was predominant with a sex ratio of 1.02. The celiac trunk was present in its modal form in 187 out of 200 cases, i.e. 93.5% (Table 1). Thus, we deduced a rate of change from normal of 6.5%.

Type I in its non-classical shape is the most frequent, observed in 126 cases out of 200, or 63%. In note 2 case of the same type whose classification does not take account but which corresponds to type IV of the classification of the celiac trunk according to Michel (Fig. 1). The different types observed are illustrated as follows in Figs. 1–8.

Table 1 Distribution of the different types of celiac trunk (TC) according to UFLACKER.

Types according to Uflacker	Celiac trunk		Variants								Unclassified (IV of Michels)	Total
	I: classic shape	I: non-classical shape	II	III	IV	V	VI	VII	VIII			
Size	61	126	2	0	1	5	2	0	1	2	200	
Frequency (%)	30,5	63	1	0	0,5	2,5	1	0	0,5	1	100	

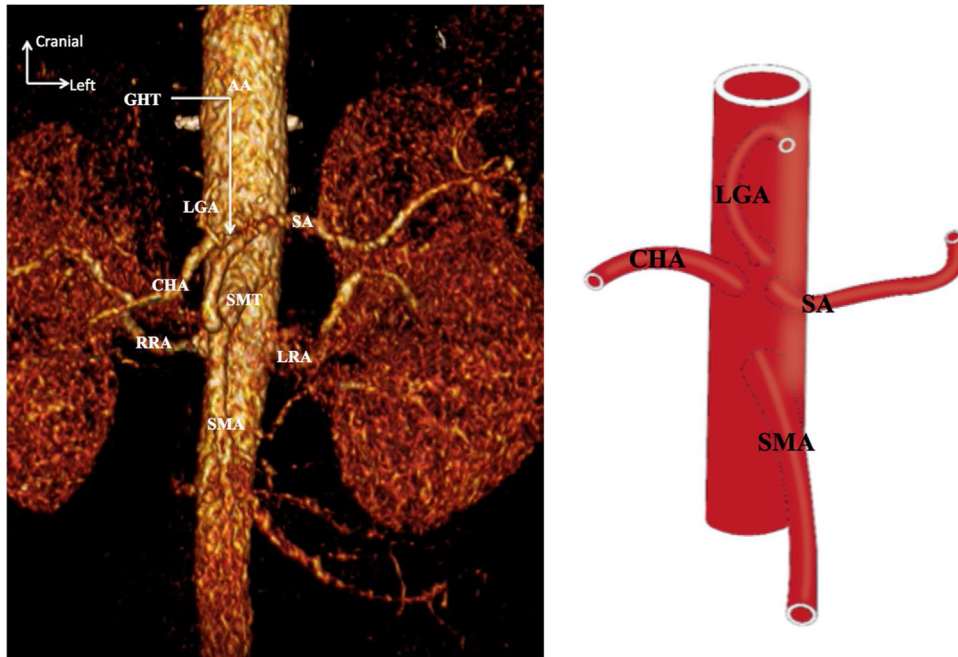


Figure 1 Ventral view of the celiac trunk, type IV of Michel in 3D reconstruction rendered in volume and then in schematic representation. AA: Abdominal aorta; SA: Splenic artery; GHT: Gastro-hepatic trunk; LGA: Left gastric artery; CHA: Common hepatic artery; SMT: Spleno-mesenteric trunk; SMA: Superior mesenteric artery; LRA: Left renal artery.

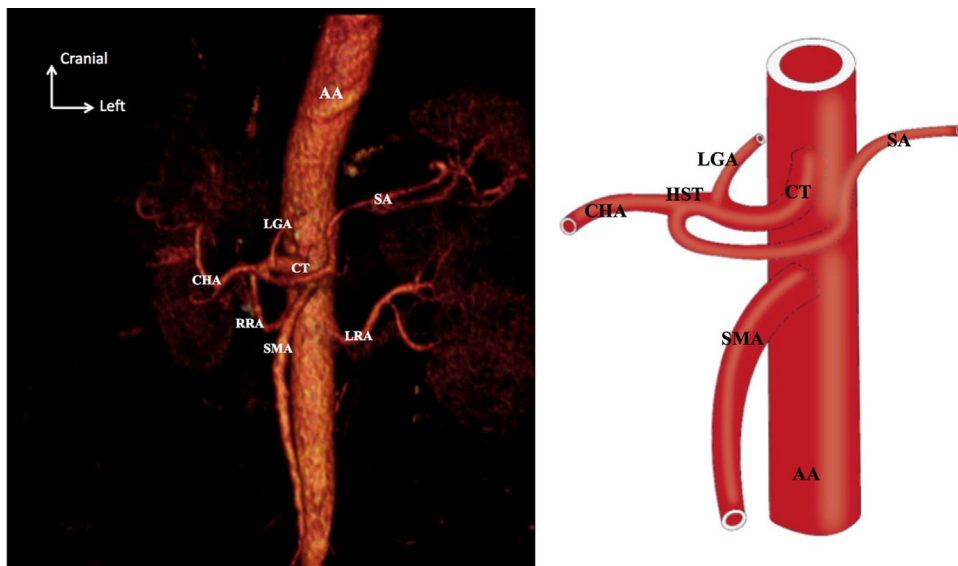


Figure 2 Ventral view of the celiac trunk, type I unconventional form of Uflacker in 3D reconstruction rendered in volume and then in schematic representation. AA: Abdominal aorta; SA: Splenic artery; LGA: Left gastric artery; CHA: Common hepatic artery; CT: Celiac trunk; SMA: Superior mesenteric artery; LRA: Left renal artery; RRA: Right renal artery; HST: Hepatosplenic trunk.

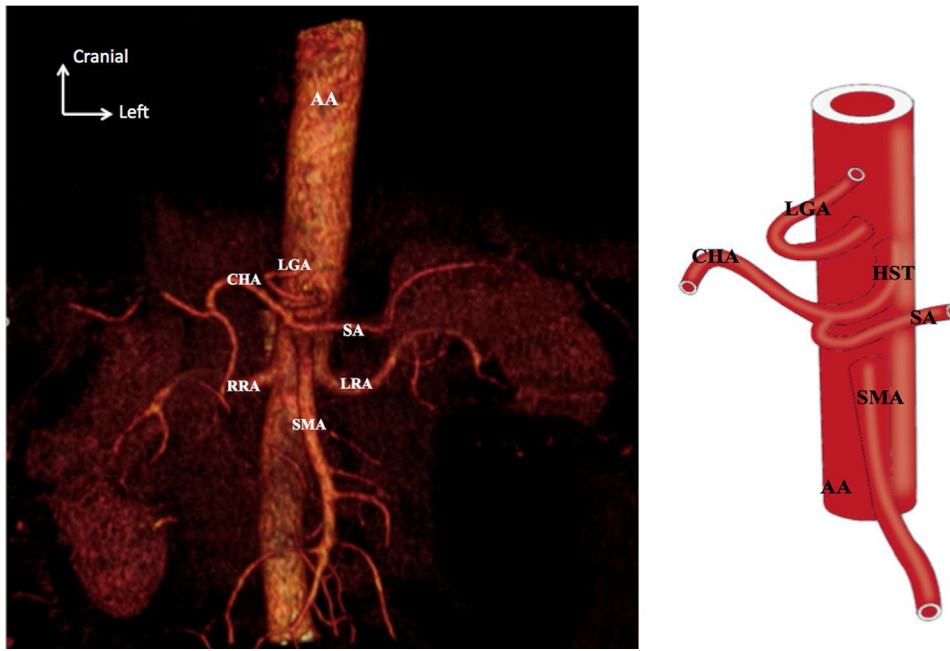


Figure 3 Ventral view of the celiac trunk, type II of Uflacker in 3D reconstruction rendered in volume and then in schematic representation. AA: Abdominal aorta; SA: Splenic artery; LGA: Left gastric artery; CHA: Common hepatic artery; SMA: Superior mesenteric artery; RRA: Right renal artery; LRA: Left renal artery; HST: Hepatosplenic trunk.

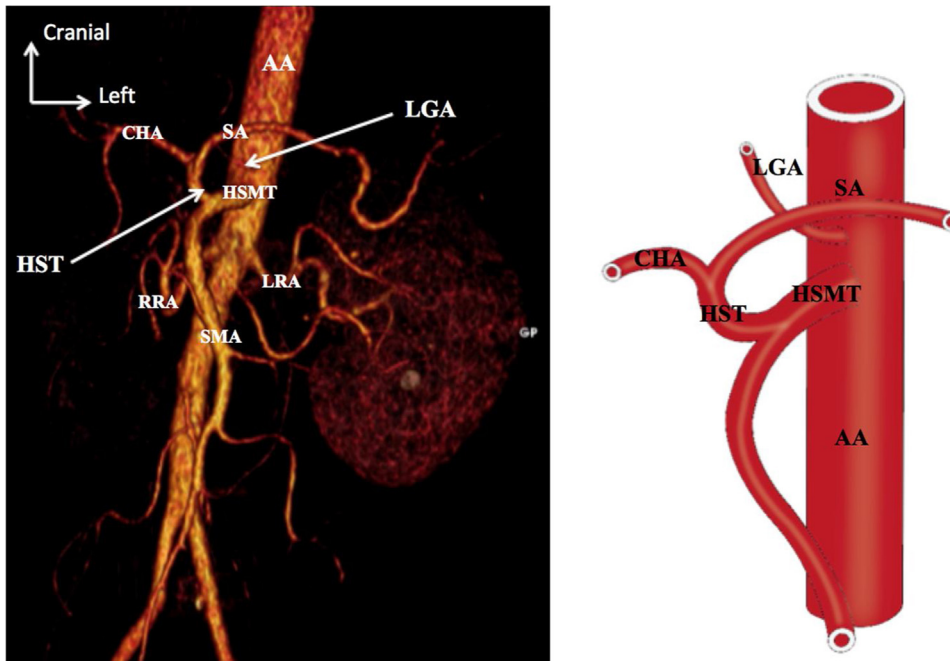


Figure 4 Ventral view of the celiac trunk, type IV of Uflacker in 3D reconstruction rendered by volume and then in schematic representation. AA: Abdominal aorta; SA: Splenic artery; LGA: Left gastric artery; CHA: Common hepatic artery; HST: Hepatosplenic trunk; HSMT: Hepatospleno-mesenteric trunk; SMA: Superior mesenteric artery; RRA: Right renal artery; LRA: Left renal artery.



Figure 5 Ventral view of the celiac trunk, type V of Uflacker in 3D reconstruction rendered by volume and then in schematic representation. AA: Abdominal aorta; SA: Splenic artery; LGA: Left gastric artery; CHA: Common hepatic artery; GST: Gastro-splenic trunk; SMA: Superior mesenteric artery; RRA: Right renal artery; LRA: Left renal artery.

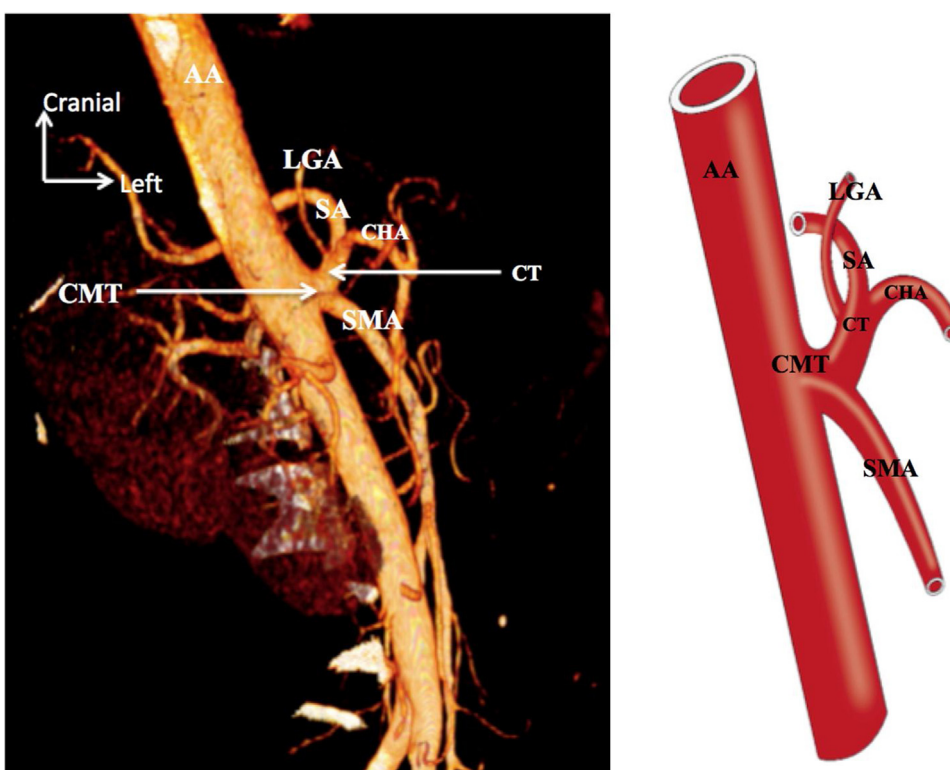


Figure 6 Right side view of the celiac trunk, type VI of Uflacker in 3D reconstruction rendered in volume and then in schematic representation. AA: Abdominal aorta; SA: Splenic artery; LGA: Left gastric artery; CHA: Common hepatic artery; CMT: Celio-mesenteric trunk; SMT: Superior mesenteric artery.

Several collateral branches have been found, the most common of which is the lower phrenic artery on the left (Table 2). Fig. 9 showing the left phrenic artery, collateral branch of the celiac trunk.

Besides the classic terminal branches of the celiac trunk, others have been observed (Fig. 10) and summarized in Table 3.

Discussion

Prevalence of variability from normal

We observed a rate of change from normal of 6.5%. In the literature we found variability of 1.7 to 46% (Table 4) [2,3,12–17]. This significant variability was explained partly by the size of the samples, the



Figure 7 Ventral view of the celiac trunk, type VIII of Uflacker in 3D reconstruction rendered in volume and then in schematic representation. AA: Abdominal aorta; SA: Splenic artery; LGA: Left gastric artery; CHA: Common hepatic artery; SMA: Superior mesenteric artery; LRA: Left renal artery.

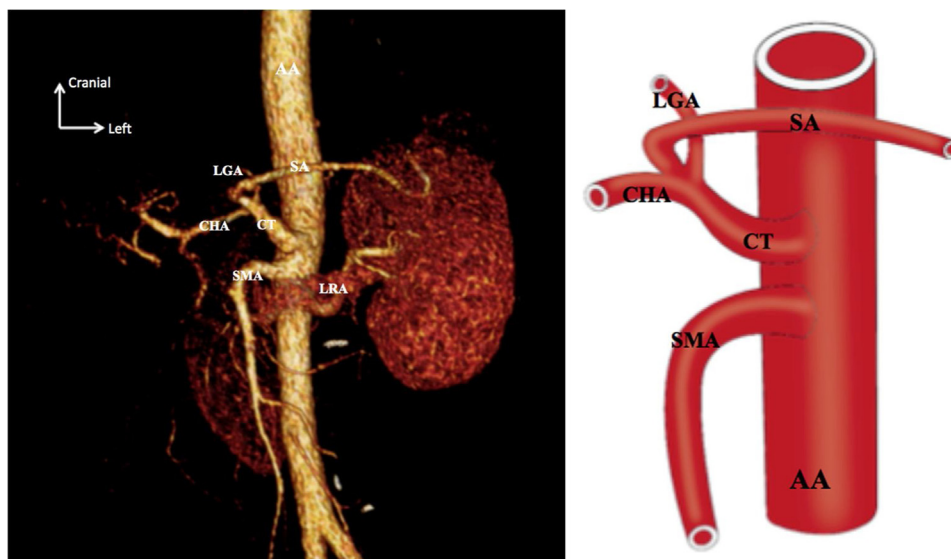


Figure 8 Ventral view of the celiac trunk, type I Classic form of Uflacker in 3D reconstruction by volume rendering and then in schematic representation. AA: Abdominal Aorta; SA: Splenic Artery; LGA: Left Gastric Artery; CHA: Common Hepatic Artery; CT: Celiac Trunk; SMA: Superior Mesenteric Artery; LRA: Left Renal Artery.

embryological anomalies and partly by the breed of the subject.

Prevalence of each type of celiac trunk

The present study allowed us to find a predominance of type I of Uflacker in 187 cases, ie 93.5% with an absence of types III and VII. The other types were distributed as follows: 2 cases of type II or 1%, 1 case of type IV or 0.5%, 5 cases of type V or 2.5%, 2 cases of type VI or 1%, 1 case of type VIII is 0.5%

and a form not classified by Uflacker but which corresponded to type IV of Michels. These results can be superimposed on those of certain authors as shown in [Table 5](#).

During embryonic life, we have a pair of dorsal aorta which give the ventral segmental arteries each. Following the fusion of the two dorsal aortas, a single aorta trunk is obtained with odd ventral segmental arteries. These segmental arteries are connected by a longitudinal anastomosis making distinguish for each ventral segmental artery a proximal portion upstream from the longitudinal anastomosis and a distal portion downstream

Table 2 Different types of collateral branches.

Different collateral branches	Size (n)	Frequency (%)
Absent	173	92.51
Dorsal pancreatic artery	2	1.06
Large pancreatic artery	1	0.53
Lower left phrenic artery	6	3.18
Lower right phrenic artery	2	1.06
Lower common phrenic trunk	1	0.53
Left inferior phrenic artery and dorsal pancreatic artery	1	0.53
Dorsal pancreatic artery and large pancreatic artery	1	0.53
Total	187	100

Table 3 Distribution of the different terminal branches of the celiac trunk other than the three classic branches.

Other terminal branches	Size (n)	Fréquence (%)
Absent	171	91.44
dorsal pancreatic artery	15	8.02
Omento-pancreatic trunk	1	0.53
Total	187	100

from the longitudinal anastomosis. The 10th, 11th, 12th, 13th and 19th ventral segmental arteries will be respectively the origin of the left gastric artery, the splenic artery, the common hepatic artery, the superior mesenteric artery and the artery inferior mesenteric. The regression of the proximal portion of the 11th and 12th ventral segmental arteries and that of the inter-segmental anastomosis uniting the 12th to the 13th leads to the modal configuration of the digestive arteries notably the celiac trunk and the superior mesenteric artery [20–22]. Table 6 summarizes the embryological origin of each variant.



Figure 9 Frontal reconstruction with MIP (Maximal Intensity Projection) showing the left phrenic artery, collateral branch of the celiac trunk (red arrow).



Figure 10 Frontal reconstruction showing the dorsal pancreatic artery, terminal branch of the celiac trunk (red arrow).

These different variants are therefore important to know not only by the anatomist but also the radiologist and the surgeon with a view to a diagnosis and an adequate management of the patient.

Table 4 Comparison of the prevalence of the variability of the normal of the present study to that of the other authors.

Authors	Country and year	Means of study	Sample	(Type I of Uflacker) %	Variation rate %
Present study	Benin 2019	Scan	200	93.5	6.5
Sureka et al. [12]	India	Scan	600	94.5	5.5
Lopez–Andujar et al. [13]	-	Surgery	1081	93.4	6.6
Jones et al. [14]	Australia 2001	Surgery	180	91.7	8.3
Araujo-Neto et al. [15]	Brazil 2015	Scan	60	90	10
Hiatt et al. [2]	-	Surgery	1000	98.3	1.7
Koops et al. [16]	Germany 2004	Scan	604	79.1	20.9
Silveira et al. [17]	Brazil 2016	Dissection	21	71.4	28.6
Chitra et al. [3]	India 2010	Dissection	50	54	46

Table 5 Comparison of our frequencies of the different variants of the celiac trunk with the literature.

Type	Present study, (Benin 2019)	Osman et al. [18] (Egypt 2016)	Araujo–Neto et al. [15] (Brazil 2015)	Torres et al. [19] (Poland 2014)
I	93.5% (187 cases)	90.5% (905 cases)	90% (54 cases)	92.7% (1455 cases)
II	1% (2 cases)	2.8% (28 cases)	8.3% (5 cases)	2.2% (34 cases)
III	0%	0.6% (6 cases)	1.7% (1 cases)	0.2% (4 cases)
IV	0.5% (1 cases)	0%	0%	0%
V	2.5% (5)	4.3% (43 cases)	0%	4.1% (64 cases)
VI	1% (2 cases)	0.6% (6 cases)	0%	0.5% (8 cases)
VII	0%	0%	0%	0%
VIII	0.5% (1 cases)	1% (10 cases)	0%	0.1% (2 cases)
Unclassified (IV de Michels)	1% (2 cases)	0.2% (2 cases)	0%	0%

Table 6 Embryological explanation of each variant of the celiac trunk.

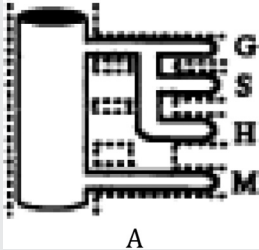
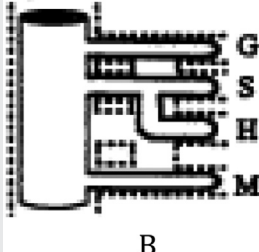
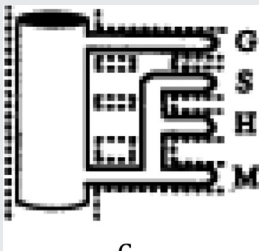
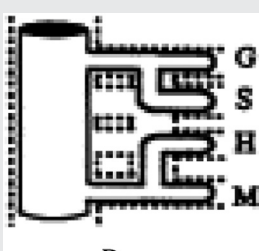
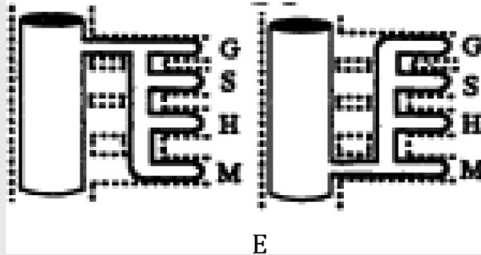
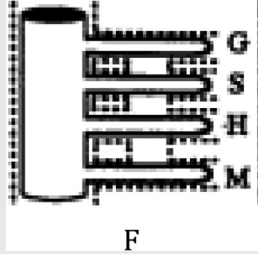
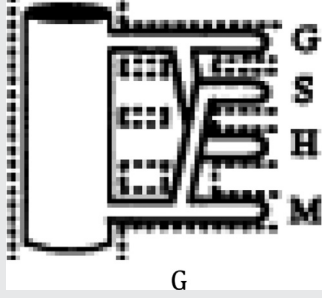
Types	Embryological explanation	Drawing [10]
I	Normal embryology	
II	Regression of the anastomosis between the 10 th and 11 th segmental artery	
IV	Regression of the anastomosis between the 10 th and 11 th segmental artery with persistence of the anastomosis between the 12 th and 13 th segmental artery	
V	Regression of the anastomosis between the 11 th and 12 th segmental artery	

Table 6 (Continued)

VI	Persistence of the anastomosis between the 12 th and the 1 ^{3th} segmental artery regression of the proximal portions of the 10 th and 11 th segmental	 <p style="text-align: center;">E</p>
VIII	Regression of the anastomosis between the 10 th and 11 th segmental artery and that between the 11 th and 12 th segmental artery with persistence of the proximal portions of the segmental arteries (10 th , 11 th and 12 th)	 <p style="text-align: center;">F</p>
IV of Michels	Duplication of the anastomosis between the 11 th and 12 th segmental artery and persistence of the anastomosis between the 12 th and 13 th segmental artery	 <p style="text-align: center;">G</p>

Conclusion

At the end of this study, a rate of change of 6.5% was found. These variants deserve special attention in the case of a pre-therapeutic vascular assessment for the surgical or interventional management of tumors and trauma of the supra-meso-colic viscera or even for organ transplantation.

Disclosure of interest

The authors declare that they have no competing interest.

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