

Variations in the Branching Pattern of the Celiac Trunk in a Kenyan Population

Variaciones en el Patrón de Ramificación del Tronco Celiaco en una Población de Kenia

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SUMMARY: The celiac trunk is the major source of blood supply to the supracolic abdominal compartment. Usually, it branches into the splenic, common hepatic and left gastric arteries to supply this region. It has however been shown to display ethnic variations in its branching pattern. Knowledge of these variations may be important in surgical and radiological procedures around the head of the pancreas. The aim was to illustrate the commonest variations in the branching pattern of the celiac trunk in a Kenyan population. The study was conducted in the Department of Human Anatomy, University of Nairobi. Were collected one hundred twenty three (123) bodies obtained from dissection cadavers and autopsy cases following ethical approval and consent from next of kin. Gross dissection of the anterior abdominal wall using an extended midline incision and retraction of the liver and stomach was performed. The celiac trunk was trifurcated in 76 (61.7%), bifurcated in 22 (17.9%) and gave collaterals in 25 (20.3%). Dorsal pancreatic artery was the most common collateral and occurred in 14.8%. Other branches included gastroduodenal and inferior phrenic arteries present in 3.3% and 4.9% respectively. The Kenyan population has a higher incidence of bifurcation and collateral branching of the celiac trunk hence need for caution during surgical procedures of the supracolic abdominal compartment.

KEYWORDS: Celiac; Variations; Kenyans; Artery.

INTRODUCTION

The celiac trunk (CT) is the first branch of the abdominal aorta (AA) at the level of the twelfth thoracic vertebrae (George, 1935; Michels, 1955). Its branches namely left gastric (LGA), common hepatic (CHA) and splenic (SA) arteries supply the primary organs of the supracolic abdominal compartment namely the stomach, pancreas, spleen and liver (Charbon & Anderson, 1989). Reported variations in the branching pattern of the celiac trunk include absence of the trunk (Vandamme & Bonte, 1985), presence of collateral vessels (Cavdar *et al.*, 1998) and anomalous branches (Cavdar *et al.*, 1997; Nonent *et al.*, 2001; Loukas & Jordan, 2006; Katagiri *et al.*, 2007) and even bifurcation of the trunk (Ucerler & Asli, 2006). Such variations in the pattern of branching of the celiac trunk may predispose to iatrogenic injury during surgical procedures such as total pancreatectomy (Vandamme & Bonte, 1990; Gielecki *et al.*, 2005) and resection of tumors of head of pancreas (Lin, 2005). Knowledge of this variable anatomy may be useful

in planning and executing radiological interventions such as celiacography (Glück *et al.*, 1983) and chemoembolisation of hepatic tumors (Aigner & Gailhofer, 2005). Although the pattern of branching displays ethnic variations (Saeed *et al.*, 2003), there is paucity of data on the branching pattern among Kenyans.

MATERIALS AND METHOD

One hundred and twenty three (123) specimens comprised 112 cadavers from the Department of Human Anatomy and 11 autopsy cases done in Chiromo and City mortuaries in Nairobi were used in this study. Ethical approval from the Kenyatta National Hospital Ethics and Research Committee and informed consent from relatives of the deceased were obtained for the use of post-mortem

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materials. Specimens with obvious pathology or topographical derangement were excluded from this study. After entry to the peritoneal cavity via an extended midline incision, the stomach and small intestines were retracted to expose the celiac trunk and its branches. The celiac trunk was exposed by following its classical branches to their source. Variations in the trifurcation pattern were noted as were the collateral branches.

A collateral branch was defined as a branch of the celiac trunk other than the left gastric, common hepatic and splenic artery. Photographs of the branching pattern of the celiac trunk were taken using a digital camera (Fuji Finepix 9.0MP, Model no. A900). Data collected was analyzed using the Statistical Package of Social Sciences (SPSS) for windows version 11.50 Chicago Illinois, 2002. The results obtained were presented using pie-charts and macrographs.

RESULTS

The celiac trunk was given off as the first branch of the abdominal aorta just below the aortic opening of the diaphragm. In all cases, it was surrounded by the crura of the diaphragm and these were used as landmarks. The celiac trunk gave rise to distributive visceral branches that were either classical (common hepatic, splenic and left gastric) or collaterals. The celiac trunk was trifurcated in 76 (61.7%), bifurcated in 22 (17.9%) and gave collateral branches in 25 (20.3%) (Fig. 1).

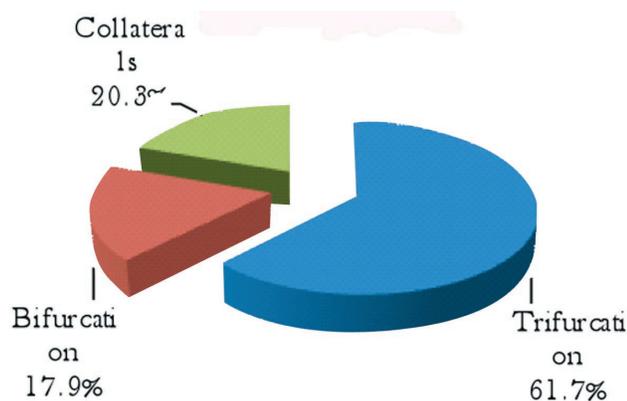


Fig. 1. Prevalence of various branching pattern of the celiac trunk.

Two patterns of trifurcation were observed; a classical “tripus halleri” (tripod) and non-classical. In the case of the tripod, the common hepatic, splenic and left gastric arteries had a common point of origin from the celiac trunk (Fig. 2).

This pattern was observed in 40 (32.5%) of the cases. Non-classical trifurcation was characterized by a common point of origin of the common hepatic and splenic arteries while the left gastric demonstrated a variable point of origin. This was observed in 36 (29.3%).

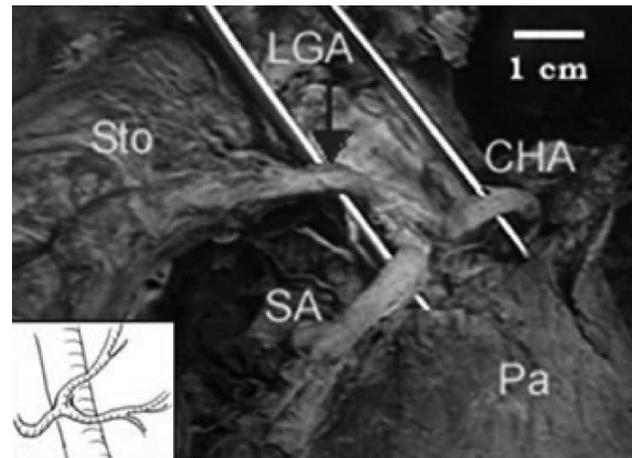
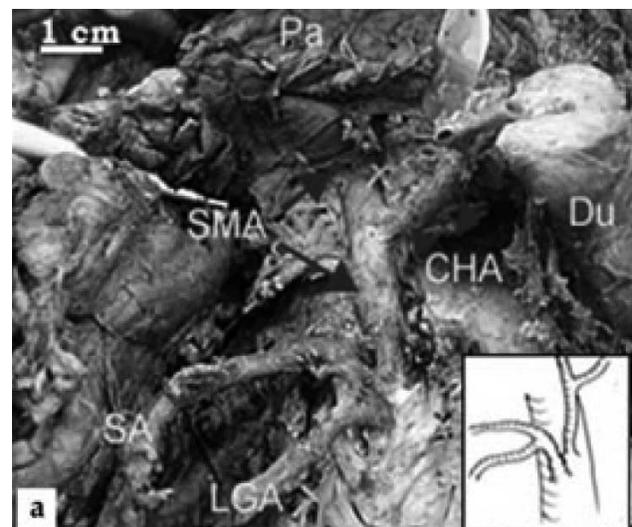


Figure 2 A classical trifurcation of the celiac trunk in an adult male cadaver. Sto – stomach, SA – Splenic artery, Pa – Pancreas, LGA – left gastric artery and CHA – common hepatic artery (an artist’s impression inset)

Two types of bifurcated trunks were observed: gastrosplenic (Fig. 3a) present in 4.9% and hepatosplenic (Fig. 3b) in 13.1%. In the case of the gastrosplenic trunk, the common hepatic originated from the superior mesenteric artery (SMA) and coursed posterior to the neck of the pancreas and was for a better part of its course intrapancreatic. It gave off the gastroduodenal artery which had a similar course in the pancreas. Where the left gastric originated directly from the aorta, its course was similar to the classical LGA.



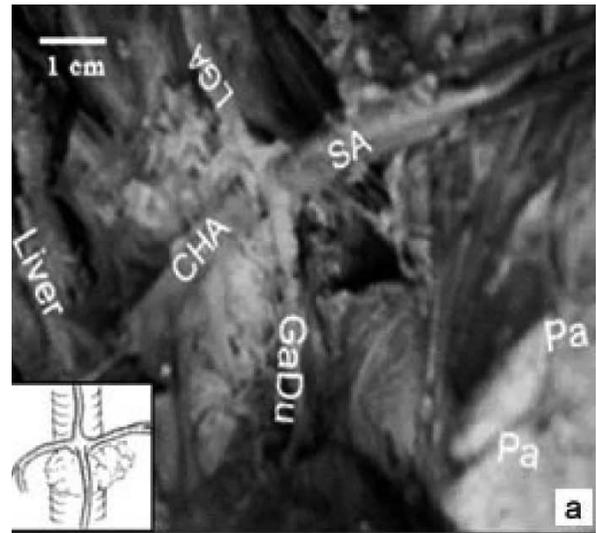
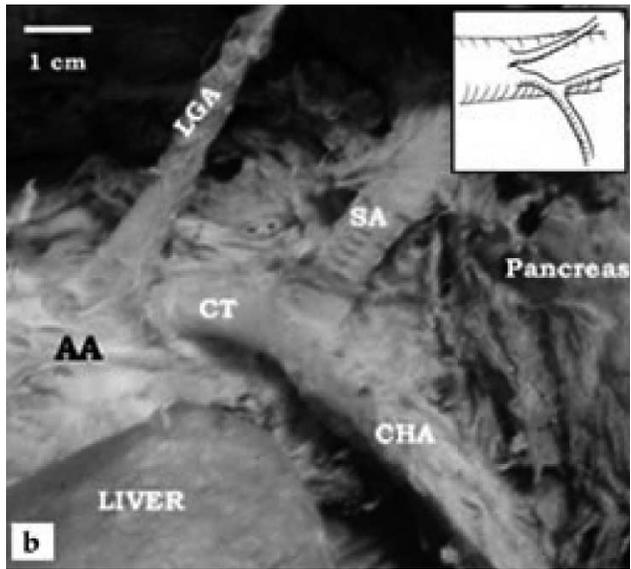


Figure 3 showing the branching pattern of the celiac trunk; (a) a gastrosplenic trunk giving off splenic artery (SA) and left gastric artery (LGA) with the common hepatic artery (CHA) originating from the superior mesenteric artery (SMA) Du, duodenum, Pa, Pancreas. (b) a hepatosplenic trunk giving off splenic artery (SA) and common hepatic artery (CHA) while the left gastric originates directly from the aorta almost at the level of the celiac trunk (CT)

Collaterals were observed in 25 (20.3%) of the cases and included dorsal pancreatic, gastroduodenal, inferior phrenic and ileal arteries. Dorsal pancreatic artery (DPA) was the most common collateral occurring in 14.8% of the cases. This artery emerged as a short vessel of medium size and had a very short course before disappearing into the substance of the pancreas at the level of the neck and proximal part of the body of the pancreas (Fig. 4a). Gastroduodenal and inferior phrenic arteries were present in 3.3% and 4.9% respectively. The inferior phrenic artery coursed superolaterally from the median plane and was distributed on the inferior (abdominal) surface of central diaphragm (Fig. 4b). In one cadaver, an ileal artery distributed to the proximal ileum was present from the celiac trunk and had a retropancreatic course parallel but anterior to the SMA (Fig. 4c). Coexistence of the collaterals was observed in some cases and mainly involved the inferior phrenic and dorsal pancreatic arteries.

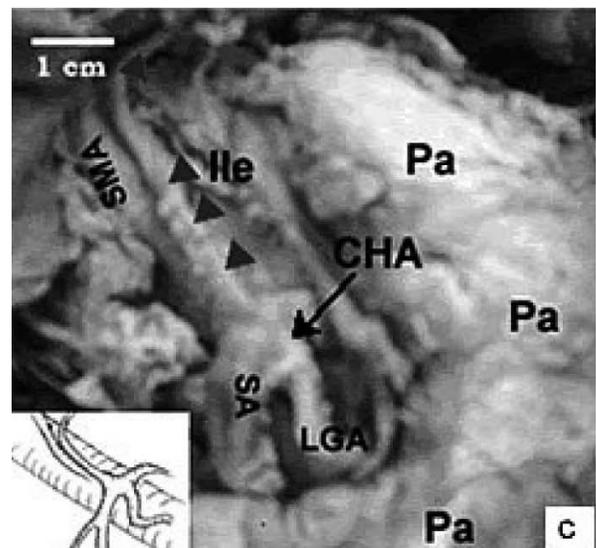
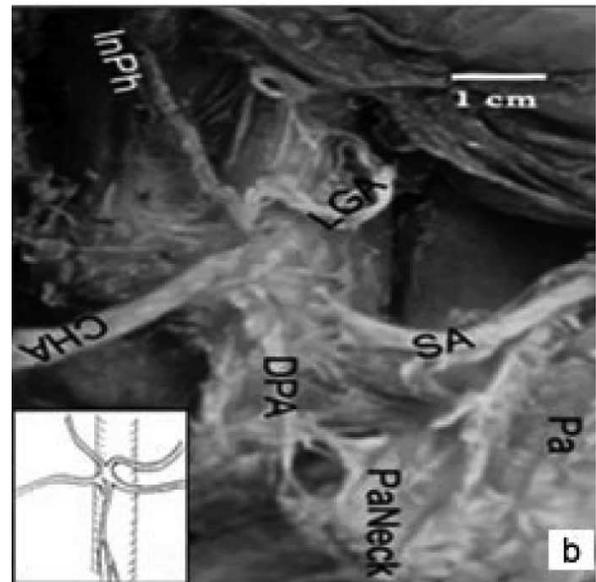


Fig. 4 Macrograph showing collateral branches of the celiac trunk; (a) the right inferior phrenic artery (InPh) and dorsal pancreatic artery (DPA) being given off by the celiac trunk together with its three classical branches, (b) gastroduodenal artery (GaDu) arising from the celiac trunk just inferiorly opposite the origin of the left gastric artery (LGA) and supplies the duodenum, (c) an ileal artery (IA) (red arrow heads) originating from the celiac trunk (CT) and running parallel but anterior to the superior mesenteric artery (SMA) behind the pancreas (Pa) which has been retracted superiorly, to supply the proximal ileum (Ile). PaNeck, neck of the pancreas, SA, splenic artery, CHA, common hepatic artery.

DISCUSSION

Observations of the present study show that the celiac trunk trifurcated in 61.7% and bifurcated in 17.9% in a Kenyan population. Reports in other populations exhibit a similar pattern though bifurcation is less (Lipschutz, 1917; Adachi, 1928; Shvedavchenko, 2001; Sahni *et al.*, 2003; Saeed *et al.*; Matsuki *et al.*, 2004) (Table I).

In the present study, two types of bifurcated trunks were observed: gastrosplenic present in 4.9% and hepatoesplenic in 13.1%. A similar prevalence has been reported in a Japanese study where the gastrosplenic and hepatoesplenic trunks (with an aortic origin of the left gastric) were present in 3% and 8% respectively (Adachi). Hiatt *et al.* (1994) described a mesenteric origin of the common hepatic in only 1.5% in an American study. Bifurcation of the celiac trunk may follow different patterns such as gastrophrenic and hepatoesplenic trunks (Vandamme & Bonte, 1985; Ucerler & Asli), a short lienogastric trunk with hepatic arteries having variable origins (Saeed *et al.*) and hepatogastric trunk with splenic artery having an aortic origin (Dermitas *et al.*, 2005).

The celiac trunk gave collateral branches in 20.3%. Previous studies however, have concentrated on the prevalence of individual collateral vessels. In the case of the DPA, observations of the current study have revealed that it may arise from the celiac trunk in 14.8%. This is similar to observations made by Hong & Freeny (1999) who reported a prevalence of 18.5%. Commonly, the DPA is given off by the SA and courses directly inferiorly into the pancreatic parenchyma where it gives several branches to the head and neck of the organ (Karakose *et al.*, 2006). Therefore, due to its short course, it is vulnerable to inadvertent ligation or injury during pancreatic surgery (Hong & Freeny).

The right inferior phrenic artery may arise from the celiac trunk in 4.9% of the cases. These are at variance with previous accounts which have described a prevalence of between 8-10% in other populations (Adachi; Saeed *et al.*; Petrella *et al.*, 2006). Other variations in the origin of inferior

phrenic artery include a common origin of both right and left vessels (Piano *et al.*, 1988) and with the LGA from the celiac trunk (Yalcin *et al.*, 2004). Only the right inferior phrenic artery was observed in our study. Following the distribution of inferior phrenic to the thoracic diaphragm where they anastomose with the superior phrenic vessels, they may be opened up in case of celiac stenosis to revascularize the supracolic abdominal compartment especially the stomach (Rosenbusch *et al.*, 1975).

Gastroduodenal artery (GaDu) arose from the CT in 3.3%, this is in agreement with observations among Chinese which have reported it to arise from the celiac trunk in 2.8% (Chen *et al.*, 2007). In this case, it is possible that stenosis of SMA may divert blood flow into the GaDu through the celiac and this may lead to aneurysm formation and rupture (Iyori *et al.*, 2004).

Variations in the splanchnic vessels are thought to have an embryological basis. Tandler (1904), suggested that ventral longitudinal anastomoses connect the four roots of the ventral splanchnic vessels and when the central two disappear, the first and fourth roots remain connected via these anastomoses. The common hepatic, left gastric and splenic arteries usually originate from the first root and the superior mesenteric from the fourth root. The ventral longitudinal anastomosis usually separates between these two roots. If this separation occurs at a higher level than usual, any one of the celiac branches can be displaced to the superior mesenteric artery (Tandler). In the present study, it is possible that the first ventral splanchnic branch formed the gastrosplenic by fusion of the splenic and left gastric arteries via the longitudinal anastomoses, and the fourth ventral splanchnic branches formed the common hepatic and superior mesenteric arteries.

The origin of collaterals particularly the inferior phrenic artery from the celiac trunk can be explained on the basis of the "typological" theories (Murakami 1995, 1998). Murakami (1998) proposed that the celiac-mesenteric system develops from six sets of paired left and right vessels (subphrenic, upper, middle and lower ventricular, and upper and lower intestinal arteries), which are modified during the later stages of fetal

Table I. Showing the variations in the branching pattern of the celiac trunk.

Source	Population studied	Sample size	Method	Trifurcation %	Bifurcation %
Lipschutz, 1917.	Germans	83	Dissection	72.0	25.0
Saeed <i>et al.</i> , 2003.	Indians	52	Dissection	75.0	7.6
Shvedavchenko <i>et al.</i> , 2001.	Russians	120	Dissection	60.8	5.0
Matsuki <i>et al.</i> , 2004.	Japanese	36	CT imaging	88.8	5.5
Current study (2007)	Kenyan	61	Dissection	61.7	17.9

development. Collaterals may be result of either the persistence of some parts of the longitudinal channels that normally disappear or disappearance of parts that normally persist. Other factors that have been suggested to cause variable anatomy of the celiac axis include the rotation of the mid-gut and its physiological herniation during development, leftward migration of the spleen and hemodynamic changes in the abdominal viscera (Reuter & Redman, 1977).

In conclusion, the celiac trunk among Kenyans exhibit variations from that in other populations. The prevalence of bifurcated celiac trunk and collateral branches in the present

study is higher than previously described. These may be a source of complications following surgical procedures such as resection of tumor of the pancreatic head and other invasive interventions such celiacography and chemoembolisation of pancreatic and liver tumors. Careful identification and dissection of these vessels is therefore important to avoid iatrogenic injury.

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MBURU, K. S.; ALEXANDER, O. J.; HASSAN, S. & BERNARD, N. Variaciones en el patrón de ramificación del tronco celíaco en una población de Kenia. *Int. J. Morphol.*, 28(1):199-204, 2010.

RESUMEN: El tronco celíaco es la principal fuente de suministro de sangre al compartimento supracólico abdominal. Por lo general, para irrigar la región, el tronco celíaco se ramifica en las arterias esplénica, hepática común y gástrica izquierda. Sin embargo, se ha demostrado que presentan variaciones étnicas en su patrón de ramificación. El conocimiento de estas variaciones pueden ser importante en los procedimientos quirúrgicos y radiológicos alrededor de la cabeza del páncreas. El objetivo de esta investigación fue ilustrar las variaciones más comunes en el patrón de ramificación del tronco celíaco en una población de Kenia. El estudio fue realizado en el Departamento de Anatomía Humana de la Universidad de Nairobi. Fueron estudiados 123 cadáveres tanto de disección como de autopsia, previa aprobación del comité de ética y el consentimiento de los familiares. Se realizó la disección macroscópica de la pared anterior del abdomen mediante una incisión mediana extendida, realizando la retracción del hígado y el estómago. El tronco celíaco se presentó trifurcado en 76 (61,7%) casos, bifurcado en 22 (17,9%), y dio colaterales en 25 (20,3%) casos. La arteria dorsal de páncreas fue la colateral más común (14,8%). Otras ramas incluidas las arterias gastroduodenal y frénica inferior se presentaron en el 3,3% y 4,9%, respectivamente. La población de Kenia tiene una mayor incidencia de bifurcación y ramificación colateral del tronco celíaco, por lo tanto, es necesario tomar precauciones durante los procedimientos quirúrgicos del compartimento abdominal supracólico.

PALABRAS CLAVE: Celíaca; Variaciones; Kenianos; Arteria.

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