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Properties of the Celiac Trunk – Anatomical Study

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A B S T R A C T

Although anatomical properties and vessel variations of the celiac trunk are well explored in the literature, there is not so much information on the arterial diameters, and this data is important for surgical procedures and angiographic examinations. The aim of this study was to investigate properties of the celiac trunk in humans by using anatomical dissection. Ninety cadavers were dissected for the celiac trunk identification and arterial diameter measurements. The results of anatomical examination showed that in 72% of all cases the celiac trunk divides into the splenic artery and the common hepatic artery, while the left gastric artery arises as a first branch and had origin between aorta, all over the celiac trunk up to a bifurcation. From the 90 cadavers, 4 presented anatomical variations. Where normal anatomy was present, the mean length of the celiac trunk was 1.9±0.08 cm and its mean arterial diameter was 0.78±0.08 cm. The splenic artery had the largest diameter (0.61±0.05 cm) and the left gastric artery had the smallest diameter (0.38±0.03 cm). Our data represent original results about anatomical variations and arterial diameter of the celiac trunk and its main branches provided by anatomical dissection.

***Key words**: anatomy, cadaver, celiac artery, dissection*

Introduction

When the anatomy of the celiac trunk is studied, the most common finding is that it arises from the anterior wall of the abdominal aorta, just below the aortic hiatus of diaphragm, and projects to the intervertebral disc between twelfth thoracic and first lumbar vertebrae[1–3]. In many cases, it gives rise to three main branches as hepatic, splenic and left gastric arteries, thus forming hepatolienogastric trunk, which frequently has the form of a tripod. The trifurcation of the celiac trunk was first described by Haller and this »tripus Halleri« was considered to be normal appearance of the celiac trunk in 1756[4]. Studies on arterial variations of the abdomen showed that 87% of celiac trunks exhibited the trifurcation, which is still considered to be normal appearance of the celiac trunk[2,5–8]. Many variation patterns of the celiac trunk bifurcation have been described as a hepatogastric, hepatosplenic or gastrosplenic trunk. Besides these variations, the trunk itself may be absent and its branches may arise directly from the aorta[9,10]. In recent literature anatomical variations of the celiac trunk have been well explored, but the information on the arterial diameter of its main branches is still insufficient, especially on a large number of samples. Da Silveira has shown in his study that from twenty one cadavers, six presented anatomical variations of at least one main branch[5]. The variable vessels showed smaller mean diameters compared to normal arteries[5]. Knowledge of the celiac trunk variations is important for both abdominal operative procedures and angiographic examinations to reduce the risk of trauma to the vessels. Arterial diameter of celiac trunk branches is of importance especially because of development of organ transplant surgery and precise radiological diagnosis of arterial aneurysms. Therefore, the aim of this study was to explore properties of the celiac trunk and the occurrence of anatomical variations of its main branches. Moreover, the purpose of this investigation was to describe the arterial diameters of the celiac trunk main branches by anatomical dissection.

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Materials and Methods

A total of ninety adult male cadavers, ranging in age from 35 to 70 years, were dissected in order to reveal the anatomical properties and branching of the celiac trunk. Forty-five cadavers fixed in 10% formalin solution were dissected at the Department of Anatomy, School of Medicine, Rijeka. The remaining 45 non-fixed cadavers maintained in a frigorific chamber were dissected at the Department of Forensic Medicine, Rijeka University Hospital Center. Our research was approved by the Institutional Review Board of the School of Medicine, Rijeka University. The abdominal cavities and retroperitoneal spaces have been dissected by the authors. Anomalous dilatations, aneurisms or occlusive disease tissues were discarded at the beginning of the study. To dissect the celiac trunk in the fixed cadavers, the pancreas was removed. In the non-fixed cadavers, the celiac trunk was reached by opening of the lesser omentum. All preparations were photographed to illustrate the results of our study. The variation patterns of the celiac trunk branching were classified according to Adachi's classification. After the quantification and description of anatomical variations of the celiac trunk and its main branches, the length of the celiac trunk was measured. With the aid of the vernier caliper (range of 0–20 cm, Aba, Germany), the celiac trunk and its main branches diameters were measured from the outer wall to outer wall of the vessels. Also, the proper hepatic, the right gastric, the left and right hepatic and the gastroduodenal artery diameters were investigated.

Statistics

Mean arterial diameters were calculated and compared between normal and variables arteries. Comparisons were made by the unpaired Student's t-test. Differences were considered significant if $p<0.05$.

Results

In 83 cadavers the celiac trunk was divided into three main branches – left gastric, common hepatic and splenic artery. The left gastric artery had origin between aorta, all over the celiac trunk up to a trifurcation. This pattern of branching was found in 65 (72%) of all examined cases (Figure 1). The Haller's tripod, in which the three arteries originated at the same level, in terminal portion of the celiac trunk, was observed in 18 (22%) out of the 90 cadavers (Figure 2). From the 90 cadavers included in our study, 4 (4.4%) presented anatomical variations. In two cases (1.7%) the celiac trunk gave rise to left gastric, common hepatic, splenic and superior mesenteric artery and formed the celiacomesenteric trunk (Figure 3). In the remaining two cases (1.7%) the left gastric artery arose from the abdominal aorta and the celiac trunk gave off the common hepatic and splenic artery while the superior mesenteric artery arose together with the celiac trunk. The length of the celiac trunk measured by vernier caliper from its origin to the point where it gives off main branches varied from 1.0 – 3.5 cm. In the form of trifurcation its length was 1.9±0.08 cm while in the form of bifurcation the length was 2.0±0.08 cm. Anatomical variations presented the largest length of the celiac trunk

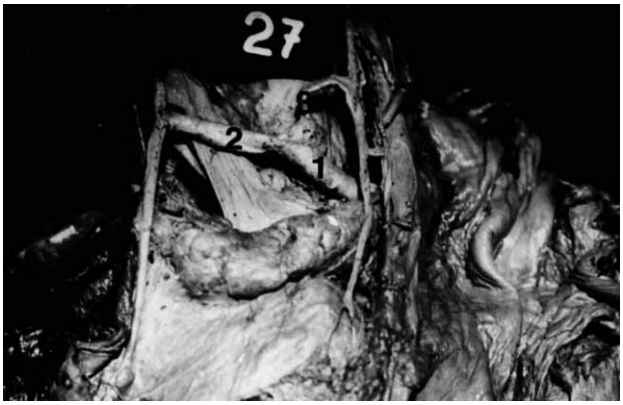

Fig. 1. The photograph of the celiac trunk bifurcation. 1 – splenic artery; 2 – common hepatic artery; 3 – left gastric artery appeared as a first branch before the celiac trunk bifurcation.

Fig. 2. The photograph of the celiac trunk trifurcation. 1 – splenic artery; 2 – common hepatic artery; 3 – left gastric artery.

Fig. 3. A common celiacomesenteric trunk arising from abdominal aorta. The short celiacomesenteric trunk bifurcates into a celiac trunk (1) and superior mesenteric artery (2).

TABLE 1
ANATOMICAL EXAMINATION OF THE CELIAC TRUNK LENGTH AND ARTERIAL DIAMETER IN THE PRESENCE OF NORMAL AND VARIABLE ANATOMY. DATA ARE AXPRESSED AS CM ± STANDARD DEVIATION OF MEAN

	Anatomical examination		Variable
	Normal – trifurcation	Normal – bifurcation	
Number of subjects	18	65	7
Celiac trunk length (cm)	1.90±0.08	2.00±0.08	2.50±0.09
Celiac trunk diameter (cm)	0.78±0.08	0.78±0.08	0.73±0.07

TABLE 2
MEAN ARTERIAL DIAMETER OF NORMAL AND VARIABLE CELIAC TRUNK MAIN BRANCHES OBTAINED BY ANATOMICAL EXAMINATION. DATA ARE EXPRESSED AS CM ± STANDARD DEVIATION OF MEAN

	Anatomical examination	
Artery	Normal	Variable
Splenic	0.61±0.05	0.61±0.06
Common hepatic	0.57±0.04	0.58±0.06
Left gastric	0.38±0.03	0.31±0.03
Proper hepatic	0.47±0.02	0.45±0.01
Left hepatic	0.30±0.04	0.29±0.02
Right hepatic	0.35±0.03	0.33±0.03
Gastroduodenal	0.42±0.03	0.40±0.02

with the average length of 2.5±0.09 cm (Table 1). In the cases of normal anatomy, the celiac trunk had the mean arterial diameter of 0.78±0.08 cm and in the cases of variable anatomy 0.73±0.07 cm (Table 1). When the diameters of the celiac trunk normal main branches were measured it was found that the splenic artery had the largest diameter (0.61±0.05 cm). The mean arterial diameter of the common hepatic artery was intermediate (0.57±0.04 cm) and finally the left gastric artery had the smallest diameter (0.38±0.03 cm) of all main branches of the celiac trunk. Mean arterial diameters of normal and variable arteries measured with vernier caliper are shown in Table 2. Except for the common hepatic and splenic arteries, all variable arteries showed smaller mean diameter compared to normal arteries, but these differences were not statistically significant.

Discussion

In the present study, from 90 cadavers, we found that the celiac trunk gave rise to three main arteries – left gastric, common hepatic and splenic artery. The celiac trunk bifurcates into the splenic and the common hepatic artery, while the left gastric artery had origin between aortas all over the celiac trunk up to a trifurcation. This type of celiac trunk was observed in 72% of all cases. Celiac trunk is a wide ventral visceral branch of the abdominal aorta and normally divides into left gastric artery, common hepatic artery and splenic artery. The trifurcation of the celiac trunk is considered to be normal anatomical appearance of the celiac trunk[4]. The authors' studies have shown that the trifurcation of the celiac trunk occurred in 87.7% of cases while the form of bifurcation was observed in 10.8% of all cadavers[10–13]. In our investigation the bifurcation pattern of the celiac trunk has been observed in 72% of cases while the Haller's tripod has been observed in only 22% of all cases, which was similar to the percentages of 24 and 25% found by Eaton, Lipshutz and Michels[14–16]. The anatomical variations of the celiac trunk are due to developmental changes in the ventral splanchnic arteries and embryologic explanation for these variations has been found by Tandler[17]. In early human embryos four primitive splanchnic branches arising from the abdominal aorta are connected by the ventral longitudinal anterior anastomosis between the four roots of the omphalomesenteric artery, of which the two central roots always disappear and the longitudinal anastomosis joins the first and fourth roots. The splenic, common hepatic and left gastric artery originates at this longitudinal anastomosis. This separation usually become from the fourth root, which represent a future superior mesenteric artery, below the last of these three branches of celiac trunk. If this separation takes place at a high level, one of the branches is displaced to the superior mesenteric artery, but if the first or fourth root disappears, a CMT will be formed[17]. Many variation patterns of the celiac trunk have been described. Adachi proposed a detailed classification of the celiac trunk variations. The distribution pattern of left gastric, common hepatic, splenic and superior mesenteric artery was classified into six types with 28 forms[18]. The superior mesenteric artery sometimes arises from, or together with, the celiac trunk and together they form the celiacomesenteric trunk (CMT)[2,19,20]. The CMT is a rare arterial variation in human. The incidence of CMT was 0–11% with an average of 1.5%. Our anatomical investigations demonstrated the CMT in two cadavers which represented 1.7% of the analyzed cases, which belonged to type IV according to Adachi's classification. The incidence of CMT in our study was not different from the data found in the literature. By reviewing the literature, some authors reported that the left gastric artery arose independently from the aorta, while the common hepatic, splenic and superior mesenteric artery had a common trunk (hepatosplenomesenteric trunk). This variation belonged to type III. Our results showed that 1.7% belonged to this type of arterial variation which is similar with previously reported results[18]. In our study we measured the length of the ce-

liac trunk from its origin to the point where the trunk gave off main branches. In the form of trifurcation its length was 1.9 cm while in the form of bifurcation the length was 2.0 cm. It is interesting to notice that the anatomical variations presented the largest length of the celiac trunk with an average of 2.5 cm. Our results are in accordance with previous reports that describe the length of the trunk between 8 and 40 mm, with an average of 25 mm[11–13,19–21]. The explanation for length variations of the celiac trunk found in the literature correlated with the celiac trunk division process. The celiac trunk with the length of 20 mm or more would give off as terminal branches the common hepatic and splenic arteries and as a collateral branch the left gastric artery, while in those with less than 20 mm, the three branches would originate at the same level and form a Haller's tripod[22]. Our results are in accordance with this hypothesis since we observed a Haller's tripod with the length of the celiac trunk of less than 20 mm in eighteen (22%) out of 90 cadavers. The high incidence of anatomical variations of the celiac trunk and its branches was widely explored in literature[5,21,23,24] but there are only a few studies about the diameter of these arteries[5,25,26]. Our results obtained by anatomical dissection showed that the left gastric artery was the smallest celiac main branch. Common hepatic artery was intermediate in size between the left gastric and splenic artery which had the largest diameter. Despite the fact that in the present study formalin fixed cadavers and fresh cadavers were used, we have obtained similar results of mean arterial diameter. Our data on formalin fixed cadavers and fresh cadavers match those obtained from the available data in the literature[5,21,26,27]. Our results suggest that there is a reduction of the arterial diameters of the celiac trunk main branches in the presence of anatomical variations of these arteries, which have clinical implications for organ transplantation.

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KARAKTERISTIKE *TRUNCUS COELIACUS* – ANATOMSKA STUDIJA

S A Ž E T A K

Iako su karakteristike celijačnog trunkusa i njegovih anatomskih varijacija objašnjena u literaturi, ipak nema dovoljno podataka o njegovom dijametru i o dijametru njegovih ogranaka. Poznavanje ovih podataka vrlo je važno u transplantacijskoj kirurgiji kao i kod angiografskih pretraga. Cilj naše studije bio je istražiti karakteristike celijačnog trunkusa i njegovih ogranaka na 90 kadavera pomoću anatomske sekcije. Rezultati anatomskog istraživanja pokazuju da se u 72% slučajeva celijačni trunkus dijeli u slezensku arteriju (*a.lienalis*) i zajedničku jetrenu arteriju (*a.hepatica communis*), dok lijeva želučana arterija (*a.gastrica sinistra*) najčešće izlazi kao prva grana iz samog celijačnog trunkusa od njegovog izlazišta iz aorte do mjesta grananja na glavne grane. U 90 kadavera pronađene su samo četiri anatomske varijacije u grananju glavnih ogranaka. Dužina celijačnog trunkusa iznosi 1,9±0,08 cm, a njegov je promjer 0,78±0,08 cm. Slezenska arterija ima najveći promjer (0,61±0,05 cm) dok lijeva želučana arterija pokazuje najmanji promjer (0,38± 0,03 cm). Naši podaci predstavljaju originalne rezultate o anatomskim karakteristikama celijačnog trunkusa i njegovih grana kao i o veličini arterijskog promjera.