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Case Report
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Left Inferior Phrenic Artery Arising From Left Gastric Artery And its Clinical and Surgical Implications

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ABSTRACT

Introduction: the inferior phrenic arteries, together with the superior phrenic arteries, are among those responsible for promoting the vascularization of the diaphragm muscle, supplying oxygen and nutrients to this vital muscle, which plays a direct role in respiratory function. For this reason, it is crucial to study the anatomy of the arteries, both in their classical presentations and in their variations. Therefore, knowledge of the clinical and surgical repercussions of the variations that can occur is necessary for a correct approach in cases of extrahepatic collateral supply of hepatocellular carcinomas and diaphragmatic and esophageal bleeding in trauma, ensuring appropriate and targeted treatment when such alterations are found.

Case report: this case report describes the prevalence and possible variations that can be found in the origin of the inferior phrenic artery, as well as the repercussions of a variation of this same artery, found during the dissection of a cadaver in an human anatomy laboratory.

Conclusion: knowledge of anatomical variations is essential to avoid surgical sequelae, possible postoperative complications and post-medical maneuvers.

Keywords: Gastric Artery; Surgery; Diaphragm; Anatomical Variation.

Introduction

The left Inferior Phrenic Artery (IPA) usually originates from a direct branch of the Abdominal Aortic Artery (AAA) in a common trunk to the left and right IPA, separately, in the portion below the diaphragm muscle, originating anterior ascending and posterior descending branches. This artery supplies especially the diaphragm muscle and can also originate small branches to the liver, stomach, cardiac part of the esophagus, adrenal glands and retroperitoneum[1,2,3].

The IPA can suffer various types of anatomical alterations, such as variations in its point of origin, the presence or absence of accessory branches, variations in its course and the division of its terminal branches. It is possible that these so-called asymptomatic alterations may not give the patient any symptoms and are largely discovered through imaging studies. However, another possibility is that there is an alteration in the vascularization of the diaphragmatic muscle, affecting the body's respiratory function; thus, symptoms of diaphragmatic dysfunction may be related, such as dyspnea, exercise intolerance, sleep disorders, hypersomnia, among other clinical manifestations, depending on the location and severity of the alteration[4].

In the human anatomy laboratory of a medical school in the interior of São Paulo, after routine dissections, a change in the origin of the IPA was found. In this case, the left IPA became a branch of the left gastric artery, an anatomical variation that is prevalent in 1.07% (95%, CI 0.25-1.89%)[5] of the population. This altered morphology can increase the risk of complications in surgical procedures, such as excessive bleeding during surgery and inadvertent injury to the artery and its branches[6], which can result in potential tissue ischemia or necrosis, as well as hindering the healing of surgical wounds and infections.

The aim of this article is to analyze the anatomical variation of the IPA found during the dissection of a human anatomical specimen from the human anatomy laboratory of a medical course in the interior of São Paulo, in order to discuss the importance of knowing the possibilities of the existing anatomical variations of this artery and their possible clinical-surgical implications.

Case Report

During routine dissection in practical classes in a human anatomy laboratory, the presence of an anatomical variation in the origin of the left inferior phrenic artery (IPA) was noticed. Although the inferior phrenic arteries are usually branches of the abdominal aorta, initially as a common trunk or in an independent way at the level of the 12th thoracic vertebra to the 2nd lumbar vertebra, in the present case, the left IPA originates from the left gastric artery, which is a branch of the celiac trunk and one of those responsible for irrigating the lesser curvature of the stomach.

In order to better understand the anatomical specimen, the arteries were dissected in the traditional manner, preserving their structures and related organs (Figure 1). In this context, the left IPA follows its

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usual path to irrigate the inferior diaphragmatic face, shown in a schematic illustration (Figure 2), with an esophageal branch in its abdominal portion.

Figure 1. Photograph of the anatomical specimen in anterior view showing the left inferior phrenic artery as a branch of the left gastric artery. Source: Elaborated by the authors.

Discussion

Vascular anatomical variations are very common in the abdomen, as the region undergoes many changes during the formation of the adult vascular system, so that many anatomical variations can develop in a single person. The types of IPA, whether right or left, vary according to the occurrence of other abdominal vascular changes, mainly observed in the celiac trunk, and are explained by embryological development. The posterior and lateral branches of the aorta in its abdominal portion can regress and the longitudinal anastomoses between them can develop in such a way as to interfere with the formation of the branch of the celiac trunk, thus impacting on the formation of the IPA, which, in the anatomical specimen in question, originates from the left gastric artery.

In medical literature, based on the relationship of syntopy with the celiac trunk, the IPA can present 6 different types of origin (Table 1)[1].

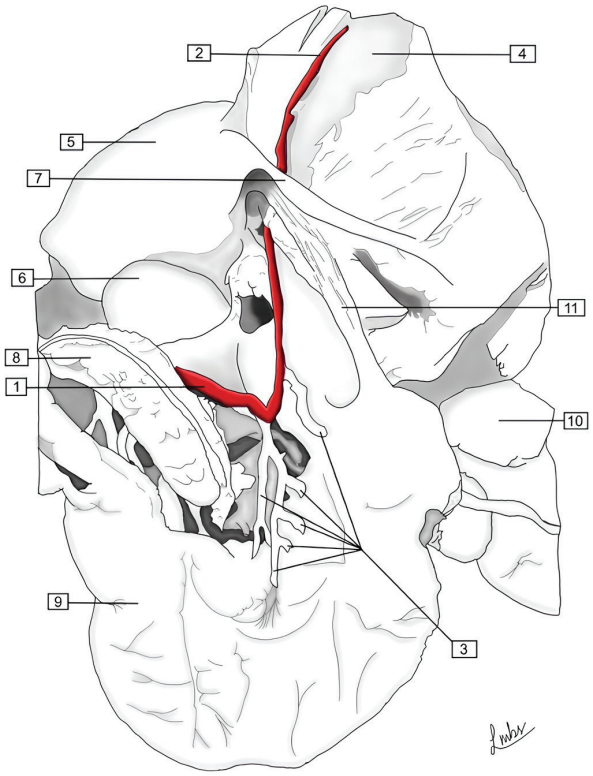

Figure 2. Schematic illustration in anterior view of the anatomical structures in evidence. (1) Left gastric artery, (2) Left inferior phrenic artery, (3) Gastric branches of the left gastric artery, (4) Diaphragm muscle, (5) Left lobe of the liver, (6) Square lobe of the liver, (7) Left triangular ligament, (8) Pancreas, (9) Stomach, (10) Spleen, and (11) Hepatogastric ligament. Source: Elaborated by the authors.

Table 1. Types of the inferior phrenic artery and their anatomical correlations. Source: Elaborated by the authors.

Types	Anatomical correlations
Type 1	The right and left inferior phrenic arteries are direct branches of the abdominal aorta.
Type 2	The right and left inferior phrenic arteries are direct branches of the celiac trunk.
Type 3	The right inferior phrenic artery and the left inferior phrenic artery arise from the left gastric artery and the celiac trunk is not present. The case described in this report fits the latter description, but with preservation of the celiac trunk.
Type 4	One inferior phrenic artery originates from the celiac trunk and the other from the abdominal aorta, and can have two subtypes: subtype 4A, in which the left inferior phrenic artery originates from the abdominal aorta and the right inferior phrenic artery originates from the celiac trunk, and subtype 4B, in which the right inferior phrenic artery originates from the abdominal aorta and the left inferior phrenic artery originates from the celiac trunk.
Type 5	The left inferior phrenic artery arises directly from the abdominal aorta, while the right inferior phrenic artery originates from the accessory hepatic artery.
Type 6	The right and left inferior phrenic arteries form a common trunk from the abdominal aorta.

For this reason, it is necessary to discuss the implications of anatomical variations in the IPA and the ways in which they can affect certain clinical conditions. In this context, the relevance of the IPA in cases of hepatocellular carcinoma (HCC) stands out, since this artery is considered to be the most common form of collateral vascular supply for HCC (83%)[7], depending on the size of the tumor lesion and its location, as assessed by arteriographies.

It is possible to observe an increase in the diameter of the right IPA, also indicative of extra-hepatic vascular supply in HCC. In cases like these, transarterial chemoembolization can be performed in order to stop the vascular supply from the IPA to the carcinoma.This procedure can be carried out without serious complications, however, the patient may experience shoulder pain, pleural effusion, rashes in the abdominal region, basilar atelectasis and mild hemoptysis.

In addition, this artery can bleed due to traumatic abdominal injuries, mainly related to the diaphragm muscle. A case report[8] described the clinical condition of a 76-year-old man who was hospitalized due to acute ventricular fibrillation and underwent cardiopulmonary resuscitation (CPR) with 30 chest compressions and two artificial ventilations, plus the use of an automatic external defibrillator. After CPR, cardiac output was restored and twelve hours later the patient was extubated, complaining of upper abdominal and back pain. Over this time, his hemoglobin level decreased from 13.4 to 8.7 mg/dL and a CT scan revealed a lesion in the right diaphragmatic pillar and hemoperitoneum. A selective digital angiography showed bleeding from a branch of the right IPA, which was contained by superselective coaxial catheterization of the artery. The patient's post-operative course was uneventful, and he was discharged on the tenth day after the procedure, with no complications at the follow-up 24 months after the embolization.

Therefore, it is important to mention that diaphragmatic rupture (of a muscle bundle or total) with IPA bleeding is a clinical-surgical implication that can occur as a result of performing CPR, and is considered a rare emergency event, leading to hemoperitoneum. In this context, transcatheter embolization techniques have been used as a first-line treatment to achieve hemostasis[8], which require delicate, safe and high-quality medical interventionist management, requiring immediate diagnosis and treatment as it is a potentially fatal situation for the patient. Finally, it can be inferred that the possibility of injury to abdominal organs, such as the diaphragm, as well as bleeding from the IPA and its anatomical variations must be considered in situations of vigorous CPR, in order to affect medical management and the patient's prognosis.

Regarding the surgical implications, there is a new approach to reconstructing the Hepatic Artery after total pancreatectomy with resection of the common hepatic artery, in which the IPA is used, preferentially on the left, but not considering its possible anatomical variations. An additional factor for this procedure is that the origin of the left IPA is common to the left gastric artery, in order to avoid complications[9]. Consequently, knowledge of classical anatomy and its variations is essential to avoid surgical sequelae, post-surgical sequelae and post-interventional treatments that affect the left IPA.

Conclusion

Considering the various clinical-surgical implications, the study of anatomical variations, especially in relation to the IPA origin, is extremely important for the effective recognition of different metastasis sites, for example, and also for the interventional management of various pathological conditions, in order to improve surgical planning and possible complications.

In this context, anatomical knowledge of the IPA is relevant to various surgical implications, both in cases of oncological pathologies, such as the extrahepatic collateral supply of hepatocellular carcinoma, as well as surgical interventions in cases of artery reconstruction, such as the hepatic artery for the treatment of pancreatic ductal adenocarcinoma. In addition, vascular anatomy influences medical management of trauma, such as diaphragmatic and gastroesophageal bleeding.

The conclusion is that surgical interventions carried out in this region must be based not only on knowledge of the topographical anatomy, but also of the possible variations that may be present, in order to conduct the procedure appropriately and according to the best patient care.

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Ethics statement

The authors state that every effort was made to follow all local and international ethical guidelines and laws that pertain to the use of human cadaveric donors in anatomical research[10].

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