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Radiologic Identification and Clinical Significance of Gastroduodenal Artery Origin

Arteria Gastroduodenalis'in Orijininin Radyolojik Tanımlanması ve Klinik Önemi

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ABSTRACT

Objectives: Bleeding of the upper gastrointestinal system originating from gastroduodenal artery (GDA) may require radioembolization when endoscopic interventions are insufficient. Knowledge of the distance between origin of GDA and origin of common hepatic artery (CHA) may reduce complications of this procedure. The aim of this study was to radiologically evaluate the origin of GDA.

Material and methods: This study was designed as an observational, non-randomized and retrospective study. GDA-CHA distance of 150 patients who underwent digital subtraction angiography (DSA) were retrospectively examined. Pearson's correlation coefficient was used to evaluate the relationship between age and GDA–CHA distance. Independent samples t-test was applied for comparisons between groups (gender and bleeding status). A p-value of <0.05 was considered statistically significant.

Results: The mean distance between origin of CHA and GDA was 38.22 mm (range: 18.39–78.66 mm). The mean distance was higher in males than females (38.9 mm vs. 37.4 mm) (t=1.134, p=0.259). The correlation analysis between age and CHA–GDA distance revealed a weak positive correlation (r=0.116) (p=0.156). In patients with active bleeding, the mean distance was 39.44 mm and 38.10 mm in non-bleeding patients(p>0,05). Subgroup analyses by sex similarly showed no significant differences between bleeding and non-bleeding groups (p>0,05). Also, no statistically significant association was found between CHA–GDA distance and age, sex, or bleeding status (p>0.05).

Conclusions: Precise localization of the GDA may reduce life-threatening complications during radiological embolization. The important GDA measurement values obtained in this study may assist interventional radiologists in achieving embolization accuracy in GDA bleeding.

Keywords: Common hepatic artery, digital substraction angiography, gastroduodenal artery, gastrointestinal bleeding, target embolization

ÖZET

Amaç: Arteria gastroduodenalis (GDA) kaynaklı üst gastrointestinal sistem kanamaları, endoskopik girişimlerin yetersiz kaldığı durumlarda hedefe yönelik embolizasyon gerektirebilir. GDA'nın çıkış noktası ile arteria hepatica communis'in (CHA) başlangıcı arasındaki mesafenin bilinmesi, bu girişimin komplikasyonlarını azaltabilir. Bu çalışmanın amacı, GDA'nın çıkış yerini radyolojik olarak değerlendirmektir.

Gereç ve Yöntem: Bu çalışma gözlemsel, randomize olmayan ve retrospektif bir çalışma olarak tasarlandı. Dijital subtraksiyon anjiyografi (DSA) uygulanmış 150 hastanın GDA-CHA mesafesi retrospektif olarak incelendi. Yaş ile GDA–CHA mesafesi arasındaki ilişkiyi değerlendirmek için Pearson korelasyon katsayısı kullanıldı. Gruplar arası karşılaştırmalar (cinsiyet ve kanama) için bağımsız örneklemler t-testi uygulandı. 0,05'ten küçük p değeri istatistiksel olarak anlamlı kabul edildi.

Bulgular: Ortalama CHA ile GDA orijinleri arasındaki mesafe 38,22 mm (aralık: 18,39–78,66 mm) olarak saptandı. Ortalama mesafe erkeklerde kadınlara kıyasla daha yüksekti. (38,9 mm>37,4 mm) (t=1,134, p=0,259). Yaş ile CHA–GDA mesafesi arasındaki korelasyon analizinde zayıf pozitif bir ilişki gözlendi (r=0,116), ancak bu ilişki istatistiksel olarak anlamlı bulunmadı (p=0,156). Aktif kanaması olan hastalarda ortalama mesafe 39,44 mm, kanaması olmayan hastalarda ise 38,10 mm olarak ölçüldü; ancak bu fark istatistiksel olarak anlamlı değildi (p>0,05). Cinsiyete göre yapılan alt grup analizlerinde de kanaması olan ve olmayan hastalar arasında istatistiksel olarak anlamlı bir fark saptanmadı(p>0,05)

Sonuç: GDA'nın doğru ve hassas lokalizasyonu, radyolojik embolizasyon sırasında yaşamı tehdit edebilecek komplikasyonları azaltabilir. Bu çalışmada elde edilen önemli GDA ölçüm değerleri, girişimsel radyologların GDA kaynaklı kanamalarda embolizasyon doğruluğunu artırmalarına katkı sağlayabilir.

Anahtar Kelimeler: Arteria gastroduodenalis, arteria hepatica communis, dijital subtraksiyon anjiyografi, gastrointestinal kanama, hedefe yönelik embolizasyon

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INTRODUCTION

Gastroduodenal artery (GDA) which is a branch of common hepatic artery (CHA), descends along the posterior aspect of the duodenum and anterior surface of the pancreas. It is a critical vascular supply, giving rise to right gastroepiploic artery and superior pancreaticoduodenal arteries. Right gastroepiploic artery primarily maintains the blood supply of gastric antrum, while superior pancreaticoduodenal branches provide the proximal duodenum and the head of the pancreas (1,2,3) (Figure 1).

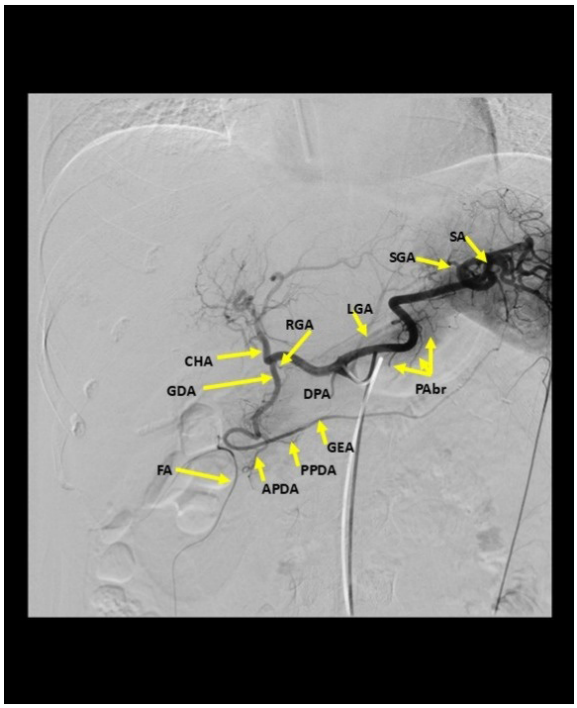


Figure 1. Arterial anatomy of the celiac trunk and its branches visualized on digital subtraction angiography. Right gastric artery (RGA), dorsal pancreatic artery (DPA), the pancreatic branches (PAbr), common hepatic artery (CHA), falciform artery (FA), anterior pancreaticoduodenal artery (APDA), posterior pancreaticoduodenal artery (PPDA) and gastroepiploic artery (GEA) are arising from the gastroduodenal artery (GDA). The faint opacification of the left gastric artery (LGA) is noted at the origin of celiac trunk. The short gastric artery (SGA) is originating from the splenic artery (SA).

A thorough understanding of GDA anatomy is essential both for the endovascular management of upper gastrointestinal bleeding and planning hepatic radioembolization procedures. In selected cases, prophylactic coil embolization of the GDA is performed before radioembolization to prevent non-target embolization and minimize the risk of duodenal injury. Radioembolization is a minimally invasive treatment for primary and metastatic liver tumors. Radioactive microspheres are delivered through the hepatic artery, selectively targeting tumors while sparing most normal liver tissue, which is primarily supplied by the portal vein. Prior coil embolization of the GDA helps prevent non-target radiation and related complications (1,4).

Upper gastrointestinal (GI) bleeding, which carries a mortality rate of approximately 10%, is most commonly caused by peptic ulcer disease located between the gastric antrum and the third portion of the duodenum. Hemorrhage from the body and fundus of the stomach typically originates from the left gastric artery, while bleeding from the pylorus and the first to third portions of the duodenum arises from the GDA. In recent years, transcatheter embolization has become the preferred treatment following endoscopic therapy for upper GI bleeding. Due to the rich arterial collateral supply of the upper GI tract, embolization typically begins distal to the most peripheral site of extravasation and extends proximally to the origin of the GDA to ensure hemostasis (1).

The aforementioned treatment techniques highlight the critical importance of a thorough understanding of the vascular branching patterns of the liver, stomach, duodenum and pancreas threatening patients. To prevent treatment-related complications during endovascular treatment of the hepatic malignancies, vascular malformations or gastrointestinal bleeding, precise knowledge of anatomy is crucial. The aim of this study is to define the anatomical relationship between the origin of CHA-GDA using digital subtraction angiography (DSA) and to provide morphometric data relevant to radiological interventions. Additionally, the study sought to contribute to the literature by reporting the anatomical characteristics of the CHA–GDA distance and comparing the measured values with those available in current studies.

MATERIALS AND METHODS

A total of 150 patients were included in the study and retrospectively evaluated using DSA. The DSA images were retrieved from the archive system of

Ankara Yıldırım Beyazıt University. The distance from the origin of the CHA to the origin of the GDA was measured using 2D-DSA images. Patients with a history of abdominal trauma and/or surgery were excluded from the study. Descriptive statistics were summarized by calculating the mean, minimum and maximum values of the measurement data. Groups were formed based on gender, age and gastrointestinal bleeding status and separate calculations were made for each group (Figure 2). Ethics committee approval was obtained from Ankara Yıldırım Beyazıt University Medical Science Ethics.

Statistical analyses

All statistical analyses were performed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA). Quantitative data were initially examined for distributional properties. The Shapiro–Wilk test was applied to assess the normality of the distribution of the continuous variable. Descriptive statistics, such as the mean, minimum and maximum values were calculated. The relationship between age and CHA–GDA distance was analyzed using Pearson's correlation coefficient. For group comparisons, the independent samples t-test (two-sided) was used to assess CHA–GDA distance in male and female participants, also with and without active gastrointestinal bleeding. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Descriptive statistics such as the mean, minimum and maximum values of the measurement data were calculated for all patients. The mean distance between the origin of GDA and CHA was 38.22 mm. Minimum and maximum values of this distance were 18.39 mm and 78.66 mm.

The relationship between age and distance was evaluated by using Pearson's correlation coefficient. The correlation coefficient was 0.116 which is indicating a weak positive relationship. Additionally, linear regression analysis was performed to test the relationship between age and GDA-CHA distance. The p-value (0.156) was greater than 0.05 (Slope: 0.073, Y-intercept: 33.83, Standard Error: 0.052).

Table 1. Demographic characteristics and common hepatic artery–gastroduodenal artery distance according to sex

	Mean age	Age range	Mean distance (mm)	Distance range (mm)	T-statistic	P-value
Total (n=150)	59.79	25-89	38.22	18.39-78.66		
Male (n=78)	60.32	25-80	38.9	25.57-78.66		
Female (n=72)	59.22	28-89	37.4	18.39-57.56	1.13	0.25

The T-test was performed whether there were significant differences between men (n=78) and women (n=72) for GDA-CHA distance. The T-test revealed that the p-value was greater than 0.05 (t-statistic: 1.134, p-value: 0.259) (Table 1).

Table 2. Common hepatic artery–gastroduodenal artery distance in male and female patients with active bleeding

	Distance mean (mm)	Distance minimum (mm)	Distance maximum (mm)	T-statistics	P-value
Female (n=4)	38.59	30.68	51.72	-0.635	0.538
Male (n=9)	41.35	32.62	49.62		

A T-test was used to compare GDA-CHA distance between male (n=9) and female (n=4) patients in bleeding group. The results of T-test showed that the p-value was greater than 0.05 (t-statistic: -0.635, p-value: 0.538) (Table 2).

The Student's t-test was used to evaluate the differences in GDA-CHA distance between bleeding and non-bleeding groups within male and female cohorts. For the male group, in bleeding patients the mean value was 41.35 mm, while it was 37.20 mm in non-bleeding patients. The t-statistic for this comparison was -0.932, with a p-value of 0.354 ($p > 0.05$). For the female group, in the bleeding patients the mean value was 38.59 mm, while it was 38.99 mm in non-bleeding patients. The t-test revealed a t-statistic of 0.148 and a p-value of 0.883 ($p > 0.05$). These findings indicate that bleeding status does not significantly influence the distance of GDA-CHA in either males or females (Table 3).

Table 3. Common hepatic artery–Gastroduodenal artery distance according to bleeding status

	Mean (mm)	Minimum (mm)	Maximum (mm)	T-statistics	P-value
TOTAL					
Bleeding patients (n=13)	39.44	30.68	51.72		
Non-bleeding patients (n=137)	38.10	18.39	78.66		
MALE					
Bleeding (n=9)	41.35	30.68	51.72		
Non-bleeding(n=69)	37.20	25.57	78.66	-0.932	0.354
FEMALE					
Bleeding (n=4)	38.59	32.62	49.62		
Non-bleeding (n=68)	38.99	18.39	57.56	0.148	0.883

As a result of this study, there is no statistically significant effect of gender and age on the distance. Furthermore, no significant difference was found between genders in patients with bleeding in CHA-GDA distance.

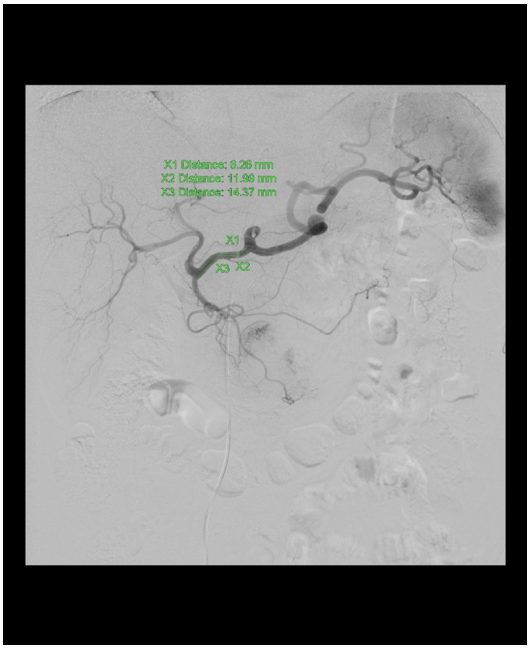


Figure 2. Measurement of the distance between the origin of the gastroduodenal artery and the bifurcation point of celiac trunk.

DISCUSSION

It is crucial to identify anatomical landmarks subcortically during emergency interventions for radiologists and surgeons. The objective data such as accurate calculation of vascular structures is important for effective intraabdominal navigation in patients with normal or changed anatomy due to previous operations. The present study was motivated by this clinical need.

The primary hypothesis of this study is that the distance between the origin of CHA and GDA may vary according to demographic characteristics and the presence of bleeding at presentation. Although the results demonstrated no statistically significant association between CHA–GDA distance and sex, age or bleeding status, the study provided reference anatomical data that may support planning in radiological interventions.

The radiologic interventional approach to CHA and GDA consists of multiple steps, from vascular access to embolization. After arterial access, selective catheterization of celiac trunk and its branches is performed under fluoroscopy with DSA. Then CHA is selectively catheterized and a microcatheter is advanced into the GDA or its distal branches to localize bleeding site and to carry out embolization often using the “sandwich” technique” to prevent back-bleeding (1,5,6,7,8).

Due to the variation in techniques, anatomical knowledge and experience, the technical success of GDA embolization ranged from 62% to 100% (6,7,8,9). Hence detailed anatomical knowledge of CHA and GDA is crucial for the success of procedures. To our opinion the present study conducted larger, diverse populations, may offer valuable insights for endovascular training in vascular fellowship programs. In addition to the literature cited, the present study has demonstrated the length of CHA-GDA segment by also taking into account gender differences in patients with and without bleeding.

Moreover, a short distance between the origin of CHA and GDA can complicate stable microcatheter positioning within the GDA. Conversely, a longer segment provides more maneuvering room and improves catheter stability. The distance and angle of origin can also affect the risk of embolic material reflux into the CHA or hepatic branches. Adequate length between the GDA origin and CHA bifurcation is crucial for precise coil deployment without compromising hepatic arterial flow (5,10,11,12). In cases where the

GDA arises sharply, too proximally, or from a tortuous CHA, advanced catheter techniques (e.g., shaped catheters, microcatheter torqueing and roadmapping) are required (8,9).

In catheter control, procedural safety and embolization planning, the distance between CHA and GDA origins appears clinically relevant. The literature lacks adequate attribution to measurements of specific anatomical structures which cause technical challenges. This study provides objective data on the vascular length from the origin of CHA to the origin of GDA that may contribute to interventional failure. Each of these anatomical findings may be used as landmarks for the future studies aimed at optimizing embolization outcomes.

In present study, we present a critical anatomical measurement from the interventional radiologist's perspective that is applicable across all causes of upper GI bleeding. Our study found no significant relation between the CHA–GDA distance and bleeding status. Even if a significant correlation had been found, it would be difficult to attribute causality based on the lack of standardization in patient medical history and medication use such as previous abdominal trauma, surgery, anticoagulant use and underlying vascular disease. So, our aim was not to assess bleeding outcomes, but rather to focus on an anatomical measurement that is critical for interventional planning.

Relation between CHA-GDA distance and bleeding status was also analyzed and found to be statistically non-significant in both sexes. There are studies in the literature that highlight the anatomical variations of CHA and GDA (13). Knipe et al. discusses the anatomical variations of GDA and its proximity to the duodenum that has significant importance in the context of upper GI bleeding (3,14). However, this study does not specifically address CHA–GDA distance in relation to bleeding risk. There are limited studies which reveals CHA–GDA distance in upper GI bleeding. Therefore, the result of this present study that there is no significant association between this anatomical distance and bleeding status, adds valuable insight to the literature.

CONCLUSION

This study, conducted on 150 patients who underwent DSA, provides quantitative data regarding the distance between the origins of CHA and GDA. The mean CHA–GDA distance was 38.22 mm. This average distance showed no statistically significant association with demographic variables such as age or sex, nor with bleeding status. These anatomical measurements of CHA–GDA distance, which contribute to the existing literature, may support safe catheterization and preoperative planning in interventional radiology and surgical procedures.

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A preliminary version of this study, entitled "Radiologic identification and clinical significance of gastroduodenal artery origin; preliminary study," was presented at the 23rd National Congress of Anatomy, organized by the Turkish Society of Anatomy and Clinical Anatomy (Ankara, Türkiye, 11–15 October 2023). The current manuscript is an expanded version of the preliminary study.

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Ethical Approval: Ethical approval has been obtained from Ankara Yıldırım Beyazıt University Health Sciences Ethics Committee with the decision dated 20.05.2024 and numbered 05-712.

Patient Consent: Patient consent was waived because the study was retrospective, all data were anonymized, and the Institutional Ethics Committee waived the requirement for informed consent.

Declaration Regarding the Use of AI-Assisted Technologies Artificial intelligence (Open AI, GPT 5.0 version) was only used to translate some sentences for readability in this study. We did not use AI for study design, data collection, data analysis, references or other aims. All outputs of AI for translation were carefully reviewed by authors.

Data Availability: The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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