Ann Med Res
Current issue list available at AnnMedRes
Annals of Medical Research
journal page: www.annalsmedres.org

Anatomic variations of the gastrocolic trunk of Henle and implications for colon surgery

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ARTICLE INFO

Keywords:
Gastrocolic trunk
Gastropancreaticocolic trunk
Henle's trunk
Colon cancer
Gastric cancer

Received: Jan 03, 2025
Accepted: Apr 10, 2025
Available Online: 25.04.2025

DOI:
10.5455/annalsmedres.2024.12.286

Abstract

Aim: Henle's trunk is a crucial venous structure involved in the drainage of veins originating from the stomach, colon, and the pancreas. Variations in the formation of the trunk exist and it can have significant clinical implications, particularly in procedures involving lymphadenectomy and vessel ligation around this location. In this study, we aimed to demonstrate variations in the venous architecture of the Henle's trunk with the use of CT images.

Materials and Methods: In this retrospective study, 287 patients who had 3D CT imaging for different purposes in a single institution between January 2018 and June 2022 were evaluated. Patients were grouped into two groups as gastrocolic trunk and gastropancreaticocolic trunk based on the presence of a pancreatic branch contributing to the formation of Henle's trunk. Variations in these two groups were retrospectively evaluated.

Results: Variations of the Henle's trunk are classified as bipod, tripod, or tetrapod. In our series (n=287), the most common subclassification of the gastrocolic trunk was a bipod which included right gastroepiploic vein and right colic vein (n=36, 12.5%). The most common subclassification of the gastropancreaticocolic trunk was a tripod which included right gastroepiploic vein, right colic vein, and anterior superior pancreaticoduodenal vein (n=80, 60.6%).

Conclusion: A thorough examination of the right colon vascular anatomy requires an understanding of venous variations of the Henle's trunk. These variations highlight the importance of individualized assessments for patients, especially those undergoing right hemicolectomy and gastrectomy. This knowledge will aid in reducing surgical complications and improving oncologic outcomes.

Introduction

The venous vascular structure of the right colon is intricate and frequently differs from that of the left side. Regarding oncologic surgery, this complex variation in the vascular structure makes lymph node dissection quite difficult around this anatomical location [1]. Furthermore, severe bleeding may arise during surgery from rupture of the delicate tributaries of the superior mesenteric vein (SMV), particularly the branches of the Henle's trunk, due to improper traction during surgery [1].

Henle originally introduced the idea of the gastrocolic venous trunk in 1868 [2]. This venous trunk, also known as the gastrocolic trunk, consists of venous supply from the stomach (right gastroepiploic vein) and the colon (middle colic vein, right colic vein, or the superior right colic vein). Various studies have also included a pancreatic branch (anterior superior pancreaticoduodenal vein) entering the trunk and renamed the trunk as gastropancreaticocolic trunk [1,3,4]. This new definition made the Henle's trunk form by three veins.

Henle's trunk becomes clinically important during complete mesocolic excision (CME) in right-sided colon surgery. Hohenberger was the first to introduce the concept of CME with central vascular ligation [5]. According to this concept, performing CME with central vascular ligation removes the most centrally draining nodes that may contain metastases [1,5]. It is, therefore, essential to understand the normal pattern as well as the variations of venous structures to minimize complications during surgery

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as well as to perform proper lymphadenectomy.

The purpose of this study is to present variations of the venous anatomy of the gastropancreaticocolic trunk of Henle in patients using 3D computerized tomography (CT) imaging.

Materials and Methods

This retrospective study included 287 patients who underwent 3D CT imaging for various indications in a single institution between January 2018 and June 2022. Patients with a history of bowel perforation, abdominal radiation history, colon cancer (and colon surgery), and inadequate evaluation of the CT images were excluded from the study since the vascular anatomy may be altered (i.e., neovascularization) or resected in the presence of a surgical history. The vascular structures forming the Henle's trunk such as the right gastroepiploic vein (RGEV), middle colic vein (MCV), accessory middle colic vein (aMCV), right colic vein (RCV), superior right colic vein (sRCV), and anterior superior pancreaticoduodenal vein (ASPDV) were evaluated using dynamic abdominal CT images using our local PACS archive system. In our study, we have used the subclassification of Henle's trunk discussed by Gao et al. and categorized it into two groups based on the involvement of the pancreatic branch [3].

Type I only included the gastric and colic branches. In type Ia, RGEV and RCV formed the trunk while in type Ib, RGEV and SRCV formed the trunk. In type Ic, RGEV, RCV, and SRCV formed a tripod and the common trunk drained into the superior mesenteric vein. In type Id, RGEV and MCV together drained into the trunk while an accessory middle colic vein was present in type Ie, forming a tripod.

The type II included gastric, colic, and pancreatic branches. In type IIa, RGEV, RCV, and ASPDV formed the trunk while in type IIb, RGEV, SRCV, and ASPDV formed the trunk. In type IIc, a superior right colic vein was present besides the right colic vein, forming a tetrapod venous structure draining into the trunk. In type IId, RGEV, MCV, and ASPDV formed a tripod while in type IIe, RGEV, MCV, aMCV, and ASPDV formed the trunk. The variations observed in our study are shown in Figure 1.

The venous tributaries that formed the Henle's trunk were analyzed using the portal venous phase. The computerized tomography images were evaluated in three different orthogonal views and sometimes a 3D structure was created for clarity.

Each patient was examined by a dual-course CT scanner in triphasic imaging, including hepatic arterial, portal venous, and hepatic venous phases. Two dual-source CT scanners were used: SOMATOM Definition AS (Siemens Healthcare, Forchheim, Germany) and Revolution CT (GE Healthcare, Milwaukee, Wisconsin). The scanning parameters were as follows: 120–140 kV tube voltage with min 140 mA–max 400 mA using automatic tube current modulation, pitch 1, matrix 512×512, slice thickness of 5 mm with 1.25 reconstruction. For 3D reconstruction, the volume rendering techniques was used by Siemens syngo.via software and the GE AW server. Also various, post-processing software (SAFIRE, ASiR-V) were automatically used for dose modulation.

The study was performed in accordance with the ethics guidelines of the Helsinki Declaration and was approved by the local ethics committee (Istanbul University-Cerrahpaşa Clinical Research Ethics Committee, approval number: E–83045809–604.01–1118237).

Results

Among the patients involved in the study (n=287), 154 were male (53.6%) and 133 were female (46.4%). The average age of the individuals was 51.17 ± 12 (age range 21–76). Among the gastrocolic trunk (n=81, type I), the most common type was type Ia with 36 patients (12.5%) (Table 1). This subtype included the right gastroepiploic vein forming a trunk with the right colic vein (Figure 2). The occurrence was followed by type Ib with 22 patients (7.7%), type Id with 17 patients (5.9%), type Ic with 4 patients (1.4%), and type Ie with 2 patients (0.7%). As observed in type Ie, an additional middle colic vein was referred to as the accessory middle colic vein.

Among the gastropancreaticocolic trunk (n=174, type II), the most commonly observed subtype was type IIa with 80 patients (27.9%) (Table 2). This subtype included the right gastroepiploic vein forming a tripod with the right colic vein and anterior superior pancreaticoduodenal vein (Figure 3). This was followed by type IIb with 36 patients (12.5%), type IId with 33 patients (11.5%), type IIc with 23 patients (8%), and type IIe with 2 patients (0.7%). Similar to type Ie, an additional middle colic vein was

Table 1. Gastrocolic subclassification of the Henle trunk based on the venous tributaries from the right colon.

Type of Henle trunk	Venous drainage	Frequency, n (%)
I		81 (28.2)
Ia	RGEV + RCV	36 (12.5)
Ib	RGEV + SRCV	22 (7.7)
Ic	RGEV + RCV + SRCV	4 (1.4)
Id	RGEV + MCV	17 (5.9)
Ie	RGEV + MCV + aMCV	2 (0.7)

RGEV: right gastroepiploic vein; RCV: right colic vein; SRCV: superior right colic vein; MCV: middle colic vein; aMCV: accessory middle colic vein.

Table 2. Gastropancreaticocolic subclassification of the Henle trunk based on the venous tributaries from the right colon.

Type of Henle trunk	Venous drainage	Frequency n (%)
II		174 (60.6)
IIa	RGEV + ASPDV + RCV	80 (27.9)
IIb	RGEV + ASPDV + SRCV	36 (12.5)
IIc	RGEV + ASPDV + RCV + SRCV	23 (8.0)
IId	RGEV + ASPDV + MCV	33 (11.5)
IIe	RGEV + ASPDV + MCV + aMCV	2 (0.7)

RGEV: right gastroepiploic vein; RCV: right colic vein; SRCV: superior right colic vein; MCV: middle colic vein; ASPDV: anterior superior pancreaticoduodenal vein; aMCV: accessory middle colic vein.

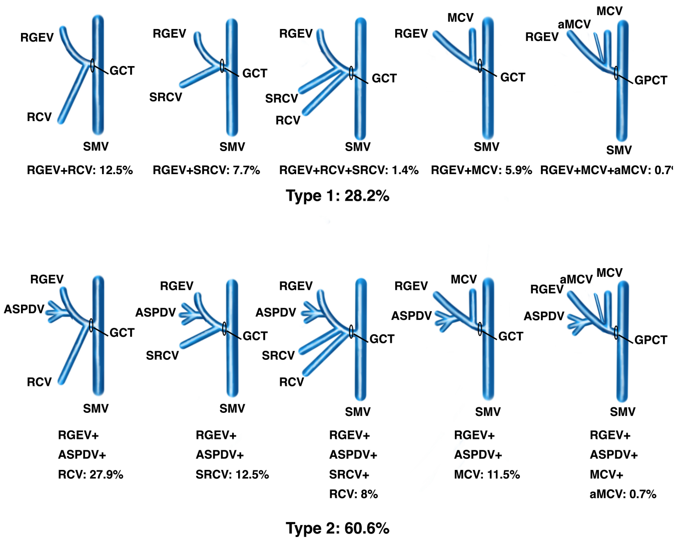

Figure 1. The venous tributaries that lead to the formation of gastrocolic (type 1) and gastropancreaticocolic (type 2) trunks.

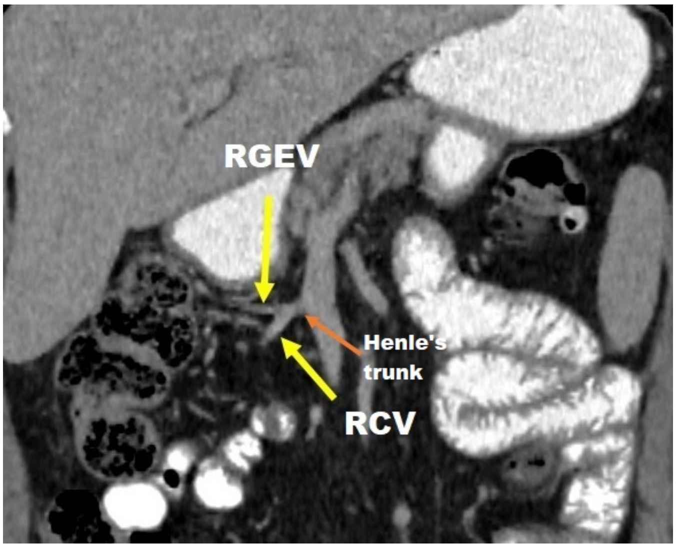

Figure 2. The RGEV and RCV forming the most commonly observed gastrocolic trunk of Henle.

referred to as the accessory middle colic vein in type IIe. We did not observe three middle colic veins in any of our patients included in the study.

In 32 patients (11.1%), there were no colic tributaries and the trunk was only formed between gastric and pancreatic branches. Since the gastropancreaticocolic trunk and the formerly known gastrocolic trunk always included a colic branch, this group did not include a colic branch and because of this reason they were referred to as the unclassifiable group. Among this group, the RGEV and ASPDV formed a common trunk before draining into the superior mesenteric vein.

Discussion

Following the principles of total mesorectal excision in rectal cancer, complete mesocolic excision was introduced by Hohenberger et al. in 1992 which revolutionized colon cancer surgery and patient oncologic outcomes [5–7]. CME involves isolation of the visceral fascia, dissection of lymph

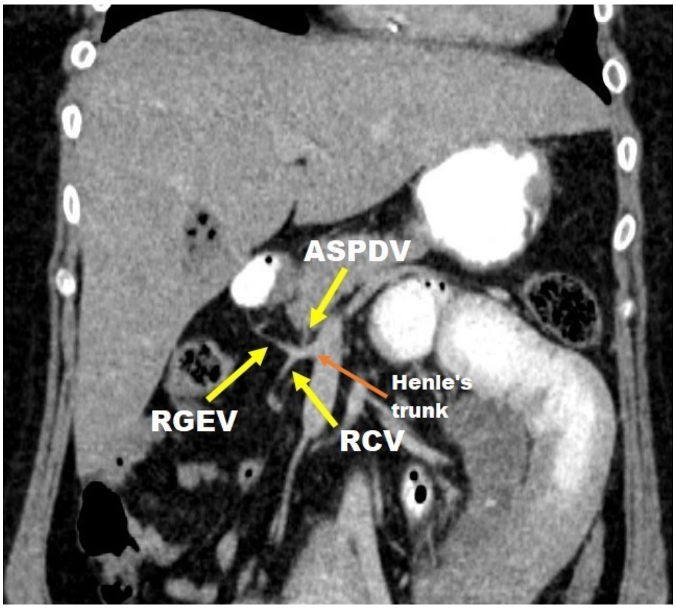

Figure 3. The RGEV, RCV, and ASPDV forming the most commonly observed gastropancreaticocolic trunk of Henle.

nodes around the origin of the mesenteric arteries, and central (high) ligation of the arteries [3,8,9]. Performing complete mesocolic excision with central vascular ligation and obtaining negative surgical resection margins by preserving the embryological planes are the essential factors that determine the oncologic outcome of the patient [1]. For this reason, understanding the normal anatomy and the variations of the venous supply is important during right colon cancer surgery. This study provides information about the formation of the Henle trunk and presents vascular variations among different individuals.

Although Henle first described the gastrocolic trunk in 1868, Descomps et al. observed an additional vein that formed the gastrocolic trunk, namely ASPDV [10]. Ever since, various cadaveric and radiological studies have been published that presented their findings. Variations of the Henle's trunk in the literature are often classified as bipod, tripod, or tetrapod. When defining vein tributaries, when more than two right colic veins or middle colic veins are present, the thicker vein is defined as the main vein whereas the thinner vein is defined as the accessory vein [3].

Cadaveric studies on the variations of Henle's trunk have yielded different results. In the majority of the studies, Henle's trunk was formed between RGEV, ASPDV, and a colic vein (gastropancreaticocolic trunk). Kuzu et al. have studied 111 cadavers with a 78.4% incidence of gastropancreaticocolic trunk. This trunk was most commonly formed between RGEV, ASPDV, and RCV (41.4%) [1]. This finding was similar to our results. Jin et al. dissected 9 cadavers with the most common observation (50%) of RGEV, ASPDV, SRCV, and RCV forming the Henle's trunk [11]. On the other hand, Yamaguchi et al. studied 58 cadavers and observed RGEV, ASPDV, and aMCV forming the Henle's trunk most commonly (55%) [12]. In their findings, the gastrocolic trunk was absent in 31% of the cadavers. Ignjatovic et al. have dissected 34 cadavers and the most common tributaries of the Henle's trunk (73.5%) were RGEV, SRCV, and ADPDV or anterior inferior pancreaticoduodenal vein [13]. Stefura et al. performed a meta-analysis on the prevalence of tributary variations of Henle's trunk [14]. Among the studies, they found that the most common venous variation forming the Henle's trunk was RGEV, SRCV, and ASPDV ($p<0.01$) [14].

Besides cadaveric studies, the prevalence of Henle's trunk was also studied with 3D CT images. Usually, these studies involved a larger number of patients simply due to the simplicity of observing radiological images. Sakaguchi et al. studied 102 patients where 79 had Henle's trunk (77.5%) [15]. The most common venous tributaries that formed the Henle's trunk were RGEV and SRCV (53.2%). The least common was RGEV and RCV (1.3%). It was important, however, to note that ASPDV was not observed in any of the cases. In another study, Ogino et al. observed 87.7% of Henle's trunk in a total of 81 patients [16]. The most commonly observed variation was RGEV, ASPDV, and RCV, which was similar to our findings. The least common variation was RGEV, ASPDV, and MCV. Our study included an occurrence of Henle's trunk in 88.8% of the cases (n=287). RGEV and RCV was the most common type that formed the gastrocolic trunk of Henle while RGEV, ASPDV, and RCV were the most common type that formed the gastropancreaticocolic trunk of Henle. The least commonly observed gastrocolic trunk subtype was RGEV, MCV, and aMCV while the least commonly observed gastropancreaticocolic trunk subtype was RGEV, ASPDV, MCV, and Amcv in our series.

Henle's trunk becomes important not only in colon surgery but also in gastric surgery. The RGEV is present in almost all types of variations of Henle's trunk as mentioned in previously. It is therefore essential to observe its course to ligate the vessel and perform proper lymphadenectomy. According to the Japanese Gastric Cancer Association, the lymph nodes inferior to the pyloric region are numbered as the number 6 lymph node station [17]. Patients with gastric cancer display metastasis to number 6 lymph nodes at a rate between 3.95–34% [3,18–22]. Due to this rate, it is necessary to remove the number 6 lymph nodes during radical gastrectomy [23–25]. The RGEV displays various drainage patterns under the head of the pancreas. Therefore, understanding the anatomical confluence of the RGEV is essential to perform proper oncologic dissection of the number 6 lymph node [22].

Another important colic tributary that form the Henle's trunk is the middle colic vein. In our study, middle colic vein were identified in all patients. Based on the data from Tables 1 and 2, in only 18.8% of the patients the middle colic vein drained into the Henle's trunk while 81.2% drained into the SMV. Maki et al. studied the variations of the middle colic vein in 3D CT angiography images [26]. According to their results, MCV was present in all patients and the MCVs drained into the SMV in 62.5% of patients, gastrocolic trunk in 29.3% of patients, inferior mesenteric vein in 4.8% of patients, splenic vein in 2.7% of patients and jejunal vein in 0.6% of patients [26].

One important limitation of this research is the radiologic nature of the study. The gastrocolic trunk of Henle has been renamed as gastropancreaticocolic trunk of Henle simply due to the observation of the presence of ASPDV. Many cadaveric studies mentioned earlier included this thin, delicate venous structure as part of the dissection. In radiologic 3D CT images, however, thin, small vessels such as ASPDV or the accessory MCV may be easily missed if the imaging modality is of bad quality. Small vessels may be missed due to motion artifacts, limited spatial resolution, low contrast enhancement, or inadequate temporal resolution. For this reason, patients with CT images that did not have adequate quality for venous structure visualization were excluded from the study.

The clinical importance of the Henle's trunk became more prominent with the introduction of complete mesocolic excision (CME) in colon surgery. In CME, the mesocolic plane is protected and the supplying arteries are highly ligated, which resulted in improved patient survival outcomes and decreased local recurrence rates. During CME of the right colon, the right colon must be freely mobilized to perform adequate lymphadenectomy. Due to the anatomical landmark of the Henle's trunk, misrecognition of the vessels can lead to uncontrollable bleeding during surgery. Hohenberger referred to this point as the "bleeding point" during right-sided CME surgery [5].

There also seems to be a lack of standardization in categorizing Henle's trunk. Because of this, we decided to group Henle's trunk into two categories based on the presence of the pancreatic vein tributary. A consensus may be reached in standardizing the subtypes of Henle's trunk and further research may be conducted to measure the quantitative values (such as the length and diameter of vessels) and the proximity of arterial and venous structures within the mesocolon.

Conclusion

Understanding the venous variations of the Henle's trunk is crucial for a comprehensive review of the vascular anatomy of the colon. The variability in its anatomy emphasizes the need for detailed knowledge during colectomy and gastrectomy in order to minimize complications and to achieve proper lymphadenectomy for better oncologic outcomes.

Disclosures

Ethics Committee Approval: Ethical approval was obtained for this study from the Istanbul University-Cerrahpaşa Clinical Research Ethics Committee (approval number: E–83045809–604.01–1118237).

Informed Consent: Not necessary for this manuscript.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept: EE, FGY; Design: EE, ANŞ, FGY; Supervision: SAK, FGY; Materials: EE; Data Collection: EE, ANŞ, SAK; Analysis: EE, MF, Literature Review: EE, ANŞ; Writing: EE, SAK, MF; Critical Review: SAK, MF, FGY.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: None.

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