Surgical and Radiologic Anatomy (2019) 41:879–887
https://doi.org/10.1007/s00276-019-02253-4

REVIEW

Gastrocolic trunk of Henle and its variants: review of the literature and clinical relevance in colectomy for right-sided colon cancer

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Received: 11 March 2019 / Accepted: 4 May 2019 / Published online: 14 May 2019

Abstract

Purpose Venous vascular anatomy of the right colon presents a high degree of variability. Henle's Gastrocolic Trunk is considered an important anatomical landmark by colorectal surgeons. The classical description concerns a bipod vascular structure or tripod, but several variants are associated to it. The aim of this study is to merge the most updated literature on the anatomy knowledge of the Gastrocolic Trunk by evaluating all possible variants, as well as to underline its surgical importance due to its topographical relationships.

Methods Twelve studies describing the anatomy of the gastrocolic trunk were selected, each of them dealing with a more or less extensive series of cases. A distinction was drawn between the gastropancreatic trunk, devoid of the colonic component, and the gastrocolic trunk; and then the frequency of the different resulting variants was reported. The data obtained from cadavers and radiological studies were analyzed separately.

Results The Gastrocolic Trunk is found in 74% of cadaver studies, and in 86% of radiological studies. Its most frequent configuration is represented by the union of right gastroepiploic vein + anterior superior pancreaticoduodenal vein + superior right colic vein, respectively, 32.5% and 42.5%, followed by the right colic vein which replaces (26.9%, 12.3%) or is added (10%, 20.1%) to the superior right colic vein.

Conclusions The superior right colic vein joins the right gastroepiploic vein and the anterior superior pancreaticoduodenal vein thus forming, in most cases, the gastrocolic trunk. The anatomical knowledge of vascular structures forms the basis for both the interpretation of preoperative radiological images and the surgical procedure itself, despite the considerable anatomical variability of tributaries.

Keywords Gastrocolic trunk · Henle · Right colic veins · Right colectomy · Colon cancer

Introduction

Since the vascular anatomy, especially the venous anatomy of the right colon, varies, scientific literature continues to arouse interest in this topic by offering several articles on this subject [1, 2, 17, 21–24, 28, 31, 35, 44, 45].

When facing the region at the lower border of the pancreas head and neck, surgeons have to take the following into consideration: the fusion of the greater omentum with the transverse mesocolon and the wide anatomical variability of the tributary veins of the superior mesenteric vein (SMV).

In pancreatic and colorectal surgery, these veins can be identified and carefully dissected to avoid bleeding because of iatrogenic injuries, such as excessive traction on the mesocolon or during SMV dissection. Furthermore, such vascular structures might be already involved in pathological processes such as pancreatic head tumors [21, 23, 28].

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In colorectal surgery, the introduction of complete mesocolic excision (CME) for surgical treatment of colon cancer, by preserving the mesocolic plane and high tie of the supplying arteries, led to significantly improved patient outcomes in Erlangen, where the 5-year cancer-related survival is now at 89% and the local recurrence rate is less than 4% after R0 resections [16, 41–43]. To perform right hemicolectomy with CME, the following actions are necessary: adequate mobilization of the right colon, complete lymph node dissection along the surgical trunk, and complete resection of the mesocolon.

The misrecognition of the vessels could lead to troublesome bleeding whose control can be difficult without sufficient anatomical knowledge. Previous studies showed that bleeding occurred during ligation of the vascular pedicle in 3–9.2% of laparoscopic right colectomy cases, requiring conversion to open surgery in 1–2% of cases [26, 39].

Hohenberger et al. focused on this critical region ("bleeding point") in the surgical community and standardized dissection of these veins as guiding structures that lead to the SMV in right-sided CME [16]. In this region, the Gastrocolic Trunk of Henle (GCT) is considered an important anatomical landmark by many surgeons [17, 30] especially for hepatic flexure and transverse colon cancers. According to the Japanese Society for Cancer of the Colon and Rectum (JSCCR), GCT defines, together with middle colic artery, the cranial border of the D3 area [37] and because of the remarkable anatomical variability of the veins flowing into it, it holds a key position in the dissection of the infrapancreatic lymph node region (ILR) for hepatic flexure and of the transverse colon cancers.

This study aims to provide an anatomical basis for Henle's GCT, in particular for its colonic component, still uncertain for its complexity and variability, based on a review of the available scientific literature and on data analysis offered by the various authors' case series. It is believed that the knowledge of these venous structures and their anatomical relationships can offer a valid support during surgery to prevent vascular and organ injuries, to maintain the surgical planes and obtain an optimal lymph node dissection.

Materials and methods

A literature search in PubMed was performed to identify studies evaluating GCT anatomy using the following search terms: 'gastrocolic trunk', 'Henle trunk', 'right colon venous anatomy', 'right colic veins'. Search results were supplemented by manual search of selected references to identify additional studies missing in the initial search. To be eligible a study had to provide a case series of anatomical description reporting on the tributaries of the GCT; only full texts and English-language studies were considered. Twelve studies were selected. The evaluation methods are summarized in three categories: cadaveric anatomy (Cadav.), radiological anatomy by Computed Tomography (CT), intraoperative anatomy (Intraop.) Because of the great variability in the terminology adopted by the various authors, it is necessary to clarify some definitions: the Ileocolic Vein (ICV) was defined as the tributary from the ileocecal marginal veins to the SMV; the Right Colic Vein (RCV) and the Middle Colic Vein (MCV) were defined, respectively, as the veins that drained from the marginal veins of the ascending colon and the transverse colon to the SMV. When two or three MCVs were present, the biggest was known as the main MCV while the smallest MCVs were defined as accessory ones (aMCV) [44]. The Superior Right Colic Vein (SRCV) was defined as the tributary from the marginal veins of the right flexure of the colon to the confluence of the GCT or the SMV [21]. The GCT for Henle was first described in 1868 as the confluence of the SRCV and the right gastroepiploic vein (RGEV) draining into the Superior Mesenteric Vein [14].

As a third element, in 1912 Descomps and De Lalaubie [6] added the anterior Inferior Pancreaticoduodenal Vein (AIPDV) to this confluence, so that the trunk became a tripod. The difference in nomenclature for a contributing pancreaticoduodenal vein, as reported by Descomps, De Lalaubie in 1912 and Gillot et al. in 1962 [11] (AIPDV), in contrast to the Anterior Superior Pancreaticoduodenal Vein (ASPDV) as reported in the majority of more recent reports [1, 21, 22, 24, 28, 29] is not completely clear.

The results that follow will show how the original bipod configuration described by Henle is found less frequently than the other combinations; among these we deliberately separated the one without a colonic component defining it as Gastropancreatic Trunk (GPT), according to a recent study [22].

Therefore, the frequency of these vascular structures (GPT and GCT) and the different combinations of right and transverse colon veins which participated in the formation of the GCT itself, when this is present, were reported. The analysis of the data was then performed separately according to the evaluation methods: cadaver or CT, considering these ones to be the most accurate, thus excluding intraoperative and mixed evaluations [23].

Results

Twelve studies, dealing with a variable number of cases, have described the anatomical configuration of the GCT in detail using radiological and anatomical examination on cadavers or intra-operative methods. For each study the gastropancreatic conformation (GPT) has been reported, and specifically the gastro-pancreato-colic (GCT) with its variants (Table 1).

Table 1 Case series of anatomical GCT description

Authors	Zhang et al. [45]	Lange et al. [23]	Yamaguchi et al. [44]	Jin et al. [21]	Ignjatovic et al. [17]	Sakaguchi et al. [35][b]	Ogino et al. [31][b]	Açar et al. [1]	Miyazawa et al. [28]	Lee et al. [24]	Alsabilah et al. [2][c]	Kuzu et al. [22]
Year	1994	2000	2002	2006	2010	2010	2014	2014	2015	2016	2017	2017
Evaluation	Cadaver	Intraop/ Cadaver	Cadaver	Cadaver	Cadaver	CT	CT	Cadaver	CT	Intraop.	Intraop.	Cadaver
No.	54	37	58	9	42	102	81	12	100	116	70	111
GPT	19/54 (35.2)	16/37 (43)		1/9 (11)				1/12 (8.3)	7/100 (7)	19/116 (16.4)	36/62 (58.1)	24/111 (21.6)
GCT	32/54 (59.2)	17/37 (46)	40/58 (69)	8/9 (89)	34/42 (81)	79/102 (77.4)	71/81 (88)	11/12 (91.6)	93/100 (93)	92/116 (79.3)	19/70 (27)	87/111 (78.4)
RGEV + A(I)SPDV + SRCV	21/32 (65.5)	14/17 (82)		3/8 (37.5)	25/34 (73.5)	42/79 (53.1)		8/11 (72.7)	71/93 (76.3)			12/87 (13.8)
RGEV + SRCV	4/32 (12.5)	3/17 (18)			9/34 (26.5)							
RGEV + A(I)SPDV + RCV			11/40 (27.5)			1/79 (1.26)	29/71 (41)				10/19 (52.5)	46/87 (52.9)
RGEV + A(I)SPDV + MCV			30/40 (75)[a]			2/79 (1.52)	1/71 (1.4)				2/19 (10.4)	2/87 (2.3)
RGEV + A(I) SPDV + SRCV + RCV	1/32 (3.1)			4/8 (50)		15/79 (18.9)	14/71 (20)	1/11 (9)	20/93 (21.5)			14/87 (16)
RGEV + A(I) SPDV + SRCV + RCV + MCV				1/8 (12.5)		9/79 (11.3)	3/71 (4)		2/93 (2.2)			2/87 (2.3)
RGEV + A(I) SPDV + SRCV + MCV						10/79 (12.6)		2/11 (18.1)				
RGEV + A(I) SPDV + RCV + MCV							22/71 (31)				7/19 (36.7)[d]	4/87 (4.6)
RGEV + A(I) SPDV + ICV + RCV + MCV							2/71 (3)					
RGEV + A(I)SPDV + ICV												2/87 (2.3)
RGEV + A(I) SPDV + RCV + ICV												3/87 (3.3)
RGEV + A(I) SPDV + RCV + SRCV + ICV												2/87 (2.3)
RGEV + A(I) SPDV + SRCV + antral branch	5/32 (15.6)											
RGEV + A(I) SPDV + SRCV + retropyloric v.	1/32 (3.1)											
RGEV + A(I) SPDV + SRCV + aSRCV										29/92 (31.5)		

GPT gastro pancreatic trunk, *GCT* gastrocolic trunk, *RGEV* right gastroepiploic vein, *A(I)SPDV* anterior (inferior)superior pancreaticoduodenal vein, *SRCV* superior right colic vein, *aSRCV* accessory superior right colic vein, *RCV* right colic vein, *MCV* middle colic vein, *ICV* inferior colic vein

[a]Considering MCV and aMCV, [b]no description about A(I)PDV, [c]SRCV not found, [d]MCV or aMCV

In Table 2 data concerning the venous anatomy of the right colon have been collected. ICV is a constant component of venous colic vascular anatomy: it is present in the totality of the cases examined [2, 22, 24, 31, 44] and it flows almost exclusively into SMV and from 2% [31] to 6.3% [22] of cases into GCT. RCV, SRCV and MCV are described and reported in different proportions.

The GCT itself, with at least one colonic venous structure, has been found in 74% of anatomical studies on cadavers, and in 86% of cases of radiological studies. Its eventual presence is revealed in both studies through its most frequent configuration (Fig. 1) represented by the union of RGEV + AS (I) PDV + SRCV (32.5%, 42.5%). After that, in varying degrees, RCV replaces the SRCV (26.9%, 12.3%) or is added to it (10%, 20.1%). The comparison of further combinations is reported in Table 3. Two studies showed no gender-related difference [2, 23].

Discussion

The present study reported several case studies in the literature referring to the venous vascular anatomy of the right colon and in particular to the structure of Henle's GCT: the aim is to contribute to the surgical anatomy, as well as to support the surgeon by highlighting that GCT is an important anatomical landmark due to its placement during surgery for hepatic flexure and transverse colon cancer. The possible mechanisms of injuries in abdominal surgery, the difficulties of hemostasis and the interest of a preoperative evaluation of GCT have already been the object of previous studies. A recent meta-analysis [38] states that pooled prevalence of venous trunk of Henle is 82.8% in cadaveric studies and 87.6% in CT-imaging studies. These values are similar to those found in the present study (74% and 86%, respectively), thus further confirming the same most common colic tributaries: SRCV and, subsequently, RCV. Gao [9] showed that the occurrence of Henle's trunk varied from 69 to 100% during autopsy and vascular casting. As can be seen from Table 1, the detection of MCV as a component of the GCT has increased in the last 10 years, an opinion shared also by Gao. The same studies were evaluated by radiological and intraoperative methods with similar results.

Voiglio [40] describes GCT as being short (less than 25 mm) but with a major calibre (3–10 mm); it arises from the inside of the transverse mesocolon root, to the right of the SMV, after leaving the root of the transverse mesocolon, it runs along the anterior aspect of the head of pancreas and along that part of the head located to the right side of the SMV.

According to Ignjatovic [18] GCT terminates in the SMV at a mean distance of 2.2 cm (range 1.6–3.2 cm) from the inferior border of the pancreas. The mean caliber of the GCT was 5.2 mm (range, 4.8–5.8 mm) and its mean length was 16.1 mm (range 10.1–20.7 mm). Other studies confirm GCT enters the SMV at the level of the uncinate process of the head of the pancreas [29]. For the components of this vascular junction, Gillot [11] described a "right area of confluence", limited cranially by the isthmus of the pancreas, 2 cm long and 1.5 cm wide, situated close to the right border and to the anterior aspect of the SMV.

We believe that GCT has a clinical relevance for two reasons. The first consists in the possible perioperative bleeding by lesion of some of its components, in particular, ASPDV, RCV and SRCV, or of itself, during the separation of the mesocolon from the pancreas "bleeding point"), in case of incongruous traction.

Unlike the left colon, arterial vascular anatomy is quite variable on the right too. While the ileocolic artery (ICA) is always present showing variations in the position (anterior or posterior) in relation to ICV, right colic artery (RCA) is present in 10–40% of cases. The right branch of the middle colonic artery (MCA) is directed to the hepatic flexure while the left branch is directed to the transverse colon. A postmortem study [17] shows that GCT has close anatomic relations to right colon arteries as well: the most common course of these arteries is caudal and parallel (thus controlling the bleeding at its source, e.g. RCA under the GCT, without damaging SMV); only in 15% of cases they are more complex, with a crossing pattern in 12% of cases. A posterior crossing pattern, which would entail a higher probability of lesion to the GCT, occurs in 2.9% of cases. Since the SRCV is the most common GCT component of the present research and, as shown by the data obtained in Table 2, it leads into the GCT in almost all cases (82.6–100%), it seems reasonable to follow its course to identify GCT itself safely. Otherwise, a top down surgical approach was proposed in robotic extended right hemicolectomy to identify the GCT early and limit vascular injury [13]. This technique first identifies RGEV as a landmark to reach the GCT and its colic component.

The second reason why the anatomical knowledge of GCT is considered of primary importance is because its location makes it an anatomical landmark for the surgeon during the phase of lymph node dissection in right colon cancer. The protocol for an adequate lymphadenectomy for Japanese colorectal surgeons includes D3 lymphadenectomy [32] which involves complete dissection of regional lymph nodes, including pericolic nodes (N1 region, stations 201, 211, and 221), intermediate nodes (N2 region, stations 202, 212, and 222), and main nodes along superior mesenteric vessels (N3 region, stations 203, 213, and 223) as defined by the Japanese Society for Cancer of the Colon and Rectum (JSCCR) [19]. To perform a correct D3 lymphadenectomy, advanced laparoscopic skills are required as well as good anatomical knowledge of this dissection area to identify and

Table 2 Anatomical description of right-sided colonic veins

Authors/vein	No./tot (%)	Flowing into the GCT No. veins/tot (%)	Flowing into the SMV No. veins/tot (%)
MCV			
Yamaguchi et al. [44]	Single 22/58 (38) Two MCVs 29/58 (50) Three MCVs 7/58 (12.1)	Main MCV 7/58 (12.1) Accessory MCVs 23/43 (53.5)	Main MCV 49/58 (84.5) Accessory MCVs 17/43 (39.5)
Jin et al. [21]	9/9 (100)	1/9 (11.1)	8/9 (88.9)
Sakaguchi et al. [35]	Single MCV 86/102 (84.4) Two MCVs 9/102 (8.8) Three MCVs 1/102 (0.9)	21/107[a] (19.6)	86/107[a] (80.4)
Ogino et al. [31]	Single MCV 40/81 (49.4) Two MCVs 37/81 (45.7) Three MCVs 4/81 (4.9)	16/81 (20) 24/74 (32.4)[b]	55/81 (68) 37/74 (50)[b]
Miyazawa et al. [28]	Single MCV 97/100 (97)	13/97 (13.4)	84/97 (86.6)
Alsabilah et al. [2]	Single MCV 70/70 (100) aMCV^{+} 11/70 (15.7)	4/70 (5.7) 5/11 (45.5)	66/70 (94.3%) 6/11 (54.5)
Kuzu et al. [22]	Single MCV 80/111 (72.1) Two MCVs 29/111 (26.1) Three MCVs 2/111 (1.8)	4/80 (5) 4/58 (6.9) 2/6 (33.3)	69/80 (86.3) 50/58 (86.2) 3/6 (50)
Açar et al. [1]	Single MCV 10/12 (83.3)	2/10 (20)	7/10 (70)
Lee et al. [24]	Single MCV 86/116 (74.1) Two MCVs 26/116 (22.4) Three MCVs 4/116 (3.5)	Main MCV 4/116 (3.4) Accessory MCVs 2/34 (5.9)[c]	Main MCV 108/116 (93.1) Accessory MCVs 26/34 (76.4)[c]
ICV			
Yamaguchi et al. [44]	58/58 (100)	0/58 (0)	58/58 (100)
Ogino et al. [31]	81/81 (100)	2/81 (2)	79/81 (98)
Alsabilah et al. [2]	70/70 (100)	–	70/70 (100)
Kuzu et al. [22]	111/111 (100)	7/111 (6.3)	103/111 (92.8)
Lee et al. [24]	116/116 (100)	0/116 (0)	116/116 (100)
RCV			
Yamaguchi et al. [44]	25/58 (43)	11/25 (44)	14/25 (56)
Jin et al. [21]	6/9 (66.7)	4/6 (66.7)	–
Sakaguchi et al. [35]	51/102 (50)	25/51 (49)	26/51 (51)
Ogino et al. [31]	Single RCV 71/81 (87.6) Two RCV 5/81 (6.2)	Main RCV 68/76[d] (84) 6/10[e] (60)	Main RCV 8/76[d] (10) 4/10[e] (40)
Miyazawa et al. [28]	56/100 (56)	8/56 (14.3)	48/56 (85.7)
Alsabilah et al. [2]	30/70 (43)	17/30 (56.7)	13/30 (43.3)
Kuzu et al. [22]	Single RCV 98/111 (88) Two RCVs 1/111 (0.9)	71/98 (72)	27/98 (28) 2/2 (100)
Açar et al. [1]	9/12 (75)	1/9 (11.1)	3/9 (33.3)
Lee et al. [24]	22/116 (19)	0/22 (0)	22/22 (100)
SRCV			
Jin et al. [21]	8/9 (89)	8/8 (100)	–
Sakaguchi et al. [35]	92/102 (90.2)	76/92 (82.6)	16/92 (17.4)
Ogino et al. [31]	17/81 (21)	17/17 (100)	–
Miyazawa et al. [28]	93/100 (93)	93/93 (100)	–
Kuzu et al. [22]	32/111 (28.8)	30/32 (94)	2/32 (6)

[a]Tot. 107 MCVs: 86 + (9 × 2) + (1 × 3); [b]the vein drained into the SMV and GCT in 2patients, SMV and IMV in 1 patient, SMV and jejunal vein in 1 patient; [c]two or more MCVs; [d]76 → 71 (single) + 5 (the main between the two veins); [e]10 → 5 × 2 RCVs. Here it is described the specific pattern of drainage of the patients presenting two RCVs

GCT gastrocolic trunk, *SMV* superior mesenteric vein, *MCV—MCVs* middle colic vein—middle colic veins, *aMCV* accessory middle colic veins, *RCV—RCVs* right colic vein—right colic veins, *ICV* inferior colic vein, *SRCV* superior right colic vein

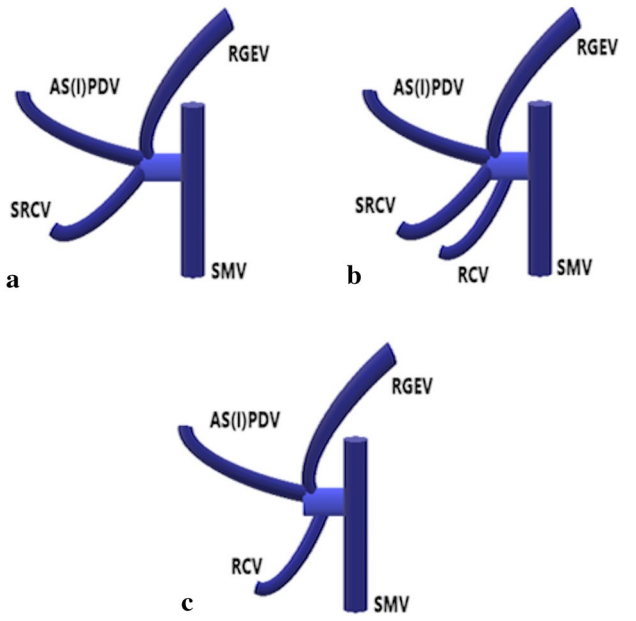

Fig. 1 Variations of the GCT: **a.** RGEV + AS(I)PDV + SRCV is the most frequent configuration in anatomical studies on cadavers (32.5%) and in radiological studies (42.5%); **b.** RGEV + AS(I)PDV + RCV + SRCV configuration is less frequent in both anatomical studies on cadaver (10%) and radiological studies (20.1%); **c.** in RGEV + AS(I)PDV + RCV configuration, RCV represents the colonic branch in 26.9% of the anatomical studies on cadavers and 12.3% of radiological studies. *RGEV* right gastroepiploic vein, *A(I)SPDV* anterior (inferior) superior pancreaticoduodenal vein, *SRCV* superior right colic vein, *SMV* superior mesenteric vein

divide the SRCV safely reducing the risk of bleeding [10]. Line running 5 mm proximal to the line connecting the origins of the GCT and the Middle Colic Artery (MCA) defines the cranial border of the D3 area [37]. Accord to Gillot's concept, instead, lymph flow is present along the "surgical trunk", that is the region of confluence of the ventrolateral SMV between ICV caudally and GCT cranially, marking therefore, the upper limit of the "surgical trunk" [12] and being used to guide the superior limit of dissection.

The major lymphatic drainage follows the colic vessels to the root of the Superior Mesenteric Artery (SMA) [27] but nodal metastases from the hepatic flexure and transverse colon cancer are sometimes found along the GCT. An anatomical postmortem study showed the presence of lymph nodes close to the GCT in 58% of cases [37]. Furthermore, direct infiltration of the greater omentum and/or presence of small vessels between greater omentum and transverse mesocolon which could serve as tracks for tumor spread to lymph nodes within the greater omentum and along the gastroepiploic vessels justify omentectomy including corresponding gastrocolic ligament and the feeding gastroepiploic vessels. In the same way, the connections between the lymphatic drainage of the pancreas and the middle colonic vessels are known [15]. Therefore, according to Perrakis et al. [33] a potential "third dimension" of lymphatic spread has to be considered in transverse colon cancer and included into radical lymph node dissection: the infrapancreatic lymph node region (ILR) and the gastroepiploic arcade

Table 3 Colonic components of GCT and their frequency in selected studies

	Cadaver studies Açar et al. [1], Ignjatovic et al. [17], Jin et al. [21], Kuzu et al. [22], Yamaguchi et al. [44], Zhang et al. [45]		CT studies Miyazawa et al. [28], Ogino et al. [31], Sakaguchi et al. [35]	
	n/TOT	%	*n*/TOT	%
RGEV + AS(I)PDV + SRCV	69/212	32.5	113/243	46.5
RGEV + SRCV	13/212	6.1	–	–
RGEV + AS(I)PDV + RCV	57/212	26.9	30/243	12.3
RGEV + AS(I)PDV + MCV	32/212	15.1	3/243	1.2
RGEV + AS(I)PDV + SRCV + RCV	20/212	10	49/243	20.1
RGEV + AS(I)PDV + SRCV + RCV + MCV	3/212	1.4	14/243	5.7
RGEV + AS(I)PDV + SRCV + MCV	2/212	0.9	10/243	4.1
RGEV + AS(I)PDV + RCV + MCV	4/212	1.8	22/243	9
RGEV + AS(I)PDV + **ICV**	2/212	0.9	–	–
RGEV + AS(I)PDV + RCV + ICV	3/212	1.4	–	–
RGEV + AS(I)PDV + RCV + SRCV + ICV	2/212	0.9	–	–
RGEV + AS(I)PDV + SRCV + antral branch	5/212	2.3	–	–
RGEV + AS(I)PDV + SRCV + retropyloric v.	1/212	0.4	–	–
RGEV + AS(I)PDV + ICV + RCV + MCV	–	–	2/243	0.8
GCT	212/286	74	243/283	86

GCT gastrocolic trunk, *RGEV* right gastroepiploic vein, *A(I)SPDV* anterior (inferior)superior pancreaticoduodenal vein, *SRCV* superior right colic vein, *aSRCV* accessory superior right colic vein, *RCV* right colic vein, *MCV* middle colic vein, *ICV* inferior colic vein

(GLR) represent these extramesocolic stations. The gastrocolic ligament (GCL), which connects the transverse colon to the stomach and the pancreatic head, consists of three parts: the gastroepiploic part (No. 204); the infrapyloric part (No. 206); and the superficial pancreatic head part (No. 14v) [5]. This study demonstrated the presence of an agreement between clinical and anatomical findings about lymph node metastasis in right-sided colon tumors. Indeed six studies [3, 5, 7, 8, 33, 39] found metastasis in infrapyloric and gastroepiploic lymph nodes. In all of them, the primary tumor was localized in the hepatic flexure, whose venous drainage is dependent on SRCV, that is the venous component that most frequently (as shown in Table 3) constitutes the GCT.

The GCT is located in an area where the fusion between the mesoduodenum with the transverse mesocolon and the greater omentum leads to the formation of a membrane of connective tissue (the fusion fascia [20]) whose dissection enables the submesocolic anterior face of the head of the pancreas to be exposed [34]. A good knowledge of the "complex anatomy of the vulnerable venous tributaries of the SMV" could prevent accidental vascular lesions and help to perform an optimal lymph node dissection, considering the tumor locations in the right flexure and the independent risk factors for loco-regional recurrence [36].

This study has some limitations, above all in relation to the different methods used for anatomical evaluation. Regarding cadaver studies some have used an injection–corrosion method, some others dissection. The scan technique instead is influenced by the phase of i.v. contrast medium in the vessels, by the scan type (helical or conventional CT) and by the scan collimation. Moreover, although ASPDV is not found in some radiological studies because of the limited length of this vein [22, 29, 35], the frequency of CT visualization of GCT (86%) is comparable to that obtained in other cases (90% [29], 89% [4], 81% [25]). The intraoperative method involves a limited operative field of view, lack of tactile sensory input and difficulties in identifying the course of some tributaries compared with postmortem anatomic studies [14].

Conclusions

SRCV joins the RGEV and the ASPDV forming the GCT in most cases; RCV can be added to or replace the SRCV in a fair proportion of cases. The anatomical variability of tributaries is remarkable. As GTH is not readily accessible, it is possible to advocate a more frequent use of SRCV, with respect to RCV, as an anatomical landmark leading to GCT during right colectomy as previously concluded by Ignjatovic [17]. Useful information obtained by preoperative 3D computed tomography for right colon [31] and pancreatic surgery [28] of GCT with its venous components should be interpreted according to the knowledge of the possible variants as well as of the most frequent configurations. Computer-assisted surgery (CAS) system, used to reconstruct preoperatively pathological lesions, was able to identify the Henle trunk in 85% of cases describing the variants [9]. It remains to be assessed whether, intraoperatively, the use of 3D visualization during laparoscopic surgery be beneficial in this regard.

Author contributions RP: project development, data management, data analysis, manuscript writing/editing. GL, VS and LB: project development. GP: project development, manuscript writing. MS: Project development, data management, data analysis.

Compliance with ethical standards

Conflict of interest The authors declare they have no conflict of interest.

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