Cynthia K. Shortell, MD, SECTION EDITOR

Duplication and transposition of inferior vena cava: A meta-analysis of prevalence

Sorin Hostiuc, PhD,[a] Costin Minoiu, PhD,[b] Ionut Negoi, PhD,[c] Mugurel Constantin Rusu, Dr Habil,[d] *and* Mihaela Hostiuc, PhD,[e] *Bucharest, Romania*

ABSTRACT

Objective: The primary aim of this article was to establish the actual prevalence of transposition and duplication of the inferior vena cava and to increase awareness about them.

Methods: A meta-analysis of prevalence was conducted of cases obtained from PubMed, Web of Science, and Scopus databases.

Results: A total of 48 studies contained data that allowed us to estimate the prevalence of these variants (39 for duplication and 32 for transposition). The overall prevalence of duplication was 0.7%, with a 95% confidence interval between 0.5% and 0.9%; for transposition, the prevalence was 0.3%, with a 95% confidence interval between 0.2% and 0.5%. The publication bias was minimal. Duplication prevalence was significantly higher in anatomy studies compared with imaging and surgery studies; for transposition, there were no statistically significant differences by detection technique.

Conclusions: The overall prevalence of duplication of the inferior vena cava is 0.7%; for transposition, it is 0.3%. Even if they are obviously rare conditions, their presence must be suspected by practitioners as they can have important clinical consequences, may require changes in the surgery protocol, or can be associated with other congenital abnormalities. (J Vasc Surg: Venous and Lym Dis 2019;7:742-55.)

Keywords: Prevalence of inferior vena cava abnormalities; Duplication of inferior vena cava; Transposition of inferior vena cava

The development of the inferior caval system and its large tributaries is a multilayered process involving three main stages characterized by the progress and subsequent selective regression of venous structures[1,2]; sometimes, not everything goes "as planned," and various congenital anomalies develop, some of them potentially having clinical consequences, even though they are usually asymptomatic and often diagnosed during routine imaging studies (often for donor nephrectomies).[3] Table I describes two classification systems of these abnormalities. Two more frequent congenital anomalies in the inferior caval system are duplication and transposition of the inferior vena cava (IVC). Their actual prevalences have not been firmly established because of their rarity, making prevalence studies extremely difficult. Moreover, the reported prevalence for both conditions varies widely between different studies. For example, for duplication, the reported prevalence is between <0.1%[6] and 3.5%[7]; for transposition, the reported range is between <0.1%[6] and 5.6%.[8] The primary aim of this article was to establish the actual prevalence of these anatomic variants and to increase awareness about them.

METHODS

We performed the study according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for reporting systematic reviews and meta-analyses of observational studies in epidemiology.

Selection criteria. Inclusion criteria: studies that contained data from which we were able to estimate the prevalence of duplication and/or transposition in various population groups. We used as exclusion criteria the absence of relevant information to reconstruct the data needed for analysis, studies with fewer than 20 patients, and case series or case reports without a specification of the study population from which the cases were drawn and without a specific detection algorithm. For articles not found in online databases but for which we have numerical data in secondary sources, we used the secondary source-based information, and we specified both the primary and the secondary source in Table II.

Search method. We analyzed the results obtained from three databases—Web of Science, Scopus, and PubMed—by using the keywords "cava duplication" and

From the Department of Legal Medicine and Bioethics,[a] and Department of Anatomy,[d] Faculty of Dental Medicine, and Department of Surgery,[c] and Department of Internal Medicine and Gastroenterology,[e] Faculty of Medicine, Carol Davila University of Medicine and Pharmacy; and the Department of Radiology, Floreasca Clinical Emergency Hospital.[b]

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Correspondence: Sorin Hostiuc, PhD, Carol Davila University of Medicine and Pharmacy, Faculty of Dental Medicine, Department of Legal Medicine and Bioethics, Sos Vitan Barzesti 9, 042122 Sector 4, Bucharest, Romania (e-mail: soraer@gmail.com; sorin.hostiuc@umfcd.ro).

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Table I. Classification systems of the inferior vena cava (*IVC*)

Author	Details
Edwards[4]	A. Major anomalies of the IVC
	I. Left cava with situs inversus
	II. Major anomalies of the vena cava proper
	a. In the suprarenal segment
	1. Azygos continuation (with right, left, or double infrarenal cava)
	2. Reception of the portal vein
	3. Reception of a right pulmonary vein
	b. In the infrarenal segment
	1. Double infrarenal (postureteric) cava
	2. Left infrarenal (postureteric) cava
	3. Lateral, preureteric cava
	4. Medial preureteric cava
	5. Coexistent preureteric cava and postureteric cava
	6. Reception of a portal tributary
	B. Lesser variations of the cava and its tributaries
	I. Attenuated or abridged representations of anomalous cavae
	a. Partial azygos continuation
	b. Infrarenal caval rudiments
	1. Abridged left or right cava
	2. Intercaval anastomoses and caval diverticula
	3. Lateral preureteric veins
	4. Medial preureteric and para-aortic veins
	II. Iliac veins
	a. Preaortic iliac confluence
	b. Reduplication
	c. Contralateral course
	III. Renal veins
	a. Anomalies of kidney and renal veins
	1. Associated with ectopia
	2. Persistent renal collar
	3. Left retroaortic renal vein
	4. Associated with horseshoe kidney
	b. Accessory renal veins
	c. Variations of extrarenal connections
	1. Suprarenal and sex veins
	2. Ureteral and preureteric veins
	3. Lumbar and azygos veins
	4. Perirenal veins
	5. Portal tributaries
	IV. Parietal channels
	a. Lumbar and ascending lumbar veins
	b. Azygos system
	c. Retroaortic veins
	d. Inferior phrenic veins
Kellman[5]	I. SVC
	A. Duplicated SVC
	B. Left SVC
	II. Infrarenal IVC
	A. Retrocaval or circumcaval ureter
	B. Duplicated IVC
	C. Transposition of the IVC
	III. Renal segment of the IVC
	A. Retroaortic left renal vein
	B. Circumaortic left renal vein
	IV. Suprarenal IVC
	A. Interrupted IVC with azygos or hemiazygos continuation

SVC, Superior vena cava.

"cava transposition" with a time frame that ranged from the beginning of each database up to June 2018 (Table III). We preferred not to use additional restrictive criteria (eg, article type) as other assortments (letters, case presentations, reviews) might have added relevant data to the meta-analysis (discussions, finding other appropriate articles). The reference list of each relevant one was scrutinized for other potentially relevant studies to be included in the meta-analysis. The references, abstract, and full text (if available) were imported in the Mendeley Desktop software (Mendeley Inc, New York, NY).

Data collection and analysis. For each study, two reviewers extracted the data separately and included it in Excel datasheets (Microsoft, Redmond, Wash). We summarized the following information: study, name of the authors, year, total number of cases, country, general inclusion and exclusion criteria, number of cases with lower inferior cava vein variations, detection method, risk of bias, and quality score. For articles from which we obtained data from secondary sources, we used only the data that were available, and the risk of bias and quality score were not computed.

Risk of bias. The risk of bias was assessed separately, for each case, by two reviewers. We analyzed selection bias (inclusion and exclusion criteria, type of study), multiple publication bias, measurement bias (method used, with autopsy and high-resolution computed tomography imaging being considered to have lower bias compared with venography), and statistical reporting bias (statistical analysis performed with the data, complete description of the data). Based on these elements, we separated the studies into three subgroups: high risk of bias, moderate risk of bias, and low risk of bias.

Table II. Studies included in the analysis, detailing the author, year, country, inclusion and exclusion criteria, and number of patients in each study

First author, year	Country	Inclusion criteria	Exclusion criteria	Technique	Study group
Zumstein,[9] 1896	Germany	Various		Autopsy	220
Gillaspie,[10] 1916	United States	Various		Autopsy	33
Gladstone,[11] 1929	United Kingdom	Various		Autopsy	876
Seib,[12] 1934	United States	Various		Autopsy	230
Adachi,[13] 1937	Japan	Various		Autopsy	1055
Ellis,[14] 1986	United States	Consecutive patients		CT	241
Mayo,[15] 1983	Canada	Various		CT	1140
Anson,[7] 1947	United States	Various		Autopsy	425
Reis,[16] 1959	United States	Various		Autopsy	500
Beckmann,[17] 1980	United States	Consecutive		Venography	132
Ueda,[18] 1983	Japan	Various		CT	874
Bartle,[19] 1987	United States	Patient referred for aortic reconstruction		Surgery	289
Hoeltl,[20] 1990	Austria	Unselected patients		CT	4520
Hoeltl,[20] 1990	Austria	Patients undergoing major retroperitoneal operations for urologic disorders		Surgery	215
Benedetti-Panici,[21] 1994	Italy	Patients with various oncologic disorders operated on with systematic aortic and pelvic lymphadenectomy		Surgery	309
Hicks,[22] 1995	United States	Prospective; patients referred for IVC filter placement or venacavography	Abnormal serum creatinine concentration, emergent procedure, internal jugular vein access, occlusion of IVC, allergy to intravenously administered contrast material, procedure performed outside the interventional radiology department	Venography or venacavography	108
Kaufman,[23] 1995	United States	Patients with abdominal aortic aneurysm, aortoiliac occlusive disease, and renal artery stenosis		MRI	150
Baptista-Silva,[24] 1997	Brazil	Living donor nephrectomies		Preoperative angiography and surgery	342
Trigaux,[25] 1998	Belgium	Consecutive		CT	1014
Shindo,[26] 2000	Japan	Surgery for aneurysmal disease or arterial occlusive disease		Surgery	166

Table II. Continued.

First author, year	Country	Inclusion criteria	Exclusion criteria	Technique	Study group
Aljabri,[27] 2001	Canada	Various	Technical reasons	CT	1788
Mandal,[28] 2001	United States	Living kidney donors		Surgery	210
Hingorani,[29] 2003	United States	Patients referred for repairs of abdominal aortic aneurysms		Surgery	184
Holden,[30] 2005	New Zealand	Renal donors		CT	100
Klemm,[31] 2005	Germany	Patients undergoing laparoscopic infrarenal para-aortic lymphadenectomy for various oncologic disorders		Surgery	86
Namasivayam,[32] 2006	United States	Kidney donors		CT	48
Holt,[33] 2007	United Kingdom	Patients with testicular germ cell tumors		Surgery	278
Koc,[34] 2007	Turkey	Consecutive adult patients	Poor opacification, previous surgery, large abdominal mass	CT	1120
Raman,[35] 2007	United States	Potential kidney donors		CT	126
Simforoosh,[3] 2007	Iran	Left-sided donor nephrectomy		Surgery (laparoscopic left-sided donor nephrectomy)	750
Castillo,[36] 2008	Chile	Patients referred for laparoscopic retroperitoneal procedure for testicular cancer		Surgery	164
Meister,[37] 2008	United Kingdom	Children, before kidney transplantation		MRI venography	29
Si-Youn,[8] 2008	South Korea	Infants with exomphalos		CT	18
Disick,[38] 2009	United States	Patients referred for laparoscopic donor nephrectomy, with complex vascular abnormalities		Surgery	39
Khamanarong,[39] 2010	Thailand	Embalmed cadavers		Autopsy	939
Apisarnthanarak,[40] 2012	Thailand	Living related kidney donors, consecutive		CT	65
Dilli,[6] 2012	Turkey	Retrospective; patients undergoing lumbar imaging for neurologic disorders		MRI	2644
Dilli,[41] 2013	Turkey	Retrospective; various abdominal problems		CT	1204

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Table II. Continued.

First author, year	Country	Inclusion criteria	Exclusion criteria	Technique	Study group
Tao,[42] 2013	China	Various	Technique related, congenital diseases of the kidney, renal tumors	CT	378
Boyaci,[43] 2014	Turkey	Patients with abdominal problems		CT	746
Zhu,[44] 2015	China	Various		CT	1452
Pandya,[45] 2016	India	Potential kidney donors		CT	200
Dimic,[46] 2017	Serbia	Patient referred for abdominal aortic surgery		Surgery	>5000
Hassan,[47] 2017	Egypt	Various		Autopsy	63
Pal,[48] 2017	India	Patients suffering retroperitoneoscopic donor nephrectomy		Surgery (peritoneoscopic donor nephrectomy)	1460
Sosnik,[49] 2017	Poland	Various		Autopsy	550
Iezzi,[50] 2019	Italy	Retrospective; consecutive cases		CT	900
Alexander,[51] 1982	United States	Retrospective		CT	1200

CT, Computed tomography; *IVC*, inferior vena cava; *MRI*, magnetic resonance imaging; *RAA*, renal artery aneurysm.

Quality assessment. Quality assessment was performed using the Quality in Prognostic Studies tool, from which we removed study attrition (which was considered not relevant for a prevalence study). For each remaining subscale (study participation, prognostic factor measurement, outcome measurement, study confounding, statistical analysis, and reporting), we graded each study as low quality (0 points), intermediate quality (1 point), or high quality (2 points).

Statistical analysis. We determined the effect size using a random-effects model computed in Comprehensive Meta-Analysis version 2 (Biostat, Englewood Cliffs, NJ). For each group and subgroup, we performed a forest plot. For the analysis of publication bias, we used the funnel plot and Duval and Tweedie's Trim and Fill. Prevalence was obtained by multiplying the prevalence estimate from the meta-analysis with 100.

RESULTS

Search synthesis. During the initial database research, we obtained 3619 articles (Table III); after deletion of duplicates and irrelevant studies, we selected 55 to be further scrutinized. By analyzing their references, we found another 12 potentially relevant articles that were also downloaded. From the 67 articles, 48 were included in the final analysis of prevalence, from which 39 contained data about duplication and 31 about transposition. Details of the search synthesis are presented in Fig 1. We detail the papers contained in the meta-analysis in Table II.

Bias and quality. From the 48 included articles, 13 were considered high quality (between 6 and 8 points); 21, medium quality (between 3 and 5 points); and 13, low quality (between 0 and 2 points). For one article, we could not obtain a full electronic text of the manuscript, and therefore the quality score could not be computed. A low bias was assessed in 9 articles, a moderate bias in 22, and a high bias in 16.

Table III. Keyword search in PubMed, Scopus, and Web of Knowledge

Keyword search	PubMed	Scopus	Web of Knowledge	No. of articles
Cava duplication	277	276	143	696
Cava transposition	506	771	213	1490
Left inferior vena cava	420	492	521	1433
Total	1203	1539	877	3619

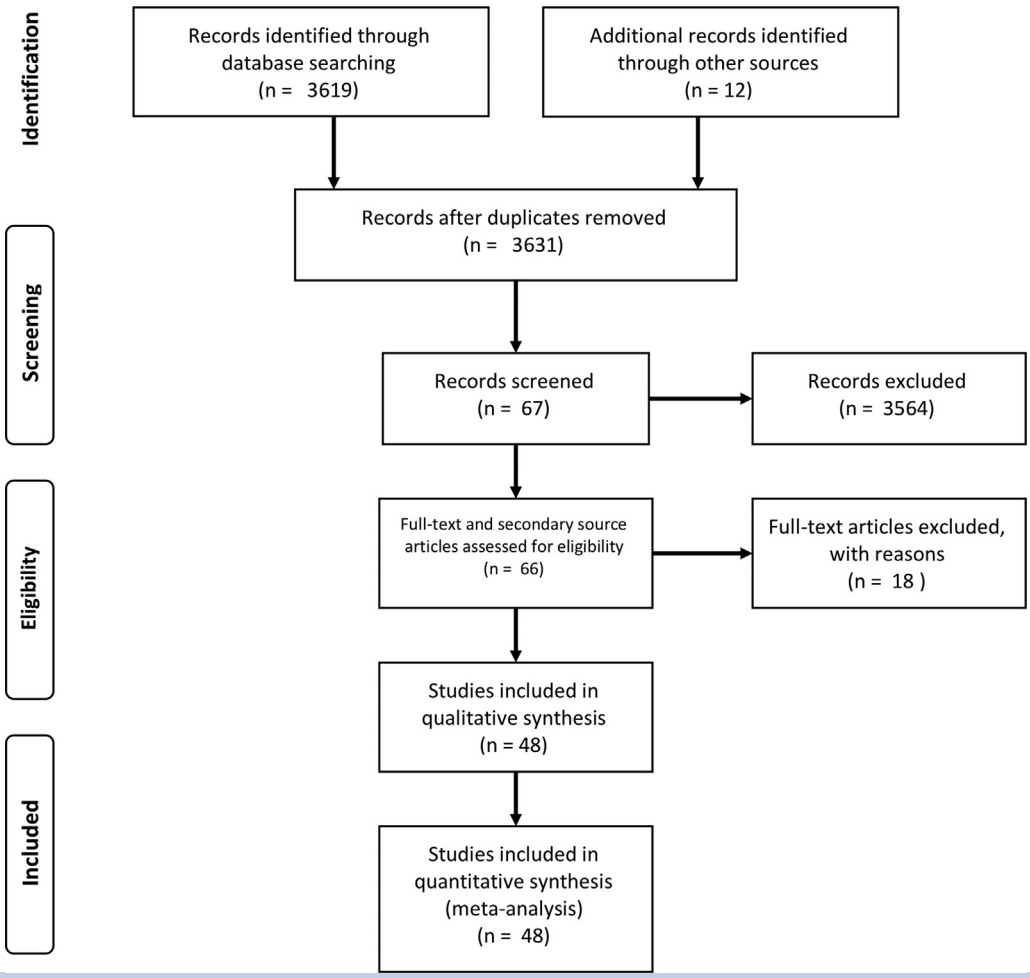

Fig 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses[112] diagram of the research methodology.

Duplication of the IVC. A total of 39 studies contained information that allowed us to estimate the prevalence of duplication. Overall, it was identified in 135 cases of the 31,890 included in the analysis. The prevalence estimate was 0.007 (confidence interval [CI], 0.005-0.009; Fig 2). Autopsy studies revealed the highest prevalence of duplication (0.017; CI, 0.011-0.027); surgery studies, the lowest (0.003; CI, 0.001-0.009); and imaging studies, an intermediary prevalence (0.005; CI, 0.003-0.007). Total heterogeneity between subgroups had a Q value of 21.859, highly statistically significant ($P < .001$). The publication bias was minimal (no studies were trimmed using Duval and Tweedie's method). The corresponding funnel plot is displayed in Fig 3.

Transposition of the IVC. A total of 32 studies contained information that allowed us to estimate the prevalence of transposition. Overall, it was identified in 65 cases of the 29,801 included in the analysis. The overall prevalence estimate was 0.003 (CI, 0.002-0.005; Fig 4). Surgery studies revealed a higher prevalence of transposition (0.007; CI, 0.002-0.022), with imaging and autopsy studies having similar prevalence values (0.003; CI, 0.002-0.005). Total heterogeneity between subgroups had a Q value of 2.502, not statistically significant ($P = .286$). The publication bias was minimal (no studies were trimmed using Duval and Tweedie's method). The corresponding funnel plot is displayed in Fig 5.

DISCUSSION

This meta-analysis aimed to clarify the prevalence of duplication and transposition of the IVC based on objective criteria and statistical methods, computing values obtained from all relevant original literature in the field. Previously, published reports in the field were mostly nonsystematic reviews, in which the prevalence values were taken from original studies, without statistical analysis. We found in this study that the prevalence of duplication (Fig 6) and transposition, two IVC anatomic variations with major impact in urologic and surgical oncology, were 0.7% and 0.3%, respectively.

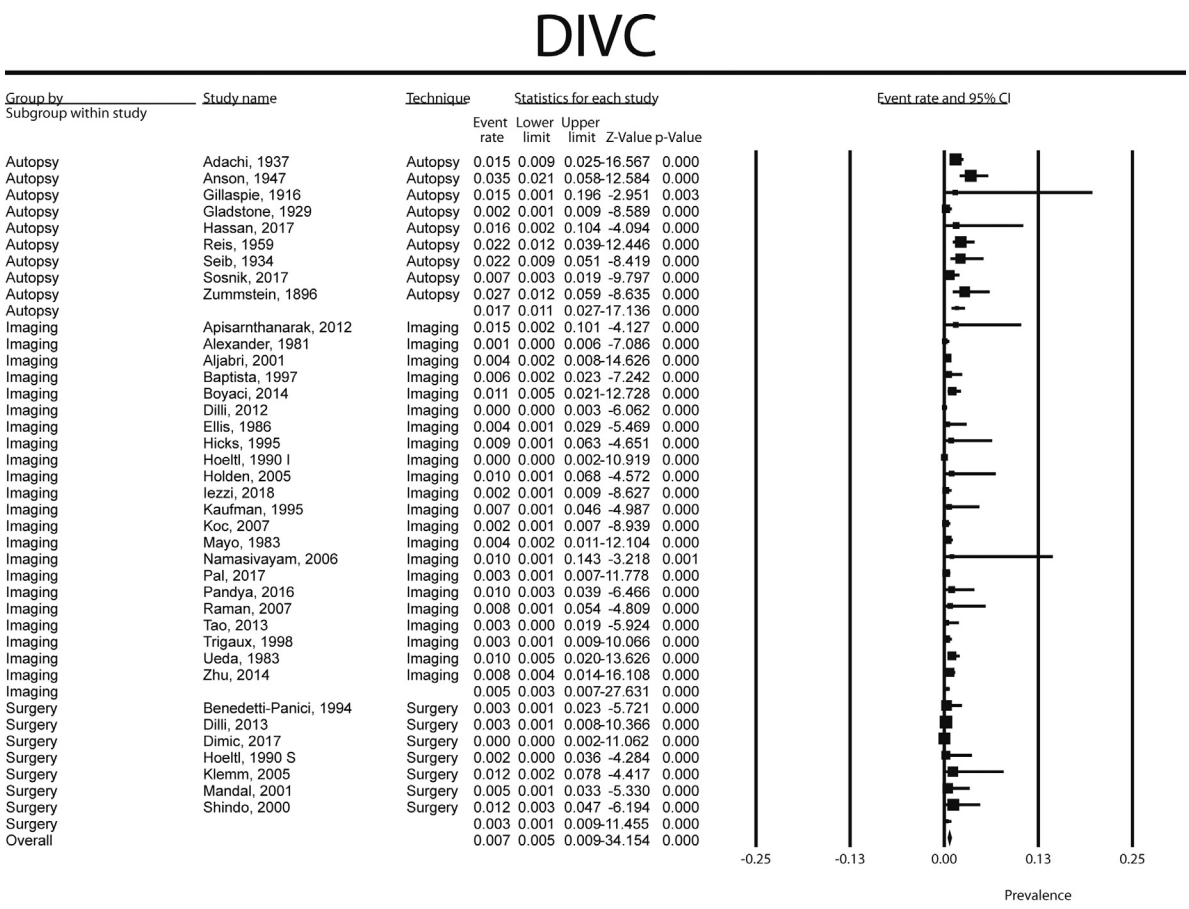

Fig 2. Forrest plot for subgroup analysis (depending on the technique) of studies on duplication of the inferior vena cava (*DIVC*). *CI,* Confidence interval.

Venous drainage of the fetus, which begins to form in the sixth intrauterine week, is initially represented by two posterior cardinal veins that drain the lower part of the body and are continued by the common cardinal veins. Gradually, from the seventh intrauterine week, the subcardinal veins, located medial to the posterior cardinal veins, begin their development and take over drainage of the lower part of the body, an event soon followed by regression of the posterior cardinal veins. During this time, numerous anastomoses are being developed between the subcardinal veins and between the subcardinal and postcardinal veins on each side. Afterward, the supracardinal veins appear, whose development is associated with regression of the subcardinal veins and formation of anastomoses between supracardinal and postcardinal veins on each side, with the right subcardinal vein becoming dominant.[1,2] The lower parts of the posterior cardinal veins become the common iliac veins. The hepatic segment of the IVC is formed through unification of the hepatic sinusoids, fused with the cranial end of the right subcardinal vein. The upper part of the left subcardinal vein leads to the formation of the left adrenal vein, and the upper end of the right supracardinal vein forms the azygos vein. The middle part of the right subcardinal vein becomes the infrarenal segment of the vena cava. Renal veins are formed from anastomoses between supracardinal and subcardinal veins. Two renal veins are initially formed on each side (dorsal and ventral), with the dorsal vein usually degenerating, leaving only the ventral renal vein. The lower parts of the subcardinal veins form the gonadal vessels. Depending on which final segment of the vena cava is abnormal, there are a few major vena caval abnormalities, which are summarized in Table I.

Duplication is caused by persistence of both the left and right supracardinal veins and morphologically consists of two caval segments, usually below the level of the renal veins. The overall prevalence of duplication, as reported by our study, is around 0.7%; anatomic studies reveal a significantly higher value than imaging and surgery.

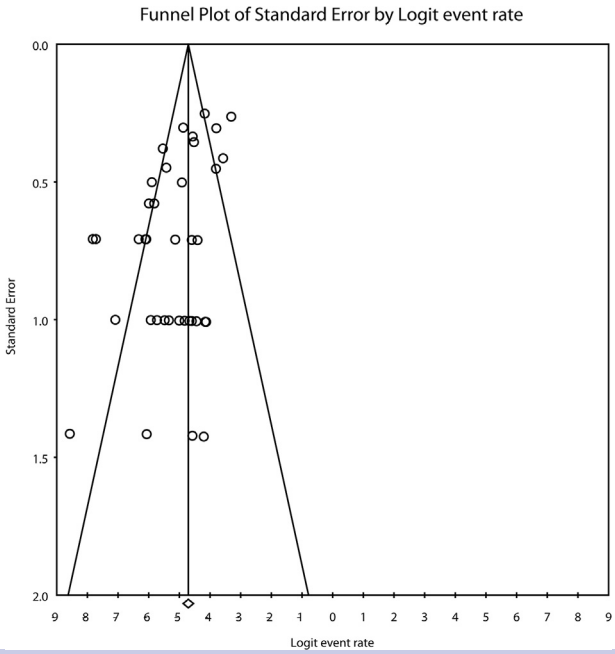

Fig 3. Funnel plot of duplication of the inferior vena cava (IVC).

When a duplication of the IVC occurs, the left IVC is usually terminated in the left renal vein, which crosses the aorta and ends in the right IVC.[52] However, different variants and variations have been reported. Ito and Ikeda[53] described a complex variation of the IVC involving duplicated IVC, the presence of an interiliac vein connecting the two branches at the level of the aortic bifurcation, two right ovarian veins (one terminating in the right IVC and one in the right renal vein), and two right internal iliac veins interconnected through small branches and ending in the right external iliac vein. Duplication can be classified as type I (major duplication), in which two symmetric trunks are identifiable, with the preaortic trunk being of the same caliber; type II (minor duplication), again with two symmetric trunks, but which are smaller compared with the preaortic trunk; and type III (asymmetric duplication), with a smaller left IVC, a larger right IVC, and an even larger preaortic trunk.[54] Another variant is represented by the right duplication, in which both trunks are located on the right side and are named ventral right and dorsal right IVC[55,56]; in this variant, the ventral trunk is derived from the right subcardinal vein and the dorsal trunk from the right supracardinal vein.[57] Paik[58] described a case of triple IVC, with two right trunks and a left trunk. Another classification separated duplication into complete, in which the left IVC receives the left renal vein and continues as a preaortic trunk that travels obliquely and empties in the right IVC, and incomplete, in which the left common iliac vein ascends as a duplicated IVC and drains in the left renal vein, which later joins the right IVC.[59]

Transposition is caused by persistence of the left supracardinal vein, associated with regression of the right supracardinal vein. The IVC is therefore located on the left side below the renal veins and on the right (normal) side, cranial from them, crosses the aorta anteriorly. In this variant, the left gonadal and adrenal veins drain directly into the IVC, and the right gonadal and adrenal veins drain into the right renal vein. Our study showed an overall prevalence of 0.3%, less than half compared with duplication; unlike duplication, there are no statistically different results by the detection technique used. The most likely reason for this is represented by the fact that once an investigator fails to identify a lower IVC in its place, it is searched for in other locations; however, if an IVC trunk is found in its place, sometimes the other trunk, in the case of duplication, is overlooked by both surgeons and radiologists.

Both duplication and transposition have been associated with various other congenital abnormalities and were shown to have various clinical and treatment-related consequences. Because of their rarity, however, most of them have been detailed in case reports or case series. See Table IV for details.

Limitations. Many included studies were not designed specifically for the detection of caval abnormalities; many were retrospective and included patients who were referred for abdominal or pelvic symptoms and disorders. Some studies showed much higher[60,111] or much lower prevalence compared with our results; this is normal in any meta-analysis of prevalence, and the mean value obtained by us could be seen as a middle ground between false positives and false negatives. Taking into account that false positives are less likely as the vessels are large, the actual prevalence is most likely a little higher than our results. This actual increase is, however, impossible to detect through current meta-analytical methods employable is studies of prevalence.

CONCLUSIONS

Duplication and transposition are rare congenital abnormalities of the IVC (with an estimated prevalence of 0.7% and 0.3%, respectively). Even if they are rare, they may lead to significant clinical consequences or may need alterations of surgery protocols. Knowledge of them is therefore paramount, not only for surgeons but also for clinicians and radiologists. Anatomic studies are more sensitive for detecting duplication; for transposition, the detection rate is similar irrespective of the employed method of identification.

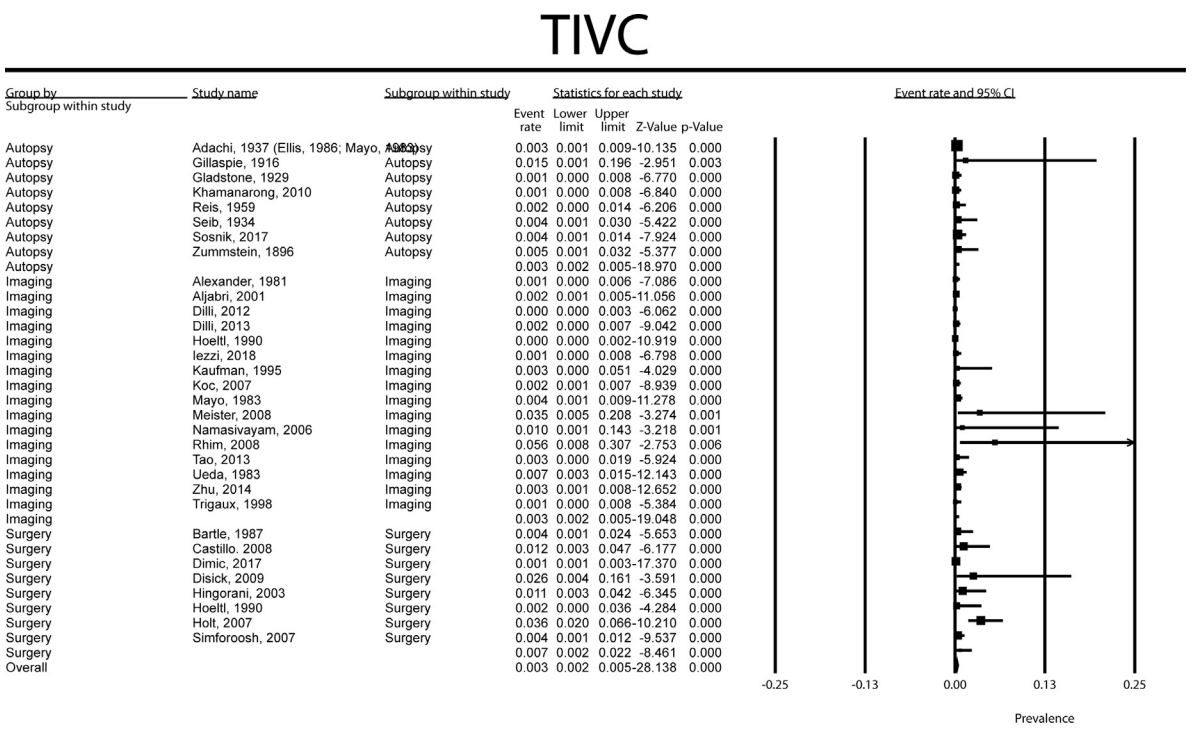

Fig 4. Forrest plot for subgroup analysis (depending on the technique) of studies on transposition of the inferior vena cava (*TIVC*). *CI,* Confidence interval.

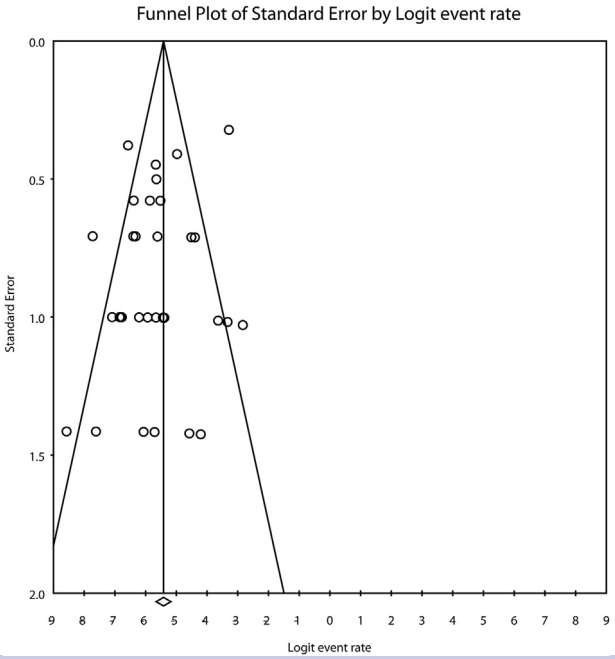

Fig 5. Funnel plot of transposition of the inferior vena cava (IVC).

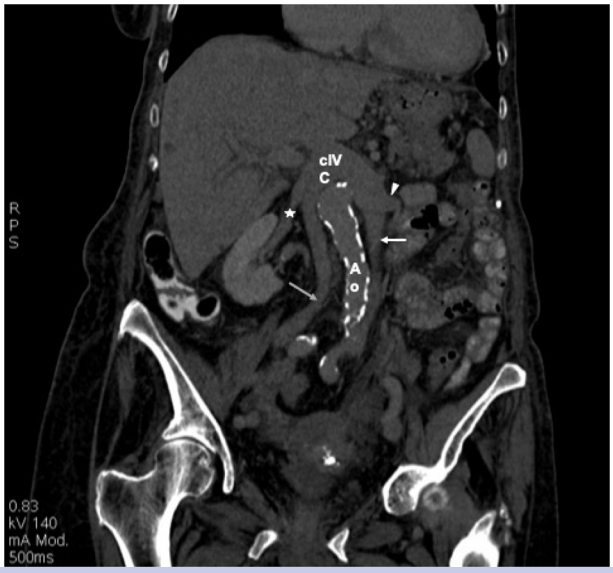

Fig 6. Late-phase postcontrast-enhanced abdominal computed tomography image in a coronal oblique plane showing infrarenal inferior vena cava (IVC) duplication (*gray arrow* on the right side and *white arrow* on the left side). The IVCs join just below the hepatic segment into a common IVC (*cIVC*). The left renal vein (*arrowhead*) drains into the left IVC; the right renal vein (*star*) drains directly into the common IVC. *Ao,* Abdominal aorta.

Table IV. Congenital abnormalities and clinical and surgery-related consequences of duplication or transposition of the inferior vena cava (*IVC*)

	Duplication of IVC	Transposition of IVC
Congenital abnormalities	• Retrocaval ureter associated with congenital absence of the iliac anastomosis[60]	• Right-sided aortic arch[61]
	• Association with various congenital heart conditions (ostium primum, ostium secundum, abnormal left atrium drainage)[62]	• Horseshoe kidney[63,64]
	• Transcaval ureter (the right ureter passes through a venous ring formed by the duplicated vena cava)[65-67]	• Unilateral renal agenesis[68]
	• Crossed renal ectopia and an abdominal aortic aneurysm[69]	• Colonic duplication[70]
	• Retroaortic left renal vein and abdominal aortic aneurysm[71]	• Bicuspid aortic valve, associated with left-sided superior vena cava draining into the coronary sinus[72]
	• Double adrenal vein[73]	• Retroaortic right renal vein and hemiazygos continuation[74]
	• Right retrocaval ureter[59]	• Left heterotaxy[75]
	• Azygos continuation, retroaortic left renal vein, and iliac vein variation[76]	• Polysplenia syndrome[77,78]
	• Interiliac vein[79]	• Left-sided gallbladder and right-sided ligamentum teres[8]
	• Renal aplasia[80]	• Beckwith-Wiedemann syndrome[81]
	• Colonic duplication[70]	• Atrial septal defect[82]
	• Bilateral retrocaval ureters[83]	
	• Renal ectopia[69]	
	• Left retrocaval ureter[84]	
	• Horseshoe kidney[85]	
	• Intrahepatic interruption, hemiazygos vein continuation, and intrahepatic venous shunt[86]	
	• Uterus didelphys, obstructed unilateral vagina, ipsilateral renal agenesis, high-riding aortic bifurcation, and intestinal malrotation[87]	
Clinical and surgery-related consequences	• May be injured during surgery[51]	• Injury during surgery[51]
	• The left portion could be mistaken for a mass or adenopathy[51]	• Changes needed of the standard surgery protocol for portal decompression, renal transplantation, aneurysm resection, pulmonary emboli[51]; in abdominal aorta surgery, it may cause difficulties in trying to dissect the aorta to mobilize it for distal and proximal control[88]
	• Changes needed of the standard surgery protocol for portal decompression, renal transplantation, aneurysm resection,[69,89,90] pulmonary emboli,[51] renal cell carcinoma,[91] hypernephroma,[92] retroperitoneal paraganglioma,[93] adrenalectomy[73]	• Difficult differential diagnosis with a left para-aortic adenopathy[94,95]
	• Can mimic neoplastic renal vein involvement[96]	• Spontaneous rupture of an aortic aneurysm into the left-sided IVC[97]
	• Because of its size and location, can be mistaken for a gonadal vein[7]	• The presence of a left-sided IVC seems to be associated with testicular germ tumors, its rate in these patients being 21 times greater than in the general population. This can be associated with ipsilateral renal agenesis, which is 11 times more frequent in patients with testicular germ tumors compared with the normal population. These two congenital disorders may be linked, as a lack of ascent of the kidney may cause nonregression of the left supracardinal vein, therefore remaining patent and causing IVC transposition.[33]

(Continued on next page)

Table IV. Continued.

	Duplication of IVC	Transposition of IVC
	• Should be suspected in cases of recurrent pulmonary embolism after the placement of an IVC filter[52,69,94,98]	• May lead to nutcracker syndrome through compression of the crossing portion of the IVC by the superior mesenteric artery.[99] This complication can be solved surgically by transposition of the right ovarian vein, therefore bypassing the IVC,[100] or by performing a transposition of the superior mesenteric artery.[101]
	• May cause ureteral obstruction, radiologically mimicking a right retrocaval ureter[102]	• Compression of the transposition in the mesoaortic angle may cause dilation and stasis in the IVC and iliac veins, potentially leading to an anatomic thrombophilia.[103]
	• Difficult differential diagnosis with a left para-aortic adenopathy[94,104]	• May lead to a variant of the May-Thurner syndrome. Normally, this syndrome is caused by compression of the left common iliac vein by the L5 body, favoring the appearance of venous thromboembolism. If the IVC is on the left side, the condition may be caused by compression of the right common iliac vein by the left common iliac artery[105,106]
	• May cause thrombosis. Mukai[107] et al described a case in which thrombosis was induced by left-sided IVC entrapment associated with right-sided common iliac vein compression. The risk is increased in the presence of additional risk factors, such as endothelial trauma, or thrombophilia.[108,109]	• Obara et al[110] described a case of idiopathic renal arteriovenous fistula associated with transposition that required nephrectomy.
	• Presence of an IVC duplication does not have negative effects for donor nephrectomy. Even if the renal vein pedicle is usually short (around 1.5 cm), similar to the length of the right renal vein, the anastomosis is easier for IVC duplication because of the specific posterior position of the renal artery on the left side compared with the usually anterior position on the right.[3]	

AUTHOR CONTRIBUTIONS

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Analysis and interpretation: CM, IN, MR
Data collection: SH, IN, MR, MH
Writing the article: SH
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