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Cadaveric Study of Incidence of Double Inferior Venacava in South India and its Clinical Relevance

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Abstract

Inferior venacava also known as posterior venacava,is the large vein that carries de-oxygenated blood from the lower half of the body into the right atrium of the heart. Double Inferior venacava is a congenital variation resulting from the persistence of the embryonic venous system. The embryogenesis of the inferior venacava [IVC] is a complex process involving the formation of several anastomoses between three paired embryonic veins. The percentage of incidence of dual inferior venacava is about 2.2–3%. The majority of cases are clinically silent and diagnosed in routine dissection studies, in retroperitoneal surgeries, incidentally on imaging for other reasons. Although venous variations are rare, their knowledge is crucial in diagnosis and treatment. *Aims*: The aim of the present study was to analyse the percentage of incidence of double inferior venacava and to identify it's clinical relevance. *Materials and Methods*: Forty formalin fixed cadavers allotted to first year MBBS students for dissection in Rajarajeshwari Medical college and hospital, Bangalore and ESIC Medical college & PGIMSR, Bangalore were studied over a period of 10 years for the double inferior venacava. *Results*: We came across the presence of double inferior venacava in one out of forty specimens, where in Right IVC was formed by right external iliac vein and right internal iliac vein at the level of fifth lumbar vertebra. The right IVC received the right gonadal vein, right renal vein and the right suprarenal vein [Figure 2]. The left IVC was formed by the left internal iliac vein and the left external iliac vein at the level of fifth lumbar vertebra. *Conclusion*: The variations of IVC should be recognized by radiologists and surgeons in order to avoid mistakes during imaging of the area or surgeries and in case of venous thromboembolic disease. These variations should not be mistaken for pathologic findings, but should be viewed as normal findings of abnormal embryogenesis.

Keywords: Inferior Venacava (IVC); Double Inferior Venacava; Venous Variation; Embryonic Venous System; Embryogenesis; Retroperitoneal Surgeries.

Introduction

The variations of the Inferior venacava and it's tributaries have been known to anatomists since 1793, when Abernethy described a congenital mesocaval shunt and azygos continuation of Inferior venacava in a 10 month old infant with polysplenia and dextrocardia [1]. Errors in the embryogenesis of the Inferior venacava can result in several anomalies. Congenital variations of the Inferior venacava originates during 4-8 weeks of embryogenesis of three paired veins, posterior cardinal veins, subcardinal veins and supracardinal veins. Variations of Inferior venacava occur in 3% of population with Double Inferior venacava being the most common.The other variations include Transposition of the Inferior venacava, Circumaortic renal vein, Retroaortic renal vein and absence of the hepatic portion of the Inferior venacava [2].

These variations are often incidental surgical and radiologic findings. Computed tomography , magnetic resonance imaging and ultrasound are all good methods of defining the anatomy, however the venogram best delineates the course of the Inferior venacava.

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However, it is important to recognize these anomalies as they can have significant clinical implications, especially for surgeons and for the treatment of thromboembolic diseases.

Materials and Methods

Forty formalin fixed cadavers allotted to first year MBBS students in Rajarajeshwari Medical college and ESIC Medical college, Bangalore were studied over a period of 10 years for the double inferior venacava.

Results

In one of an adult male cadaver, Right IVC was formed by right external iliac vein and right internal iliac vein at the level of fifth lumbar vertebra. The right IVC received the right gonadal vein, right renal vein and the right suprarenal vein (Figure 2).

The left IVC was formed by the left internal iliac vein and the left external iliac vein at the level of fifth lumbar vertebra. The persistence of left IVC is due do failure of regression of left posterior cardinal vein. The left IVC ran upwards and at the level of kidneys joined the right IVC. The left IVC received the left gonadal vein, left renal vein and the left suprarenal vein (Figure 2).

The oblique vein of communication was present between left internal iliac vein and right IVC at the level of fifth lumbar vertebra. This oblique vein of communication crossed from right to left side anterior to body of fifth lumbar vertebra (Figure 3) which belongs to Type 2b [13] (Figure 1).

Table 1: Study of Incidence of Double inferior venacava done by various authors

Author	Year	Type of study	Incidence
Palit S	2002	Cadaveric	1
Gayer G, Luboshitz J	2003	Radiologic	1 out of 9
Anupam K Kakaria	2007	Radiologic	1
Cannon Milani	2008	Venogram	1
S Morita	2009	Radiologic	28 out of 36
Ng WT, NgSS	2009	Radiologic	3
Mayuri Shah	2011-12	Cadaveric	2 out of 20
Present study	2017	Cadaveric	1 out of 40

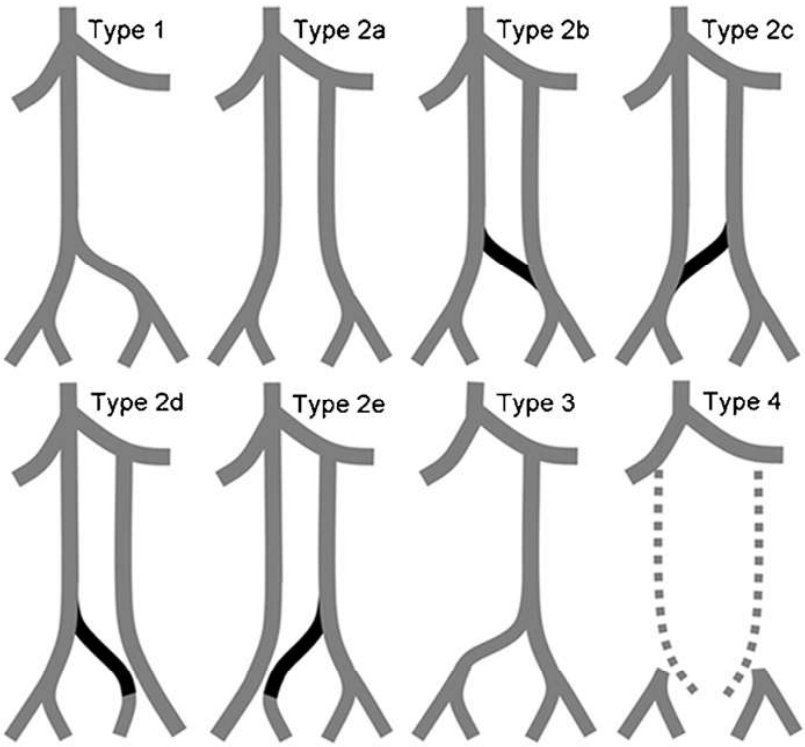

Fig. 1: Schematic drawings of the following pelvic venous variations of IVC anomalies: type 1, normal iliac connection (including azygous continuation); type 2a, double IVC with no interiliac communication; type 2b, double IVC with interiliac communication form the left CIV; type 2c, double IVC with interiliac communication from the right CIV; type 2d, double IVC with interiliac communication from the left IIV; type 2e, double IVC with interiliac communication from the right IIV; type 3, left IVC with symmetrical-to-normal iliac connection; and type 4, no iliac connection in the case of absence of the infrarenal IVC, with dilated bilateral gonadal veins (dotted lines). Interiliac communicating veins are in black. IVC: inferior vena cava; CIV: common iliac vein; IIV: internal iliac vein [13].

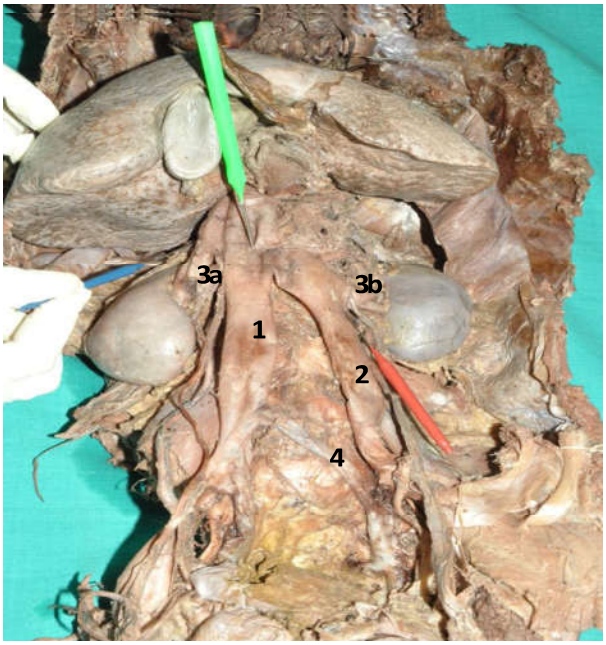

Fig. 2: Figure showing left inferior venacava[2] joining the right inferior venacava [1] at the level of renal veins[Right renal vein3a, Left renal vein 3b]. Further right & left inferior venacavae were joined by transverse caudal venous anastomoses-persistent inter-posterior cardinal venous channel [4]

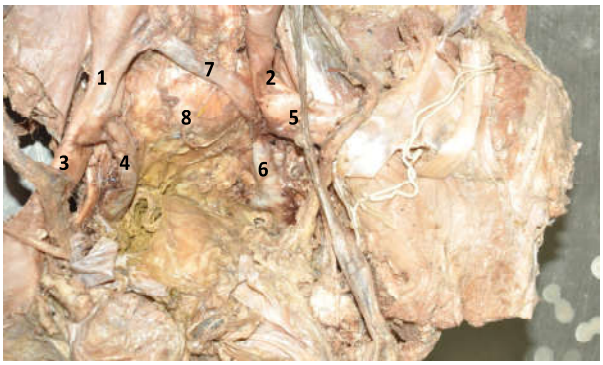

Fig. 3: Figure showing the formation of Right inferior venacava[1] by the union of right External iliac vein [3] and right internal iliac vein[4]. The formation of left inferior venacava [2] by the union of left external iliac vein[5] and left internal iliac vein[6]. Further the Oblique communication between the two venacavae[7] at the leval of fifth lumbar vertebra [8]

Discussion

The embryogenesis of the IVC is a complex process involving the formation of several anastomosis between three paired embryonic veins. The result is numerous variations in the basic venous plan of abdomen and pelvis . A left IVC typically ends at the left renal vein, crosses anterior to the aorta to form a normal right sided pre-renal IVC. In dual IVC, the left IVC typically ends at left renal vein which crosses anterior to aorta to join right IVC [1].

Double Inferior venacava should be suspected in cases of recurrent pulmonary embolism following placement of an IVC filter. As with left IVC, misdiagnosis of abberant vessel as lymphadenopathy should be avoided. The complexity of the antogeny of the IVC, with numerous anastomosis formed between the three primitive veins can lead to a wide array of variations in the basic plan of venous return from abdomen and lower extremity [1].

Variations in normal anatomy of IVC occurs in 3% of population. Double IVC results from failure of regression of left supracardinal vein, where as a left sided IVC is due to regression of right supracardinal vein [2].

Dual IVC occurs next to transposition and has been reported to occur in 0.2-3% of population. During the embryonic development, formation of IVC is a complex multistep process involving three paired venous channels (posterior cardinals, sub-cardinals and supra-cardinals). Dual IVC arises as a result of persistence of right and left supra-cardinal and sub-cardinal veins [3].

Dual IVC –Embryologically, the ventral vessel originates from the right sub-cardinal vein, whereas the dorsal vessel originates from the right supra-cardinal vein. Although extremely rare, radiologists should recognize it [4].

Two IVC, posterior to the level of the renal veins, anterior to these only one. The caliber of these paired trunks seems about the same, but the left is, of the two, the lesser.

Amongst Gibbons, divided IVC occurs most frequently in the female; this is probably true of the human race. The usual persistence of the right cardinal vein as the entire vena cava may be connected with the lower position of the right kidney; at any rate , in case of a left IVC and often in the cases of divided IVC, the left kidney was lower than the right [5].

Double IVC is a congenital anomaly resulting from the persistence of the embryonic venous system. The majority of the cases are clinically silent and diagnosed incidently on imaging for other reasons. However, these venous anomalies may have significant clinical implications, especially during retroperitoneal surgery and in the treatment of thromboembolic diseases [6].

If IVC is absent, blood from lower limbs may pass through the diaphragm into SVC by way of large vein in the location of ascending lumbar and azygos veins. As a result, the hepatic veins drain directly to the right atrium through the normal caval

opening in the diaphragm.It should be noted that any venous channel returning blood through the aortic hiatus of the diaphragm is called "persistent posterior cardinal vein [7]."

Anomalies of IVC appear during venous development between sixth to eighth week of fetal life. The retroperitoneal venous system develops from three pairs of veins, posterior cardinal, supracardinal and subcardinal veins. Thrombosed dual IVC mimicks para-aortic lymphadenopathy or other retroperitoneal mass. This is not surprising as paraaortic lymphnodes are a common site for metastases from local and distant tumours and for diseases of the reticuloendothelial system. Other differential diagnosis for soft tissue mass lying to the left of the aorta in the upper abdomen include enlargement of the left gonadal or hemiazygous vein, a circumaortic or retroaortic left renal vein,an extra renal pelvis or post-operative herniation of either stomach or bowel after a nephrectomy or splenectomy. Anatomical variants of IVC occur in upto 4% of population and may be complicated by thrombophlebitis, when their appearance may become even more misleading [8].

IVC also known as posterior venacava, is a large vein that carries de-oxygenated blood from the lower half of the body into the right atrium of the heart. Rare anomalies of IVC include the absence of a part of the IVC, azygos and hemiazygos, continuation of a duplicated IVC, double SVC, double IVC , hypoplasia, agenesis and interruption of IVC. Anomalies of IVC is more common in males particularly in western countries; that is probably due to gene mutations that appear in these populations. Additionally, surgeons must be aware of variations during organ transplantation, radical nephrectomy, sympathectomy, or ureteric surgery. It could be fatal to mistakenly injure the inferior venacava during an operation of abdomen. If there is undiagnosed double IVC, there may be re-occurrence of embolisms by thrombus from left IVC, giving rise to higher occurrence of thromboembolic disease and pulmonary embolism [9].

IVC is a composite vessel which develops caudo-cranially from persistent caudal part of right posterior cardinal vein, right supracardinal vein, anastomosis between right supracardinal and sub-cardinal vein, right subcardinal vein, new vessel extending between the right subcardinal vein and common hepatic vein which is derived from the suprahepatic part of the right vitelline vein [10].

Radiologically, the presence of dual IVC can be mistaken as a pathological lesion such as lymphadenopathy or left pyelo-uretric dilation [11].

Although such anomalies are generally asymptomatic, they have important ramifications in certain settings (eg; when pulmonary embolism occurs after filter placement in the right IVC because of t he presence of left IVC). They can also be a source of diagnostic uncertainity and make surgery more hazardous [12].

The gonadal veins may be misinterpreted as a double IVC because they run close to the ipsilateral IVC lumen, particularly the left gonadal vein that drains into the left renal vein. Evaluation of the peripheral connection of these veins is crucial in distinguishing them from IVC anomalies because the gonadal veins definitely originate from the ovaries or testis [13].

Duplication of IVC is a rare finding in radiological studies, and it's main differential diagnosis is Lymphadenopathy, aortic aneurysm and retroperitoneal cysts [14]. In a few reported articles the duplication of IVC may be associated with recurrence of pulmonary thromboembolism, if the anatomical variation goes undiagnosed [15]. Duplicated venacava along with other vessel anomalies in the retroperitoneum can lead both to misdiagnosis and to surgical complications. Surgeons, radiologists, oncologists and urologists have to cope with retroperitoneum region, should not only have a thorough knowledge of normal anatomy of this region but also they should be familiarized with the potent anatomical variations and with the exact type of each variation as well [16].

The knowledge of caval variation can prevent misinterpretation of mediastinal masses, iliac occlusion with venous collaterals and paravertebral lymphnode enlargement.

Conclusion

Hence, the variations of IVC should be recognized by radiologists and surgeons in order to avoid mistakes during imaging of the area or surgeries and in case of venous thromboembolic disease. These variations should not be mistaken for pathologic findings, but should be viewed as normal findings of abnormal embryogenesis.

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