CASE REPORT

Is Prenatal Diagnosis of Duplicated Inferior Vena Cava Really Feasible?

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Abstract

Aim: The aim is to describe ultrasound features of duplicated inferior vena cava in fetus in order to make a challenging detection of fetal venous anomalies more feasible.

Background: Duplication of inferior vena cava (IVC) is well-known and thoroughly described by adult anatomists entity. Meanwhile, there are few publications available concerning prenatally detected inferior vena cava anomalies though they are of great importance for surgeons and radiologists.

Case description: We presented two cases of double IVC diagnosed in fetuses during routine ultrasound examination. Typical sonographic visualization of two venous vessels on both sides of the aorta in the transverse view of the fetal abdomen during assessment of kidneys with the same blood flow direction makes feasible the diagnosis of dual IVC.

Conclusion: Visualization of two venous vessels on both sides of the aorta in the transverse view of the fetal abdomen is typical for dual IVC. Color Doppler, demonstrating the same blood flow direction in these vessels, may prove the diagnosis. Thus, though venous assessment is not currently included in standard screening protocol, it is possible to detect this venous anomaly during mandatory ultrasound assessment of fetal kidneys.

Clinical significance: The inferior vena cava anomalies may be asymptomatic, but influence the adult life being of great importance during surgery, so antenatal diagnosis is crucial.

During ultrasound assessment of kidneys in the transverse view of the fetal abdomen, which is done routinely, visualization of two venous vessels on both sides of the aorta should raise the suspicion of dual IVC. The duplication of IVC can be confirmed by color Doppler demonstrating the same blood flow direction in these infrarenal segments of IVC, opposite to that of the aorta. Though venous assessment is not currently included in standard prenatal screening protocol, it is possible to detect this venous anomaly during mandatory ultrasound assessment of fetal kidneys.

Keywords: Case report, Duplication, Fetal anomalies, Inferior vena cava, Prenatal diagnosis.

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Background

Duplication of inferior vena cava (IVC) is well known and described by anatomists in adults' humans. Meanwhile, there are few publications available concerning prenatally detected IVC anomalies, though they are of great importance for surgeons and radiologists.

Case Description

We report two cases of double IVC detected prenatally.

Case 1

A 40-year-old woman, G7, P2, Rh-negativa, was diagnosed with COVID-19 infection at 7 weeks. Choroid plexus cysts were detected at 18 + 6 weeks, invasive diagnostic tests were not carried out. Choroid plexus cysts were not visible at 31 + 6 weeks, when examination of the fetal abdomen demonstrated two vessels ascending along with the aorta, the vessel on the left side crossed aorta superficially after receiving the left renal vein (shown in Fig. 1) and joined right **IVC** emptying into the right atrium. In the transverse view of the fetal abdomen slightly below the level of kidneys three vessels were visualized in front of the spine presenting the aorta and two segments of IVC. Double IVC was diagnosed.

The pregnancy was complicated by preeclampsia at 36 weeks, spontaneous delivery occurred at 37 weeks, the baby weight was 3250 cm, Apgar score 8/8.

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Case 2

A 24-year-old woman, primigravida, presented for routine ultrasound examination at 32 weeks 4 days. Past history, the course of pregnancy and 1st and 2nd trimester screening results were unremarkable. In the transverse view of the fetal abdomen two vessels of the equal size were visible on both sides of the aorta slightly below the level of kidneys. Color Doppler demonstrated the same blood flow direction in these infrarenal segments of IVC, opposite to that of the aorta. (shown in Fig. 2).

Slightly up to that view we found rather large preaortic trunk connecting the left venous vessel with the right one. (shown in Fig. 3).

3D-rendering with Color Doppler clearly demonstrated the left IVC crossing the aorta anteriorly and obliquely (shown in Fig. 4).

The right IVC drained into the right atrium. The rest of fetal anatomy was normal. The diagnosis was the duplication of the IVC. The baby was born at 41 weeks, weighing 3110 gr, Apgar score 8/9. The diagnosis of double IVC was confirmed postnatally in both cases.

Discussion

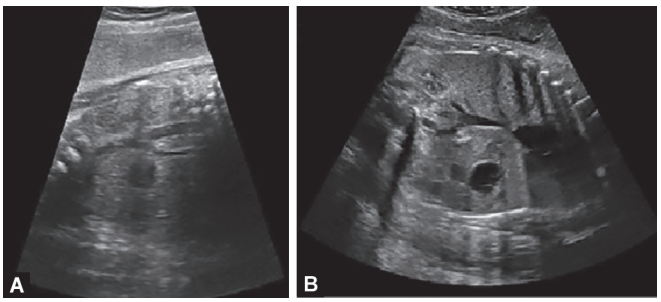
Congenital anomalies of venae cavae are not uncommon with a reported prevalence up to 8.7%[1] and represented as prerenal (interrupted IVC), renal (retroaortic renal vein and circumaortic venous callor) and post-renal or infrarenal (duplicated IVC, left-sided IVC, and retrocaval ureter) variations.[2] Duplicated IVC is the most common anomaly with the incidence of 0.2–3%.[3,4] It has been well described by anatomists in adult humans.

The IVC development is a complicated process including formation of three paired embryonic veins: posterior cardinal, draining the lower extremities, subcardinal, draining the kidneys, and supracardinal veins, gathering blood from the body walls, formation of anastomosis with subsequent regression of some veins.[5,6] The infrahepatic IVC develops between the 6th and 8th weeks of embryonic life.

The subcardinal veins form the stem of the left renal vein, the suprarenal veins and the prerenal segment of the IVC. After regresstion of the left subcardinal vein and the left supracardinal vein, the right supracardinal vein forms the infrarenal IVC.[7] Blood from the left part of the body is directed to the right side via the intersupracardinal and interpostcardinal anastomoses. The subcardinal-hepatic anastomosis form then the suprarenal segment of IVC. The renal segment of IVC is formed by the right suprasubcardinal and postsubcardinal anastomoses.[3] The right-sided venous system continues to develop, and left-sided major veins regress.[8]

The persistence of the left supracardinal vein is the main cause of the IVC anomalies, the most clinically important of which are: the IVC duplication, the transposition of IVC or left-sided IVC, the circumaortic left renal vein, and the retro-aortic left renal vein.[7]

Duplication of IVC results from the persistence of both supracardinal veins forming duplicated infrarenal IVC segments[9] which go up on both sides of the aorta joining anteriorly at the level of the renal arteries, the confluence forms the suprarenal IVC.[7] In both described cases two infrarenal segments of the IVC were clearly visible, with left IVC continued after receiving the left renal



Figs 1A and B: Parasagittal views of the fetal abdomen. (A) Venous vessel crosses aorta slightly above the level of the kidney. (B) The confluence of two infra-renal segments of the inferior vena cava

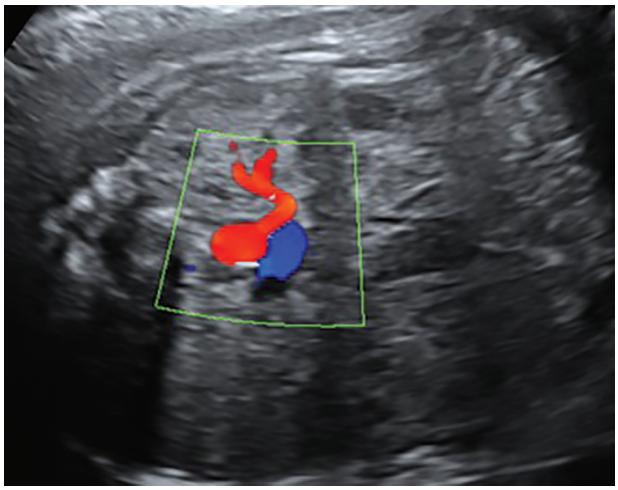


Fig. 3: Color Doppler in transverse section of the fetal abdomen at the level of the left renal artery arising from the aorta with the large trunk (in blue) crossing the aorta

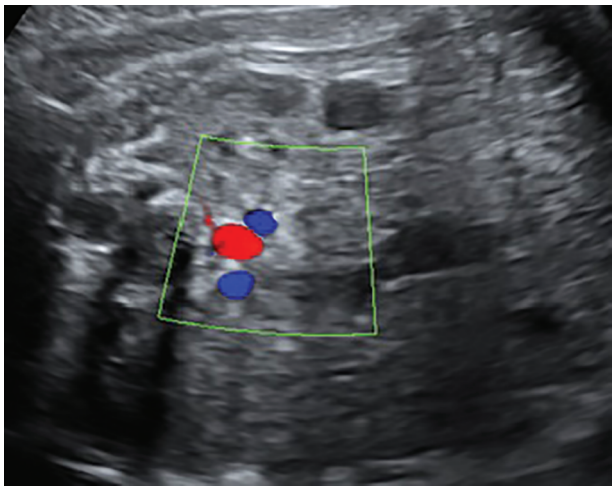


Fig. 2: Transverse view of the fetal abdomen slightly below the renal veins. Color Doppler demonstrating the same direction of the blood flow in the both vessels, representing duplicated IVC

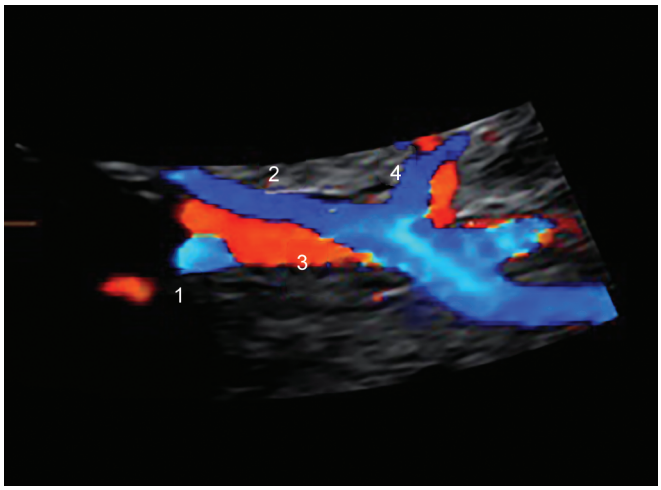


Fig. 4: 3D-rendering plus Color Doppler demonstrate the right IVC (1), the left IVC (2), crossing the aorta (3) after receiving the left renal vein (4)

vein with a preaortic trunk that crossed obliquely the aorta joining the righ IVCt. The findings were consistent with the double IVC.

Natsis et al.[10] proposed the classification of the complete IVC duplication depending on the gross appearance of the preaortic anastomotic trunk between the left and right IVC into three types: major, minor, and asymmetric. Type I or major duplication is described as two symmetrical and approximately of the same diameter trunks going bilaterally and a preaortic trunk of the same size. Type II or minor type is diagnosed with two bilaterally symmetrical and approximately of the same caliber IVC, but with the larger preaortic trunk. Type III or asymmetric type is formed by two asymmetric IVC and large preaortic trunk.[10]

Type II of complete duplication of IVC was diagnosed according to the classification of Natsis et al.[10] since bilaterally going venous trunks were symmetrical and approximately of the same caliber, but smaller in comparison to the preaortic trunk in both cases.

Inferior vena cava anomalies in adults are asymptomatic and being diagnosed mostly incidentally being sometimes missdiagnosed.[4,7] However they are of great importance for surgeons and oncologists, the correct diagnosis is crucial for surgery in the retroperitoneal region or lymph node sampling.[11] Dual IVC should be suspected in cases of recurrent pulmonary embolism after implantation of an IVC filter[7] as well as in young patients with bilateral deep vein thrombosis.[12] Double IVC can potentially be misinterpreted by radiologists as left-sided lymphatic adenopathy, left pyeloureteric dilation, saccular aortic aneurysms, retroperitoneal cysts, or as the aberrant vessel.[3,5,7,9] The needs to recognize congenital IVC anomalies prior to any invasive procedures are obvious[13] as well as the needs of a clear description of the pathology for radiologists.

Bakry et al.[9] reported prenatally diagnosed double IVC with interruption of the suprarenal part with azygous continuation. Mosimann et al.[14] described a IVC duplication in one fetus in a monochorionic diamniotic twins. Zhang et al. reported on series of prenatally diagnosed cases of left IVC and double IVC and showed high rate of associated anomalies, mostly cardiac.[15]

Duplication of the IVC is reported in combination with anomalies of genitourinary system such as cloacal exstrophy, horseshoe kidney or renal agenesis, uterus didelphys, obstructed vagina; with intestinal malrotations as well as with another vascular abnormalities: high-riding aortic bifurcation, retro-aortic left renal vein, circum-aortic renal vein ("venous collar"), continuation of the right IVC with the azygos vein and of the left with the hemiazygos vein, diagnosed in adult patients.[16-19]

However, there are rather limited data on prenatal visualization of IVC anomalies.

Prenatal management depends on the spectrum of discovered anomalies. We have not found any reported association of double IVC with chromosomal or genetic disorders, so it is implied not to offer any chromosomal or genetic testing during pregnancy.

Conclusion

Visualization of two venous vessels on both sides of the aorta in the transverse view of the fetal abdomen during ultrasound assessment of kidneys should raise the suspicion of dual IVC. Color Doppler, demonstrating the same blood flow direction in these vessels, may prove the diagnosis as well as visualization of two veins running on both sides of the abdominal aorta with the left sided IVC crossed the aorta anteriorly and entering the right one in fetal parasagittal planes. Thus, though venous assessment is not currently included in standard prenatal screening protocol, it is possible to detect this venous anomaly during mandatory ultrasound assessment of fetal kidneys that makes prenatal diagnosis of dual IVC feasible.

Clinical Significance

The IVC anomalies may be asymptomatic, but influence the adult life being of great importance during surgery, so antenatal diagnosis is crucial.

During ultrasound assessment of kidneys in the transverse view of the fetal abdomen, which is done routinely, visualization of two venous vessels on both sides of the aorta should raise the suspicion of dual IVC. The duplication of IVC can be confirmed by color Doppler demonstrating the same blood flow direction in these infrarenal segments of IVC, opposite to that of the aorta. Though venous assessment is not currently included in standard prenatal screening protocol, it is possible to detect this venous anomaly during mandatory ultrasound assessment of fetal kidneys.

Acknowledgments

This research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki.

We are stating that patients have given their written informed consent to publish their case (including publication of images).

Study approval statement: Ethics approval was not required (Ethics committee of 1st Minsk clinic hospital).

Consent to publish statement: We state that written informed consent was obtained from parents of babies for publication of the details of their medical case and any accompanying images.

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References

1. Mayo J, Gray R, St Louis E, et al. Anomalies of the inferior vena cava. AJR Am J Roentgenol 1983;140(2):339–345. DOI: 10.2214/ajr.140.2.339
2. Kellman GM, Alpern MB, Sandler MA, et al. Computed tomography of vena caval anomalies with embryologic correlation. Radiographics 1988;8(3):533–556. DOI: 10.1148/radiographics.8.3.3380993
3. Bass JE, Redwine MD, Kramer LA, et al. Spectrum of congenital anomalies of the inferior vena cava: cross-sectional imaging findings. Radiographics 2000;20(3):639–652. DOI: 10.1148/radiographics.20.3.g00ma09639
4. Ang WC, Doyle T, Stringer Mark D. Left-sided and duplicate inferior vena cava: a case series and review. Clinical Anatomy 2013;26(8):990–1001. DOI: 10.1002/ca.22090
5. Phillips E. Embryology, normal anatomy, and anomalies. In Venography of the inferior vena cava and its branches, Ferris EJ, Hipona FA, Kahn PC, Phillips E, Shapiro JH (eds). Baltimore, Md: Williams & Wilkins, 1969; 1–32.
6. Baeshko AA, Zhuk HV, Ulezko EA, et al. Congenital anomalies of the inferior vena cava and their clinical manifestation. Eur J Vasc Endovasc Surg 2007;14(1):8–13. DOI: 10.1016/j.ejvsextra.2007.02.007
7. Kapetanakis S, Papadopoulos C, Galani P, et al. Anomalies of the inferior vena cava: a report of two cases and a short review of the literature. Folia Morphol (Warsz) 2010;69(3):123–127. PMID: 21154280. Available at: https://journals.viamedica.pl/folia_morphologica/article/view/15865
8. Kabakus I, Kocher M, Agha A, et al. Left-sided inferior vena cava with hemiazygos continuation to left superior vena cava. Cureus 2019;11(12):e6503. DOI: 10.7759/cureus.6503.
9. Bakry H, Leibovitz Z, Shapiro I, et al. P20.05: Prenatal diagnosis of inferior vena cava duplication. Ultrasound Obstet Gynecol 2019;54(S1):221. DOI: 10.1002/uog.21076
10. Natsis K, Apostolidis S, Noussios G, et al. Duplication of the inferior vena cava: anatomy, embryology and classification proposal. Anat Sci Int 2009;85(1):56–60. DOI: 10.1007/s12565-009-0036-z
11. Cheung K, Wong E. Duplicated inferior vena cava in a patient with ampullary adenocarcinoma: a case report and literature review

of anatomical variations. Cureus 2020;12(11):e11576. DOI: 10.7759/cureus.11576
12. Gayer G, Luboshitz J, Hertz M, et al. Congenital anomalies of the inferior vena cava revealed on CT in patients with deep vein thrombosis. AJR Am J Roentgenol 2003;180(3):729–732. DOI: 10.2214/ajr.180.3.1800729
13. Tong Z, Gu Y. A case series of duplicated inferior vena cava: mind the side, or fail to trap! Int J Clin Exp Med 2015;8(5):8029–8031. PMCID: PMC4509312; PMID: 26221367. Available at: https://e-century.us/files/ijcem/8/5/ijcem0004563.pdf
14. Mosimann B, Amylidi-Mohr S, Surbek DV, et al. Double inferior vena cava in a monochorionic twin pregnancy with selective fetal growth restriction. BMJ Case Rep 2021;14(3):e240379. DOI: 10.1136/bcr-2020-240379
15. Zhang Z, Wang J. Ultrasound diagnosis of left inferior vena cava and double inferior vena cava in fetus. Zhejiang Da Xue Xue Bao Yi Xue Ban 2019;48(4):446–452. DOI: 10.3785/j.issn.1008-9292.2019.08.16
16. Starly B. A rare vascular anomaly - Type III asymmetric duplicated inferior vena cava. Case 12098. European society of radiology. 2014. URL: https://www.eurorad.org/case/12098. DOI: 10.1594/EURORAD/CASE.12098
17. Coskun A, Okur N, Ozdemir O, et al. Uterus didelphys with an obstructed unilateral vagina by a transverse vaginal septum associated with ipsilateral renal agenesis, duplication of inferior vena cava, high-riding aortic bifurcation, and intestinal malrotation: a case report. Fertil Steril 2008;90(5):2006.e9–2006.e11. DOI: 10.1016/j.fertnstert.2008.05.030
18. Shaha P, Garg A, Sahoo K, et al. Duplication of inferior vena cava with associated anomalies: a rare case report. J Clin Diagn Res 2016;10(3):TD01-TD04. DOI: 10.7860/JCDR/2016/18240.7406.
19. Petik B. Inferior vena cava anomalies and variations: imaging and rare clinical findings. Insights Imaging 2015;6(6):631–639. DOI: 10.1007/s13244-015-0431-z.