

The Types of Connections Between the Portal Sinus and Main Portal Vein in Foetuses

Tipos de Conexiones entre el Seno Portal y la Vena Porta Principal en Fetos

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GÜRSESES, C.; EROL, O.; ISENLİK, B. S.; KARADAG, B. & ERKAN, F. S. The types of connections between the portal sinus and main portal vein in foetuses. *Int. J. Morphol.*, 37(2):752-756, 2019.

SUMMARY: In the prenatal period, the three types of connections between the portal sinus and main portal vein have been published in the literature: T, X and H-shaped. The T type is the most frequent in the literature, and the aim of our study is to define the percentage of the connection types during the prenatal period in our population. In this prospective study, 237 women between 20 and 38 weeks of pregnancy without a foetal anomaly or pregnancy-related complications were included, and the precordial veins of the foetuses were examined using a wide-band color Doppler technique. The types of connections were determined by two specialists according to the shape of the colour coded vessels in Doppler examinations. The criteria of Czubalski & Aleksandrowicz (2000) were used. All of the connection types in patients were confirmed using video clips and were stored in the picture archiving and communication system. In 237 patients, the types of connection were determined by the first specialist as 189 foetuses (79.7 %) with the X-shaped or side-to-side connection, 16 foetuses (6.8 %) with the T-shaped or end-to-side type and 32 foetuses (13.5 %) with the H-shaped or parallel-coursed vessels connected with a short segment. The most common types of connections between the portal sinus and main portal vein in foetuses are X shaped or side-to-side, which is contrary to previous studies.

KEY WORDS: Foetus; Main portal vein; Portal veins; Variations; Umbilical vein.

INTRODUCTION

The afferent system of the foetal precordial vein includes the intrahepatic umbilical vein (UV), left portal vein (LPV) with three branches (superior, inferior and middle), portal sinus (PS), ductus venosus (DV), right portal vein (RPV) with two branches (anterior and posterior) and main portal vein (MPV), which carries blood from the spleen and gut. The portal sinus is a part of the umbilicoportal system between the inferior branch of the LPV and the beginning of the RPV (Paris *et al.*, 2004; Sinkovskaya *et al.*, 2013; Chaoui *et al.*, 2014) (Fig. 1).

The MPV is formed by the superior mesenteric vein and splenic vein, is located in the right anterolateral of the inferior vena cava (IVC) and connects to the PS lateral and down to the DV origin in an oblique course from left to right (Fig. 2).

Junctional variations between the MPV and PS exist in normal foetal anatomy, and T, X and H-shaped connection types are published in the literature (Czubalski &

Aleksandrowicz; Kivilevitch *et al.*, 2009). In this prospective study, the aim was to define the percentage of the connection types during the prenatal period in our population.

MATERIAL AND METHOD

This prospective study was conducted between January 2018 and May 2018. A total of 237 singleton uncomplicated pregnant women between 18 and 40 weeks of pregnancy were included in the study. Written informed consent from the patients for a Doppler examination and ethical approval from the Institutional Review Board were obtained before beginning the study. In cases of discordance of more than 7 days between the age based on the last menstrual date and age based on ultrasound biometry measures, the foetal age was recalculated. Patients with diabetes mellitus, hypertension or preeclampsia, polyhydramnios, a foetal congenital abnormality, foetal growth restriction or macrosomia were excluded.

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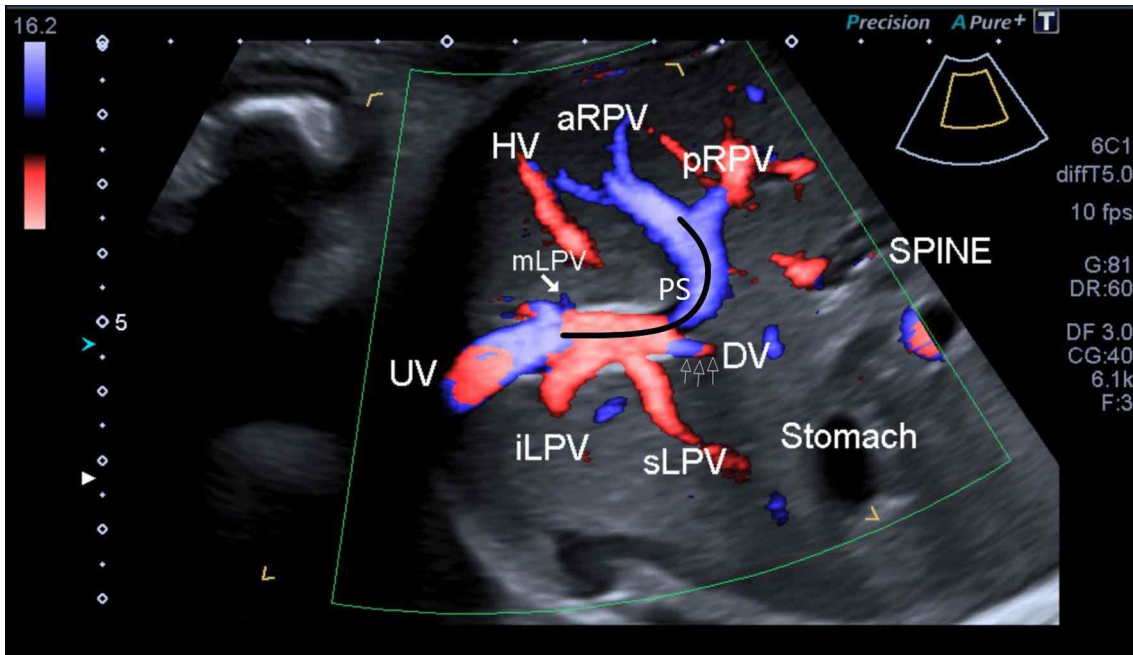


Fig. 1. The relationships of the afferent system of the foetal precordial veins and the portal sinus. UV=Umbilical vein, iLPV=Inferior branch of the left portal vein, sLPV=superior branch of the left portal vein, DV=Ductus venosus, PS=Portal Sinus (curved black line), mLPV= Medial branch of Left portal vein, aRPV=Anterior branch of the right portal vein, pRPV=Posterior branch of the right portal vein, HV=Hepatic vein.

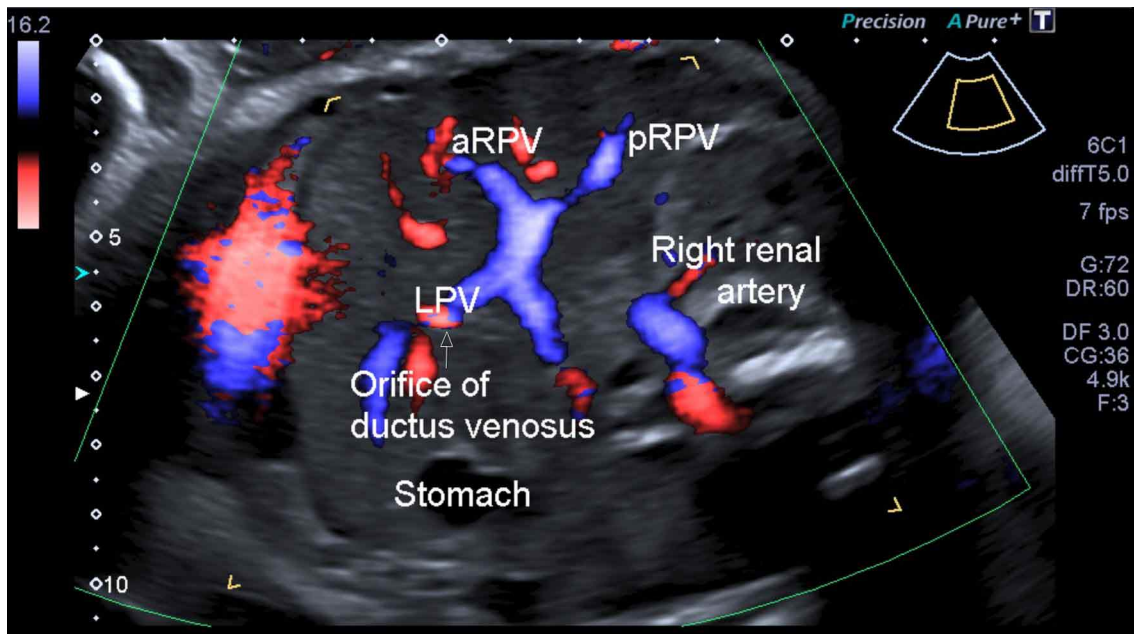


Fig. 2. The relationships of the portal sinus, the main portal vein and the renal artery in an X type connection. LPV=Left portal vein, aRPV=Anterior branch of the right portal vein, pRPV=Posterior branch of the right portal vein.

The L-shaped umbilico-portal venous system was located in the transverse plane of the foetal abdomen, and the UV, LPV, PS, DV and RPV were visualized by a grayscale and colour Doppler (CD) and colour-compared mode (twin view) ultrasound technique. The transducer plane was mo-

ved slightly lateral and brought into parallel with the short leg of the L shape, which consists of the PS and part of the RPV, and the transducer was moved slightly down and angled in the cephalad direction depending on the foetal anatomy. The “catch and stretch” technique was used after a period of

experience to visualize the MPV and RPV branches in the CD images. Usually, the connection can be observed at the renal artery level with a parallel plane (Fig. 3).

The types of connections were determined using the shape of the colour coded vessels of images obtained by the two-dimensional high-resolution CD technique with a wide-band frequency and video-assisted reviews performed retrospectively. Additionally, the following criteria, which characterize the type of connection according to Czubalski & Aleksandrowicz were used: for the T-shaped type, the presence of only one right portal vein branch; for the X-shaped type, the presence of two independent veins running to the right lobe of the liver; and for the H-shaped type, the presence of a short communicating vessel and two independent veins running to the right lobe of the liver.

The connection diameters in opposite directions were measured in CD images (“a” and “b” in figures), and the “a/b” ratios were calculated.

All CD examinations were performed by two experienced specialists on obstetrical imaging. Interobserver variability was analysed with the Statistical Package for Social Sciences (SPSS, Chicago, IL; version 17.0).

The precordial veins of the fetuses were examined using a wide-band CD technique, advanced dynamic flow

(ADF), using a 2–6 MHz broadband convex transducer Toshiba Applio 500 system (TUS-A500, Toshiba Medical Systems Europe B.V., Zilverstraat 1, 2718 RP, Zoetermeer, The Netherlands).

The still images and/or real-time video clips were stored in the picture archiving and communication system (PACS) by Sectra PACS (Sectra AB, Teknikringen 20, SE-583 30 Linköping, Sweden).

The acoustic output level was set to minimum in accordance with the As Low As Reasonably Achievable (ALARA) principle, and the maximum mechanical index was 1, 1. The imaging parameters were set as dynamic range (DR) 70, dynamic frequency (DF) 3.0, colour gain (CG) 40, colour PRF 5, 9 and color filter (F) 4.

The Statistical Package for Social Sciences (version 25.0; SPSS, Chicago, IL) was used to perform statistical analysis. The Shapiro–Wilk test was used to assess the conformity of the continuous variables in the study relative to the normal distribution. Continuous variables are expressed as the mean, median, minimum, and maximum, whereas categorical variables are expressed as percentages and frequencies. Differences between categorical values were assessed using the c2 test. The correlation between the two different measurements was quantified using the Pearson’s rank correlation coefficient. A p value of less than 0.05 was considered statistically significant.

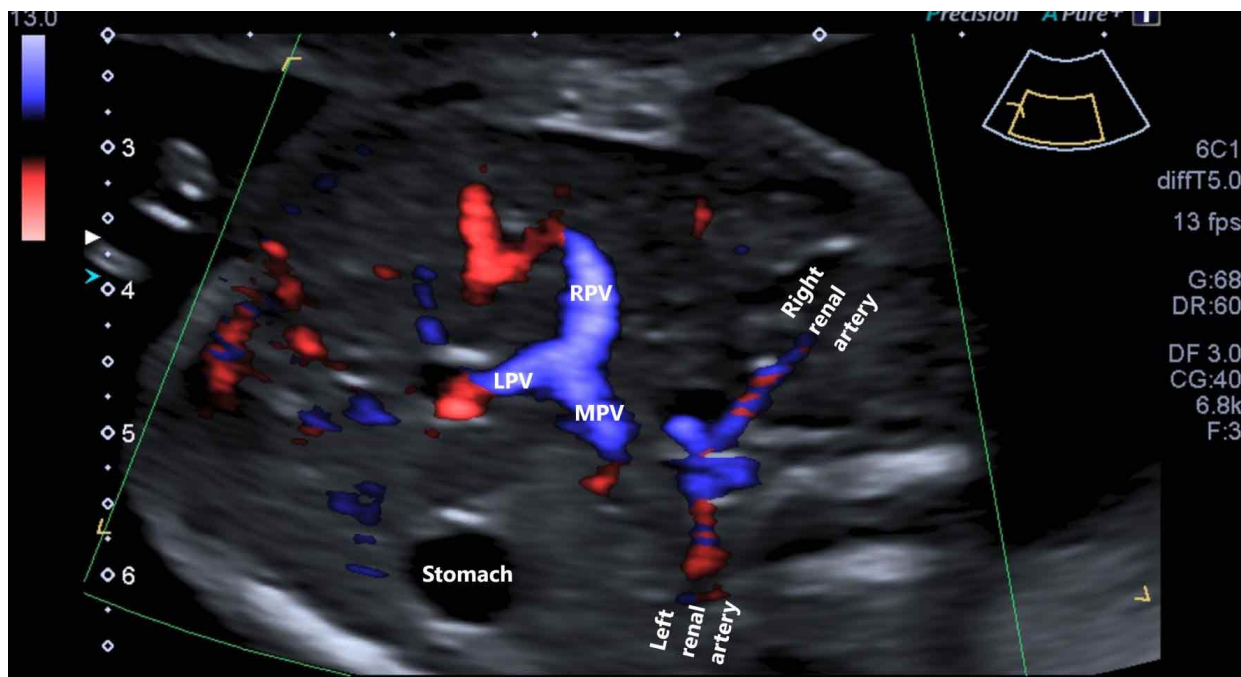


Fig. 3. The relationships of the portal sinus, the main portal vein and the renal artery in a T type connection. LPV=Left portal vein, RPV=Right portal vein, MPV=Main portal vein.

RESULTS

A total of 237 pregnant women were included in the study. The mean age of the participants was 27.1 ± 5.96 years, and the mean gestational age was 26 ± 5.4 weeks. One hundred seventy-four (73.4 %) participants were in the second trimester and 63 (26.6 %) were in the third trimester.

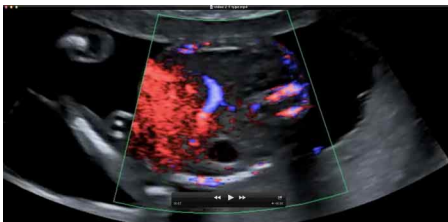
In the 237 patients, the types of connections were determined by the first specialist as follows: 189 foetuses (79.7 %) had the X-shaped or side-to-side connection (Figs. 2 and 4, Video 1), 16 foetuses (6.8 %) had the T-shaped or end-to-side type (Figs. 3 and 5, Video 2) and 32 foetuses (13.5 %) had the H-shaped or parallel-coursed vessels connected with a short segment (Figs. 6 and 7, Video 3). The rates were determined by the second specialist as 192 (81.0 %), 15 (6.3 %) and 30 (12.7 %), respectively.

In the X type connections, the a/b ratios were more or equal to "1", and in H type connections, the ratios were less than 1.

The interobserver variability was ignorable. The measurements made by the two different researchers were significantly correlated with each other ($r=0.976$, $p<0.001$).



Video 1.



Video 2.



Video 3.

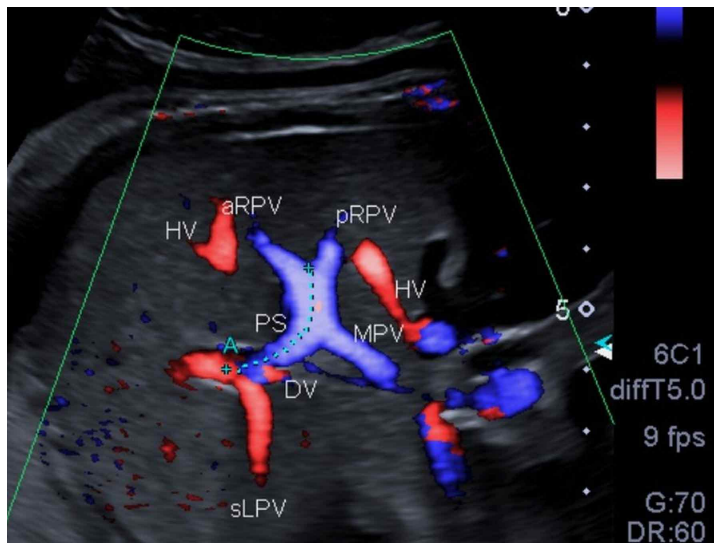


Fig. 4. The X type connection between the portal sinus and the main portal vein. sLPV=superior branch of the left portal vein, DV=Ductus venosus, PS=Portal sinus, aRPV=Anterior branch of the right portal vein, pRPV=Posterior branch of the right portal vein, MPV=Main portal vein, HV=Hepatic vein.

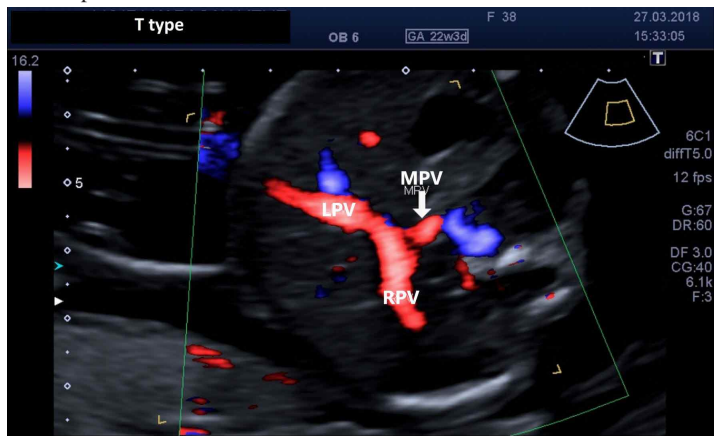


Fig. 5. The T type connection between the portal sinus and the main portal vein. LPV=Left portal vein, RPV=Right portal vein, MPV=Main portal vein.

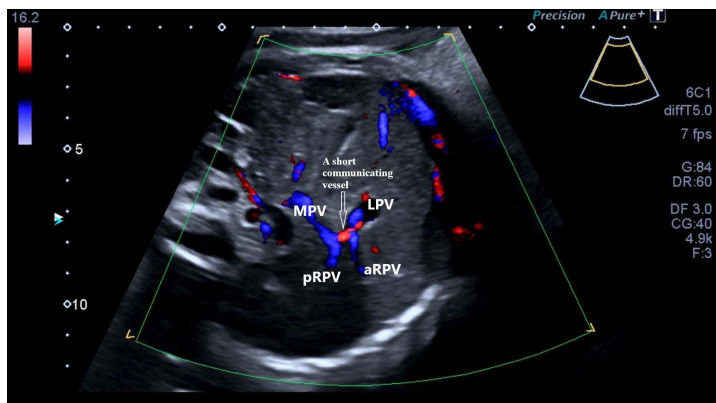


Fig. 6. The T type connection between the portal sinus and the main portal vein. LPV=Left Portal Vein, MPV=Main portal vein, aRPV=Anterior branch of the right portal vein, pRPV=Posterior branch of the right portal vein.

DISCUSSION

The foetal precordial venous system examination is a challenging evaluation. It is crucial to visualize the portal sinus and its connections in the prenatal period, either to make an accurate measurement of the abdominal circumference or to diagnose of arterio-venous vascular abnormalities. Wideband CD techniques, such as high definition flow-GE, advanced dynamic flow-Toshiba, and e-Flow-Hitachi, in addition to grayscale imaging, provide satisfactory anatomic vascular details of the complex venous system. Three-dimensional (3D) ultrasound is a supplementary technique, which is not used in this prospective study, aim was to define the connection types between the PS and MPV with video-assisted decision making during the examination or afterwards, but without the use of a 3D imaging facility.

The anatomy of the afferent precordial vein appears to be complicated; however, if it is systematically evaluated, it is easy to understand, and when the normal anatomy is known, abnormalities of the vessels can be more easily detected.

The results are contrary to those of previous studies (Czubalski & Aleksandrowicz; Kivilevitch *et al.*; Yagel *et al.*, 2010) in which T-shaped end-to-side connections are the most frequent type. And the reviews about the connection types in the medical literature (Chaoui *et al.*; Sinkovskaya *et al.*; Yagel *et al.*, 2015) are based on the previous studies (Czubalski & Aleksandrowicz; Kivilevitch *et al.*). There might be some reasons for our conflicting results; Czubalski & Aleksandrowicz included a limited number of autopsies, and there might be some foetal or maternal complications of a T-shaped pregnancy. The different results that we found compared to those of Kivilevitch *et al.* on living fetuses are thought to be due to the difference in the determination of the right portal vein branches. It is understood that Kivilevitch *et al.* did not consider the branches of the right portal vein for typing the connections, which is an essential point according to Czubalski & Aleksandrowicz. The geographical and ethnic features might be other reasons for the discrepancy.

CONCLUSION

The most common types of connections between the portal sinus and main portal vein in fetuses are X shaped or side-to-side connections, in contrast to previous studies.

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RESUMEN: En el período prenatal, se han publicado en la literatura los tres tipos de conexiones entre el seno portal y la vena porta principal: en forma de T, X y H. El tipo T es el más frecuente, y el objetivo de nuestro estudio fue definir el porcentaje de tipos de conexión durante el período prenatal en nuestra población. En este estudio prospectivo, se incluyeron 237 mujeres entre 20 y 38 semanas de embarazo, sin anomalías fetales o complicaciones relacionadas con el embarazo, y se examinaron las venas precordiales de los fetos utilizando una técnica Doppler de banda ancha. Los tipos de conexiones fueron determinados por dos especialistas según la forma de los vasos codificados por color en los exámenes Doppler. Se utilizaron los criterios del estudio de Czubalski & Aleksandrowicz. Todos los tipos de conexión en los pacientes se confirmaron mediante videoclips y se almacenaron en el sistema de comunicación y en archivo de imágenes. En 237 pacientes, el primer especialista determinó en 189 fetos (79,7 %) la conexión en forma de X o de lado a lado; en 16 fetos (6,8 %) la forma de T o Tipo de extremo a lado; y en 32 fetos (13,5 %) los vasos en forma de H o paralelos, conectados con un segmento corto. Los tipos más comunes de conexiones entre el seno portal y la vena porta principal en los fetos son en forma de X o de lado a lado, lo que es contrario a estudios anteriores.

PALABRAS CLAVE: Feto; Vena porta principal; Venas porta; Variaciones; Vena umbilical.

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Received: 05-12-2018
Accepted: 01-02-2019

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