ORIGINAL RESEARCH PAPER

Gynecology

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APPLICABILITY OF DOPPLER ULTRASOUND IN EXTRA-CARDIAC ABNORMALITIES (SECOND PART)

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ABSTRACT

Introduction: Fetal Doppler ultrasound is the method of choice to identify alterations that put the fetus at risk, this tool has revolutionized the traditional conception of Perinatology, as it gives the opportunity to understand that the pathophysiological process of the sick fetus presents hemodynamic deterioration. **Objective:** To describe the applicability of fetal Doppler ultrasound in the main infradiaphragmatic extracardiac anomalies. **Methods:** Bibliographic review of scientific articles published in Spanish and English and their corresponding validation under Caspe and PRISMA tools. Results: An analysis of 28 bibliographic citations was carried out under the aforementioned systematic search, in which the main fetal anomalies were separated under the infradiaphragmatic and cerebral concept. **Conclusion:** There is limited literature regarding Doppler ultrasound evaluation in relation to extra-cardiac anomalies, and among them there are discrepancies in the findings found among various authors.

Introduction

Ultrasonography is the imaging modality of choice for pregnancy evaluation because of its relatively low cost, its real-time capabilities, its safety, comfort, and operator experience. (1)

In Ecuador, there is no national registry that determines the frequency or incidence of fetal anomalies, however, thesis works have been able to help determine a referential panorama of these anomalies.

According to Angara Evelyn et al, representative data of one of the most important maternity wards in Quito, such as the "Isidro Ayora" Maternity Hospital, through descriptive analysis in one year of research, 265 births expressed as a major congenital malformation are described. (2)

Likewise, according to Ayala Felix et al, (3) present their results at the National Maternal Perinatal Institute of Lima during the 2018 period, in which interestingly, in addition to describing the incidence of congenital malformations, apart from describing their higher frequency in women with low education and economic resources.

Doppler flowmetry has revolutionized the traditional conception of Perinatology as it gives the opportunity to understand that the pathophysiological process of the sick fetus presents a hemodynamic deterioration. (4)

Understanding the importance of Doppler ultrasound leads to quality fetal surveillance that allows us to perform timely interventions, thus optimizing the ideal time to carry out delivery and modifying the type of prenatal control. (4)

Doppler ultrasound is the method of choice due to its high sensitivity which, in addition to being non-invasive and accessible, helps to identify life-threatening alterations of the fetus such as extracardiac anomalies, which is sometimes supportive in the monitoring and treatment of them.

METHODS:

A bibliographic review of scientific articles published in Spanish and English was carried out, by means of a bibliographic search under metasearch engines; Pubmed, Google scholar, MEDLINE, SCOPUS and in Latin American journals: Scielo, Latindex as well as repositories of University Thesis.

The search terms were under the MeSH term: "ultrasound" or "echography"; "fetal"; "Doppler"; "Abnormalities" or "abnormalities"; "No" or "non"; "Cardiac" or "non heart"; "vascular".

Once the scientific article was obtained, it was analyzed and evaluated under the Caspe and PRISMA tools; Likewise, the search year was delimited for those articles greater than or equal to 2015, except those of relevant historical connotation.

The objective of this research is to describe the applicability of fetal Doppler ultrasound to identify alterations suggestive of extra-cardiac anomalies and to highlight its usefulness in high-risk pregnancies in clinical practice.

RESULTS:

A bibliographic analysis of 92 bibliographic citations was carried out under the aforementioned systematic search in which the main fetal pathologies could be determined with an important relationship in terms of the feasibility and applicability of Doppler ultrasound.

INFRADIAPHRAGMATIC VASCULAR ANOMALIES

FETAL VOLVULUS: Prenatal ultrasound diagnosis is revealed as direct signs: the 2D "swirl sign" or color Doppler representing the coiling of dilated intestinal loops or the mesenteric vein around the superior mesenteric artery with color Doppler, as well as indirect signs : arcuate digestive dilation, meconium pseudocyst, ascites, or hydrohydric level within a dilated loop. (5–9)

DUODENAL ATRESIA: Congenital duodenal obstruction (CDO) is a common congenital malformation of the digestive tract. (10) Few studies currently exist on the ultrasound characteristics of these two types of obstructions. (10)

The best results have been evaluated with a GE Voluson E8, GE Voluson 730 and Philips-A70 color Doppler diagnostic ultrasound, with a three-dimensional abdominal volume probe with a frequency of 4 to 8 MHz and an abdominal detector with a frequency of 1 to 5 MHz. The maximum normal transverse diameter of the duodenum should not exceed 0.2 cm at 20 to 25 weeks of gestation, 0.3 cm at 25 to 30 weeks of gestation, 0.6 cm at 30 to 35 weeks of gestation, and 0.8 cm at 35 to 40 weeks of gestation. (10)

CONGENITAL VASCULAR LIVER BYPASS: Congenital aberrant hepatic vascular communications are the result of intrahepatic or extrahepatic errors in vascular development or involution during the transition from fetal to neonatal hepatic circulation. (11)

Affected patients are often studied first with real-time Doppler ultrasound, these aberrant hepatic vascular communications include portosystemic venous shunts (which can be intra- or extrahepatic and include patent ductus venosus), arterioportal, arteriovenous, or mixed shunts. (11–13))

RENAL VENOUS THROMBOSIS: It is a poorly described diagnostic finding, the etiology is not clear in most cases, although thrombophilia was found in some affected fetuses. (14)

Rapid deterioration of fetal condition, abnormal fetal Doppler, occurrence of hydrops fetalis, may accompany fetal venous thrombosis. Furthermore, color Doppler flow mapping can demonstrate abnormal arterial perfusion and absence of venous perfusion of the affected kidney. (14,15)

GASTROSCHISIS:

consists of a failure to close the abdominal wall during the embryogenesis period, it is a congenital defect of the abdominal wall, paraumbilical, in which, through a small hole, often to the right, an umbilical ring Normally, the intestinal loops lie outside the abdomen and exposed to amniotic fluid. (16)

The evaluation by Doppler flowmetry is carried out based on the study of the mesenteric vessels, simultaneous obtaining of arterial and venous flow, to calculate the percentage that the venous flow represents at the peak of the artery velocity, the fetus-placental Doppler hemodynamic profile, including the acceleration / deceleration time of the pulmonary artery. (16)

VESICAL AND CLOACAL EXTROPHY: It is a defect in the caudal folding of the abdominal wall that has a range of alterations from epispadia to exposure of the posterior wall of the bladder to the amniotic cavity, its ultrasound diagnosis is based on visualizing an insertion umbilical cord lower than usual, the persistent absence of the bladder in the pelvic region but with a normal volume of amniotic fluid and associated with a hypogastric mass with protruding loops, the utility of Doppler ultrasound for this pathology is not appreciated. (17)

CANTRELL PENTALOGY: (thoracoabdominal ectopia cordis), also called Cantrell-Heller-Ravitch syndrome or pentalogy syndrome and peritoneum-pericardial diaphragmatic hernia since five anomalies are associated: epigastric defect of the supraumbilical abdominal midline, defect of the lower third of the sternum, anterior segment of the diaphragm deficiency, pericardial defects and congenital cardiac malformations Doppler functionality lies in the cardiac flow and vessels around it. (17)

VASCULAR DISORDERS IN RELATION TO THE CENTRAL NERVOUS SYSTEM

CHIARI II MALFORMATION: it is a congenital anomaly characterized by a small posterior fossa with a downward displacement of the rhombencephalon towards the foramen magnum. Doppler evaluates the impedance parameters of cerebral flow (resistance index [IR] and pulsatility index [PI] respectively). (18–20)

FETAL GALENE VEIN (VGAM): it is a very rare congenital malformation of the cerebral blood vessels, they form between the sixth and eleventh week of gestation due to the fistula between the cerebral arteries and the deep draining veins of the brain, the vein The median forebrain precursor to the vein of Galen is significantly enlarged and aneurysmal. (21,22)

Orthogonal VGAM diameters (ie, craniocaudal, laterolateral, anteroposterior) are evaluated by ultrasound; VGAM volume, calculated from the three diameters with the ellipsoid formula; and presence / absence of straight sinus dilation. (21–27)

Color Doppler blood flow is used to detect the filling of the blood flow in VGAM and to observe the distribution of the cerebral arteries and connecting VGAM vessels, while the spectrum is used to monitor the spectrum of blood flow. (21–27)

DISCUSSION

For Chaturvedi et al, (11) patients affected by congenital hepatic vascular shunts, these aberrant hepatic vascular communications include portosystemic venous shunts, arterioportal, arteriovenous or mixed shunts for which Doppler flow will help in their diagnosis.

For Shrots S, et. al, (18) Chiari malformation indicates supratentorial microstructural changes, however more research is needed on the role of image diffusion metrics in evaluating abnormal brain development, parenchymal damage, and the efficacy of fetal surgery. In particular, McLone et al, (18) indicate that it is due to the decompression of the intracranial vesicles causing overcrowding, a decrease in the size of the third ventricle and changes in the fetal skull.

Karadeniz et al. (28) referred to the diagnosis of prenatal vein of Galen (VGAM) as the companion of other abnormal fetal conditions and a poor prognosis, while isolated fetal VGAM often has a better prognosis, whereas Elmahoruk et al (23) It appears that the vein of Galen is caused by the high-flow, low-resistance arteriovenous connection in VGAM, causing a compensatory increase in blood volume and cardiac output

and leads to high-output heart failure, but in experience the presentation was different and leads to hemodynamic modification in the form of central cyanosis and increased end-diastolic pressure of the left ventricle and pulmonary venous congestion.

CONCLUSION

The applicability of Doppler ultrasound has spread throughout the world in recent years; To obtain better results, it is necessary to train obstetricians in the use of this technique, considered a non-invasive complementary diagnostic means in pregnant women at risk, in order to make timely decisions such as carrying out quality fetal surveillance that allows performing timely interventions and modify the type of prenatal control, determine the time of termination of pregnancy to avoid fetal complications, and thus reduce neonatal morbidity and mortality rates.

Likewise, the constant bibliographic review of these anomalies is important since, having a low incidence, it leads to frequent changes in terms of assessment with predictive purposes.

CONFLICTS OF INTEREST

None reported by the authors

REFERENCES:

1. Reddy UM, Filly RA, Copel JA. Prenatal Imaging. Obstet Gynecol [Internet]. 2008 Jul;112(1):145–57. Available from: http://journals.lww.com/00006250-200807000-00024
2. Angara Gudiño EL, Vinelli Merino WH. Epidemiología de Malformaciones Congénitas Mayores en neonatos del Hospital Gineco-Obstétrico Isidro Ayora de enero a diciembre 2015. Vol. 1, Repositorio Tesis Universidad Central del Ecuador. Universidad Central del Ecuador; 2017.
3. Ayala-Peralta FD, Guevara-Ríos E, Carranza-Asmat C, Luna-Figueroa A, Espinola-Sánchez M, Racchumí-Vela A, et al. Factores asociados a malformaciones congénitas. Rev Peru Investig Matern Perinat [Internet]. 2019 Dec 17;8(4):41–55. Available from: https://investigacionmaternoperinatal.inmp.gob.pe/index.php/rpinmp/article/view/171
4. Martínez-Rodriguez, Pablo;Oliva-Caceres L. Flujometría Doppler. REV MED HONDUR [Internet]. 2014;82(1):27–32. Available from: http://www.bvs.hn/RMH/pdf/2014/pdf/Vol82-1-2014-9.pdf
5. Jakhere SG, Saifi SA, Ranwaka AA. Fetal small bowel volvulus without malrotation: The whirlpool & coffee bean signs. J Neonatal Perinatal Med [Internet]. 2014;7(2):143–6. Available from: https://www.medra.org/servlet/aliasResolver?alias=iospress&doi=10.3233/NPM-1476013
6. Monard B, Mottet N, Ramanah R, Riethmuller D. Prenatal Diagnosis of a Segmental Small Bowel Volvulus with Threatened Premature Labor. Case Rep Obstet Gynecol [Internet]. 2017;2017:1–5. Available from: https://www.hindawi.com/journals/criog/2017/7642784/
7. Fukushima S, Fujioka K, Ashina M, Ohyama S, Ikuta T, Nishida K, et al. Fetal Primary Small Bowel Volvulus Associated with Acute Gastric Dilatation Detected by Ultrasonography. Kobe J Med Sci. 2019;64(4).
8. Yamashiro KJ, Galganski LA, Hirose S, Stark RA. Midgut volvulus and complex meconium peritonitis in a fetus with undiagnosed cystic fibrosis. J Pediatr Surg Case Reports [Internet]. 2019 Jan;40:26–9. Available from: https://linkinghub.elsevier.com/retrieve/pii/S2213576618302380
9. Faure J, Bartholmot C, Prodhomme O, Mousty E, Grosjean F, Fuchs F. EP12.21: Fetal small bowel volvulus: ultrasound and MRI findings - which is the best? Ultrasound Obstet Gynecol [Internet]. 2017 Sep;50:307–307. Available from: http://doi.wiley.com/10.1002/uog.18491
10. Yin C, Tong L, Ma M, Tan X, Luo G, Fei Z, et al. The application of prenatal ultrasound in the diagnosis of congenital duodenal obstruction. BMC Pregnancy Childbirth [Internet]. 2020 Dec 3;20(1):387. Available from: https://bmcpregnancychildbirth.biomedcentral.com/articles/10.1186/s12884-020-03078-5
11. Chaturvedi A, Klionsky NB, Saul D. Ultrasound with Doppler evaluation of congenital hepatic vascular shunts. Pediatr Radiol [Internet]. 2018 Oct 7;48(11):1658–71. Available from: http://link.springer.com/10.1007/s00247-018-4247-0
12. De Gottardi A, Berzigotti A, Buscarini E, García Criado A. Ultrasonography in Liver Vascular Disease. Ultraschall der Medizin - Eur J Ultrasound [Internet]. 2018 Aug 2;39(04):382–405. Available from: http://www.thieme-connect.de/DOI/DOI?10.1055/a-0647-1658
13. LAVERDURE N, Lallier M, Dubois J, Paganelli M. A205 CONGENITAL ABSENCE OF THE PORTAL VEIN: DOES IT REALLY EXIST? J Can Assoc Gastroenterol [Internet]. 2018 Mar 1;1(suppl_1):359–60. Available from: https://academic.oup.com/jcag/article/1/suppl_1/359/4916365
14. Weber SK, Müller A, Geipel A, Berg C, Gembruch U. Prenatal renal vein thrombosis in dichorionic twin pregnancy. Arch Gynecol Obstet [Internet]. 2014 Sep 23;290(3):587–90. Available from: http://link.springer.com/10.1007/s00404-014-3240-6
15. Has R, Corbacioglu Esmer A, Kalelioglu IH, Yumru H, Yüksel A, Ziylan O. Renal failure due to renal vein thrombosis in a fetus with growth restriction and thrombophilia. J Obstet Gynaecol Res [Internet]. 2014 Apr;40(4):1124–7. Available from: http://doi.wiley.com/10.1111/jog.12300
16. Olavarría AS, Larrazábal N, Mora YM De. Mesenteric venous / arterial index in gastroschisis cases: a new prognostic tool. Rev Peru Ginecol Obs [Internet]. 2019;65(4):449–54. Available from: doi:https://doi.org/10.31403/rpgo.v65i2203
17. Díaz C, Copado Y, Muñoz G, Muñoz H. Malformaciones De La Pared Abdominal. Rev Médica Clínica Las Condes [Internet]. 2016;27(4):499–508. Available from: http://dx.doi.org/10.1016/j.rmclc.2016.07.009
18. Shrot S, Soares BP, Whitehead MT. Cerebral Diffusivity Changes in Fetuses with Chiari II Malformation. Fetal Diagn Ther [Internet]. 2019;45(4):268–74. Available from: https://www.karger.com/Article/FullText/490102
19. McLone DG, Dias MS. The Chiari II malformation: cause and impact. Child's Nerv Syst [Internet]. 2003 Aug 1;19(7–8):540–50. Available from: http://link.springer.com/10.1007/s00381-003-0792-3
20. Guleria S, Kelly TG, Maheshwari M, Segall HD. An Atypical Case of Chiari II Malformation Mimicking Partial Rhombencephalosynapsis. Neuroradiol J [Internet]. 2012 Oct;25(5):528–32. Available from: http://journals.sagepub.com/doi/10.1177/197140091202500505
21. Li T, Zhang Y, Nie F, Peng M, Li Y-Z, Li P. Diagnosis of foetal vein of galen aneurysmal malformation by ultrasound combined with magnetic resonance imaging: a case series. BMC Med Imaging [Internet]. 2020 Dec 12;20(1):63. Available from: https://bmcmedimaging.biomedcentral.com/articles/10.1186/s12880-020-00463-6
22. Cao L-R, Cai C-Q. Vein of Galen Aneurysmal Malformation: An Updated Review. J Pediatr Neurol [Internet]. 2019 Apr 8;17(02):045–56. Available from: http://www.thieme-connect.de/DOI/DOI?10.1055/s-0038-1635108
23. Elmahrouk AF, Helal A, Ismail MF, Hamouda T, Mashali M, Jamjoom AA, et al. Isolated right superior vena cava draining into the left atrium in a child with vein of Galen aneurysmal malformation—case report. J Cardiothorac Surg [Internet]. 2018 Dec 13;13(1):66. Available from: https://cardiothoracicsurgery.biomedcentral.com/articles/10.1186/s13019-018-0758-x
24. Sivasankar R, Limaye US, Wuppalapati S, Shrivastava M. Endovascular Management of Vein of Galen Aneurysmal Malformations: A Retrospective Analysis over a 15-Year Period. J Vasc Interv Neurol. 2019;10(3).
25. El Mekabaty A, Pearl MS, Mershon B, Berkowitz I, Gailloud P, Huisman TAGM. Susceptibility weighted imaging in infants with staged embolization of vein of Galen aneurysmal malformations. J Neuroradiol [Internet]. 2019 May;46(3):214–21. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0150986117303760
26. Mortazavi MM, Griessenauer CJ, Foreman P, Bavarsad Shahripour R, Shoja MM, Rozzelle CJ, et al. Vein of Galen aneurysmal malformations: critical analysis of the literature with proposal of a new classification system. J Neurosurg Pediatr [Internet]. 2013 Sep;12(3):293–306. Available from: https://thejns.org/view/journals/j-neurosurg-pediatr/12/3/article-p293.xml
27. Komiyama M, Miyatake S, Terada A, Ishiguro T, Ichiba H, Matsumoto N. Vein of Galen Aneurysmal Malformation in Monozygotic Twin. World Neurosurg [Internet]. 2016 Jul;91:672.e11-672.e15. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1878875016301589
28. Karadeniz L, Coban A, Sencer S, Has R, Ince Z, Can G. Vein of Galen aneurysmal malformation: Prenatal diagnosis and early endovascular management. J Chinese Med Assoc [Internet]. 2011 Mar;74(3):134–7. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1726490111000311