ournal or OR	IGINAL RESEARCH PAPER	Obstetrics & Gynecology
APP ULT SUG (FIR	LICABILITY OF FETAL DOPPLER RASOUND TO IDENTIFY ALTERATIONS GESTIVE OF EXTRA-CARDIAC ANOMALIES ST PART)	KEY WORDS: Ultrasound, doppler, fetus, vascular, malformation.
Arévalo Jaramillo María Daniela	Independent Investigator	
Paredes Andrade Gisela Janet	Independent Investigator	
Albán Intriago José Daniel	IndependentInvestigator	
Martínez Gutiérrez José Andrés	Independent Investigator	
López Valarezo Johanna Alejandra	Independent Investigator	
Rivera Obando Alain Michel	Independent Investigator	
Velasco Mora Sofía Alejandra	Independent Investigator	

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 a hemodynamic deterioration. **Objective:** To describe the applicability of fetal Doppler ultrasound in the main extra cardiac anomalies. **Methods:** Bibliographic review of scientific articles published in Spanish and English and their corresponding validation under CASPe and PRISMA tools. **Results:** A bibliographic analysis of 92 citations was carried out under the aforementioned systematic search in which the main fetal anomalies were separated under the supradiaphragmatic, infradiaphragmatic and cerebral concept. **Conclusion:** There are a limited literature regarding Doppler ultrasound evaluation in relation to extra-cardiac anomalies, and among them there are discrepancies in the findings found between 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)

The highest incidence of fetal malformations occurred in mothers with limited economic resources, as well as low educational and nutritional level, and little attendance at prenatal evaluation, with a striking fact representing 51% of fetal malformations corresponding to the circulatory system, 42% System Central Nervous System, 23% chromosomal, 22% digestive tract, 17% facial malformation, 8% musculoskeletal system and 7% respiratory system. (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.

Ayala et al, (3) divide the incidence of fetal malformations in adolescent mothers, middle-aged mothers, and elderly mothers; macrocephaly predominates in adolescent mothers with 44.4%, undescended testicle 22.2%, hydrocephalus 11.1%, among others; in middle age, other congenital malformation syndromes of exogenous causes with 15.4%, followed by congenital renal malformation 11%; congenital anemia and macrocephaly 7.7%; among other; and in advanced maternal age, Down syndrome predominates with 26.4%, followed by other congenital malformation syndromes due to exogenous causes with 15.1%; multiple malformations with 7.1% among others.

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. Objectives: 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.

SUPRADIAGRAMMATIC VASCULAR ANOMALIES

RIGHT OPENING SUBCLAVIA ARTERY (ASDA): is the most common congenital anomaly of the aortic arch; the right aortic arch recedes between the right common carotid and right subclavian arteries, instead of being distal to them; thus, this makes it difficult to fuse the right common carotid and right subclavian arteries to form the brachiocephalic artery. (5–7)

ASDA may be a useful ultrasound marker for Down syndrome in first trimester screenings. (5)

For Chaoui et al., During fetal echocardiography, the course of the right subclavian artery is observed after the evaluation of the 4-chamber projection, the outflow tracts and the 3-vessel and tracheal projection, in addition to the segmental view approach. In B-mode, color Doppler ultrasound is used to visualize the 3-vessel cross-sectional view and the trachea. (8)

LEFT FETAL BRACHICEFALIC VEIN: Also known as innominate vein, it runs in the superior mediastinum posterior to the thymus and anterior to the transverse aortic arch and the aortic branches, it can be visualized in color Doppler ultrasound at the level above the 3-view vessel, it is a normal and isolated variant does not justify an alteration in the routine management of pregnancy, but its absence or dilation is pathological and warrants a complete examination of abnormalities and a fetal echocardiography. (9-11)

CYSTIC HYGROMA: (lymphangioma) is a vascular anomaly associated with lymphatic malformations and formed by accumulation of fluid located mainly in the cervicofacial and axillary regions. (12.13)

The sonographic findings of cystic hygroma include collections of thin-walled, serpeginous or multisept intradermal fluid often found in the cervical regions. (14)

The color Doppler may not show an obvious internal flow that can be distinguished from the hemangioma as well, the color Doppler ultrasound is effective for the detection of intralesional hemorrhages, it can show pulsations from the septa towards the cysts, the differential diagnosis should also include encephalocele or cervical teratoma. (15)

FETAL MEDIASTINAL TERATOMA: Fetal teratomas are the most common tumors diagnosed prenatally, most are benign and are cured by complete resection of the mass during the neonatal period. (16)

Prenatal diagnosis has improved the perinatal management of these lesions, a comprehensive prenatal evaluation including conventional ultrasound, Doppler, echocardiography, and fetal magnetic resonance imaging, is essential for effective perinatal counseling and management. (16-18)

Doppler echocardiography traces the venous duct (DV) and umbilical vein (UV) as measurements that reflect the impediment to forward venous flow. (18.19)

The abnormal DV flow pattern is defined as almost absent or reversed flow with atrial contraction, whereas the abnormal UV flow pattern is defined as the presence of venous pulsations.(18–21)

Cardiac output for the right and left ventricle was estimated by pulsed wave Doppler interrogation through the pulmonary and aortic valves, respectively, using the formula: flow = $[3.14 \times \text{semilunar valve radius2} \times \text{velocity-time integral} \times \text{heart rate}] / estimated weight in kilograms, the normal$ combined right and left cardiac output in the fetus is 400 to500 ml/kg/min.(20-24)

FETAL PULMONARY ARTERY: its measurement under fetal Doppler ultrasound is a predictor of neonatal respiratory distress, its diagnosis is evaluated by measuring the pulsatility index (PI), resistance index (IR) and the relationship between acceleration time and execution time (TA / TE), while for now the pulsatility indices (IP) and resistance index (IR) do not show a greater contribution, the relationship between acceleration time and execution time (TA / TE) a cut-off point> 0.3 refers to prognostic sensitivity. (25)

CYSTIC ADENOID: Pulmonary cystic adenoid malformation (CCAM) is a rare abnormality of lung development, in most diagnosed cases the lesion is unilateral and in a single lung lobe, this pathology does not benefit from Doppler ultrasound. (26.27)

BRONCHOPULMONARY ABDUCTION:

Bronchopulmonary sequestration (SBP) is a rare congenital malformation of the respiratory tract characterized by a mass of non-functioning lung tissue, not communicated with the tracheobronchial tree. (28.29).

The diagnosis is established by observing by ultrasound a homogeneous increase in lung echogenicity and by identifying with color Doppler the systemic artery that nourishes the lesion, and that is characteristic of this pathology, although currently 3D Doppler ultrasound can provide more sensitivity to the diagnosis.(28.29)

Its pathognomonic sign is the demonstration with color Doppler or Power Doppler of an aberrant systemic nutrient vessel originating in the descending aorta, in addition to the nutritive artery, they always have a venous system that can drain systemically or, well, to the pulmonary veins. (28.29)

DISCUSSION

The transition from intrauterine to extrauterine life is a crucial event that requires adequate adaptation of the newborn, in relation to specific changes in the development of its organs as well as circulatory, metabolic, thermoregulation and pulmonary ventilation changes. (1)

Regarding supra-diaphragmatic vascular pathologies (ASDA), since the reports by Chaui et al, (2) above the presence of aberrant right subclavian artery in fetuses with Down syndrome, this finding has been described by several authors in high-risk pregnancies. and confirmed in a metaanalysis by Aghatokleus et al. (3) However, a last systemic review by Scala et al, (4) showed that this finding did not occur as frequently in patients with Down syndrome, so for our practice In general, it is necessary to consider that this aberration must be handled with care and provide additional information to the final evaluation.

The presence of a fetal left brachiocephalic vein has been reported to be consistently and reliably visualized and measured on a 2D ultrasound in the second and third trimesters of pregnancy, and in some fetuses in the first trimester, consideration should be given to the findings. from Nagashima et al. (5) Since he reports in his review with respect to this anomaly an incidence of 0.57% in association with congenital heart disease and in less than 0.02% as an isolated finding, as well as most of the cases, the course is left lateral to the aortic arch, crossing from left to right, anterior to the trachea, anterior and superior to the pulmonary trunk and posteriorly crossing the ascending aorta, for which it is considered to be present at the time of ultrasound analysis.

For Rodríguez et al. (6), in Mexico and Ruiz et al, in Chile (7) the situation of the cystic hygroma observed in the cervical region and on the left side is the most frequent described in the bibliography, since 75% of the referred cases present this localization, when a fetal cystic hygroma is detected, a thorough ultrasound study is recommended, in order to rule out other abnormalities, because it has been described that it can be associated with lymphedema (69%), hydrops (46%), oligohydramnios (68%), intrauterine growth retardation, polyhydramnios and cardiac alterations, which result in a decrease or absence of fetal movements.

Regarding the measurement of the fetal pulmonary artery, although there are certain parameters, there are still incongruities, perhaps due to differences in studies in relation to gestational age, as also reported by Guan et al, (8) Moety et al, (9) and the results are still contradictory between acceleration time / ejection time, perhaps explained by fetal maturation, however these parameters should be taken into consideration when reporting results until having more solid bases.

For Chaturvedi et al, (10) patients affected by congenital hepatic vascular shunts, these aberrant hepatic vascular communications include portosystemic venous shunts, arterioportal, arteriovenous or mixed shunts for which the Doppler flow will help in their diagnosis.

For Shrots S, et. al, (11) Chiari malformation indicates supratentorial microstructural changes, however more research is needed on the role of image diffusion metrics in the evaluation of abnormal brain development, parenchymal damage and the efficacy of fetal surgery. McLone et al. (11) 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. (12) referred to the diagnosis of prenatal Galen's vein (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 (13) It appears that the vein of Galen is caused by the highflow, 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 care, and thus reduce neonatal morbidity and mortality rates.

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

CONFLICTS OF INTEREST

None reported by the authors

REFERENCES

- 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
- 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.
- 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:// investigacion matern operinatal.inmp.gob.pe/index.php/rpinmp/article/view/171
 Martínez-Rodriguez, Pablo;Oliva-Caceres L. Flujometría Doppler. REV MED
- 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
- Gursoy Erzincan S, Karamustafaoglu Balci B, Tokgoz C, Kalelioglu IH. Incidence of an Aberrant Right Subclavian Artery on Second-Trimester Sonography in an Unselected Population. J Ultrasound Med [Internet]. 2017 May;36(5):1015-9. Available from: http:// doi. wiley. com/ 10.7863/ ultra. 16.05075
- Bataeva RS. OP16.10: Prenatal diagnosis of aberrant right subclavian artery (ARSA) in unselected population: our own experience. Ultrasound Obstet Gynecol [Internet]. 2017 Sep;50:101–101. Available from: http:// doi. wiley. com/10.1002/uog.17848
- Song MJ, Han BH, Kim Y-H, Yoon SY, Lee YM, Jeon HS, et al. Prenatal diagnosis of aberrant right subclavian artery in an unselected population. Ultrasonography [Internet]. 2017 Jul 1;36(3):278–83. Available from: http://eultrasonography.org/journal/view.php?doi=10.14366/usg.16046
- ultrasonography, org/journal/view.php?doi=10.14366/usg.16046
 Chaoui R, Heling K-S, Sarioglu N, Schwabe M, Dankof A, Bollmann R. Aberrant right subclavian artery as a new cardiac sign in second- and third-trimester fetuses with Down syndrome. Am J Obstet Gynecol [Internet]. 2005 Jan;192(1):257–63. Available from: https:// linkinghub. elsevier. com/ retrieve/pii/S0002937804007033
- Han J, Sun L, Gu X, Zhang Y, Guo Y, Hao X, et al. Prenatal Diagnosis of the Fetal Retroesophageal Left Brachiocephalic Vein: Case Series and Review of the Literature. J Ultrasound Med [Internet]. 2020 Feb 24;39(2):397–405. Available from:https://onlinelibrary.wiley.com/doi/abs/10.1002/jum.15099
- Sinkovskaya E, Abuhamad A, Horton S, Chaoui R, Karl K. Fetal left brachiocephalic vein in normal and abnormal conditions. Ultrasound Obstet Gynecol [Internet]. 2012 Nov;40(5):542–8. Available from: http:// doi. wiley. com/10.1002/uog.11166
- Shah N. Fetal Left Brachiocephalic Vein (LBCV): Visualization and Its Measurements in Indian Population. J Fetal Med [Internet]. 2020 Jun 14;7(2):145–7. Available from: http://link.springer.com/10.1007/s40556-020-00239-6
- Sadick M, Müller-Wille R, Wildgruber M, Wohlgemuth W. Vascular Anomalies (Part 1): Classification and Diagnostics of Vascular Anomalies. RöFo -Fortschritte auf dem Gebiet der Röntgenstrahlen und der Bildgeb Verfahren [Internet]. 2018 Sep 6;190(09):825–35. Available from: http://www.thiemeconnect.de/DOI/DOI?10.1055/a-0620-8925
- Wassef M, Blei F, Adams D, Alomari A, Baselga E, Berenstein A, et al. Vascular Anomalies Classification: Recommendations From the International Society for the Study of Vascular Anomalies. Pediatrics [Internet]. 2015 Jul 1;136(1):e203–14. Available from: http:// pediatrics. aappublications. org/ cgi/doi/10.1542/peds.2014-3673
- Phillips H, McGahan J. Intrauterine fetal cystic hygromas: sonographic detection. Am J Roentgenol [Internet]. 1981 Apr;136(4):799–802. Available from:http://www.ajronline.org/doi/10.2214/ajr.136.4.799
- Furue A, Mochizuki J, Onishi Y, Kawano S, Kanai Y, Kemmochi M, et al. Ultrasonic findings of fetal axillary lymphangioma with intralesional hemorrhage. J Med Ultrason [Internet]. 2016 Apr 26;43(2):285–9. Available from:http://link.springer.com/10.1007/s10396-015-0695-4
- Peiró JL, Sbragia L, Scorletti F, Lim FY, Shaaban A. Management of fetal teratomas. Pediatr Surg Int [Internet]. 2016 Jul 25;32(7):635–47. Available from:http://link.springer.com/10.1007/s00383-016-3892-3
- Chervenak FA, Isaacson G, Touloukian R, Tortora M, Berkowitz RL, Hobbins JC. Diagnosis and management of fetal teratomas. Int J Gynecol Obstet [Internet]. 1986 Dec;24(6):476–476. Available from: http:// doi. wiley. com/ 10.1016/0020-7292%2886%2990047-0
- Yuan S-M. Fetal Primary Cardiac Tumors During Perinatal Period. Pediatr Neonatol [Internet]. 2017 Jun;58(3):205-10. Available from: https://linkinghub.elsevier.com/retrieve/pii/S1875957216302443

- Yuan S-M, Lin H. Fetal intrapericardial teratomas. Turk J Pediatr [Internet]. 2019;61(2):163. Available from: http://www.turkishjournalpediatrics.org/ doi.php?doi=10.24953/turkjped.2019.02.001
 Yuan S-M. Fetal Intrapericardial Teratomas: An Update. Z Geburtshilfe
- Yuan S-M. Fetal Intrapericardial Teratomas: An Update. Z Geburtshilfe Neonatol [Internet]. 2020 Aug 23;224(04):187–93. Available from: http:// www.thieme-connect.de/DOI/DOI?10.1055/a-1114-6572
- Ouldamer L, Wagner A, Potin J, Poinsot J, Perrotin F. Prise en charge prénatale d'un tératome péricardique par drainage péricardio-amniotique : présentation d'un cas. J Gynécologie Obs Biol la Reprod [Internet]. 2012 Feb;41(1):92–5. Available from: https:// linkinghub. elsevier. com/ retrieve/ pii/S0368231511002031
- Kohl T, Strümper D, Witteler R, Merschhoff G, Alexiene R, Callenbeck C, et al. Fetoscopic Direct Fetal Cardiac Access in Sheep. Circulation [Internet]. 2000 Oct 3;102(14):1602–4. Available from: https:// www. aha journals. org/doi/10.1161/01.CIR.102.14.1602
- Arvind A, Rajeshkumar R, Thakur D, Sridhar A, Sivaprakasm M. Successful management of a neonate with antenatally detected mature intrapericardial teratoma. Ann Pediatr Cardiol [Internel]. 2019;12(2):182. Available from: http://www.annalspc.com/text.asp?2019/12/2/182/257405
- Morales-Quispe JA, Rebollar-Domínguez A, Caballero-Caballero R, Gutiérrez-Gutiérrez I, Jara-Alvis P, Brunner-Cruz G, et al. Teratoma intrapericárdico en etapa neonatal: Diagnóstico y evolución. Arch Cardiol Mex.2011;81(1).
- Kamaleldin Abdelhamid M, Said Abdel Ghani H, Abdel Wadood Khalil O, El-Gelany S, Mohamed Osman N. Quantitative Ultrasound Texture Analysis of Fetal Lung Versus Fetal Pulmonary Artery Doppler as a Predictor of Neonatal Respiratory Distress Syndrome (RDS). Int J Med Imaging [Internet]. 2020;8(2):23. Available from: http:// www.science.publishing.group.com/ journal/paperinfo?journalid=156&doi=10.11648/j.ijmi.20200802.12
- Vega RB, González JMM, Valdés EA, González AA, Olmo S, Camino FV. ginecología y obstetricia Diagnóstico prenatal.2015;42(2):83–5.
 Mex GO. Enfermedad adenomatoidea quística pulmonar , diagnóstico y
- Mex GO. Enfermedad adenomatoidea quística pulmonar , diagnóstico y manejo intrauterino .Reporte de un caso y revisio n bibliográfica Congenital cystic adenomatoid malformation of the lung , intrauterine. 2015;320–7.