10.5005/jp-journals-10009-1533

REVIEW ARTICLE

Ventriculomegaly

[1]Vincenzo D'Addario, [2]Luca Di Cagno, [3]Pasquale Capuano, [4]Mariangela Cialdella

ABSTRACT

Fetal cerebral ventriculomegaly (VM) is defined as an enlargement of the lateral ventricles of the developing fetal brain. It is diagnosed when the width of one or both lateral ventricles, measured at the level of the atrium, is ≥10 mm. Ventriculomegaly is defined as mild when the atrial width is 10 to 12 mm, moderate 12.1 to 15 mm, and severe >15 mm. It can be isolated, but often is a sign of different pathological conditions. Since the prognosis in cases of VM depends mainly on the associated anomalies, a careful examination of the fetus, particularly of the brain, is mandatory. Magnetic resonance imaging (MRI) can be a useful diagnostic tool complementary to ultrasound in order to recognize subtle brain anomalies, such as neuronal migration and proliferation disorders. In this review article, the diagnostic workup, the counseling, and the outcome of fetal VM are discussed.

Keywords: Fetus, Hydrocephalus, Prenatal diagnosis, Ultrasound, Ventriculomegaly.

How to cite this article: D'Addario V, Di Cagno L, Capuano P, Cialdella M. Ventriculomegaly. Donald School J Ultrasound Obstet Gynecol 2017;11(4):276-281.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

Fetal cerebral VM is defined as an enlargement of the lateral ventricles of the developing fetal brain. The prevalence ranges from 0.3 to 1.5 per 1,000 births in different series. Ventriculomegaly is more common in males; the male-to-female sex ratio is 1.7.

It can be caused by a variety of disorders that result in neurological, motor, and/or cognitive impairment. The mechanisms producing VM are various. One is the abnormal turnover of cerebrospinal fluid as a consequence of an obstruction to flow or a hyperproduction of fluid. The most usual location of the internal or "noncommunicating" VM is the aqueduct of Sylvius, which can be obstructed by abnormalities, such as forking, septum, gliosis secondary to infections, and blood clots secondary to intraventricular bleeding. In the external or "communicating" VM, the obstruction is outside the ventricular cavities in the arachnoid spaces, such as Chiari II malformation, where the VM is secondary to the effacement of the cisterna magna. Ventriculomegaly may be associated with anomalies of the brain, such as corpus callosum agenesis, neuronal migration and proliferation disorders, or destructive lesions, such as tumors and vascular malformations. When no abnormality is associated, it is defined as isolated VM.

[1]Professor, [2,3]Consultant, [4]Resident

[1,4]Department of Obstetrics and Gynecology, University of Bari Bari, Italy

[2]Obstetrics and Gynecology Unit, Cerignola Hospital, Italy

[3]Obstetrics and Gynecology Unit, Barletta Hospital, Italy

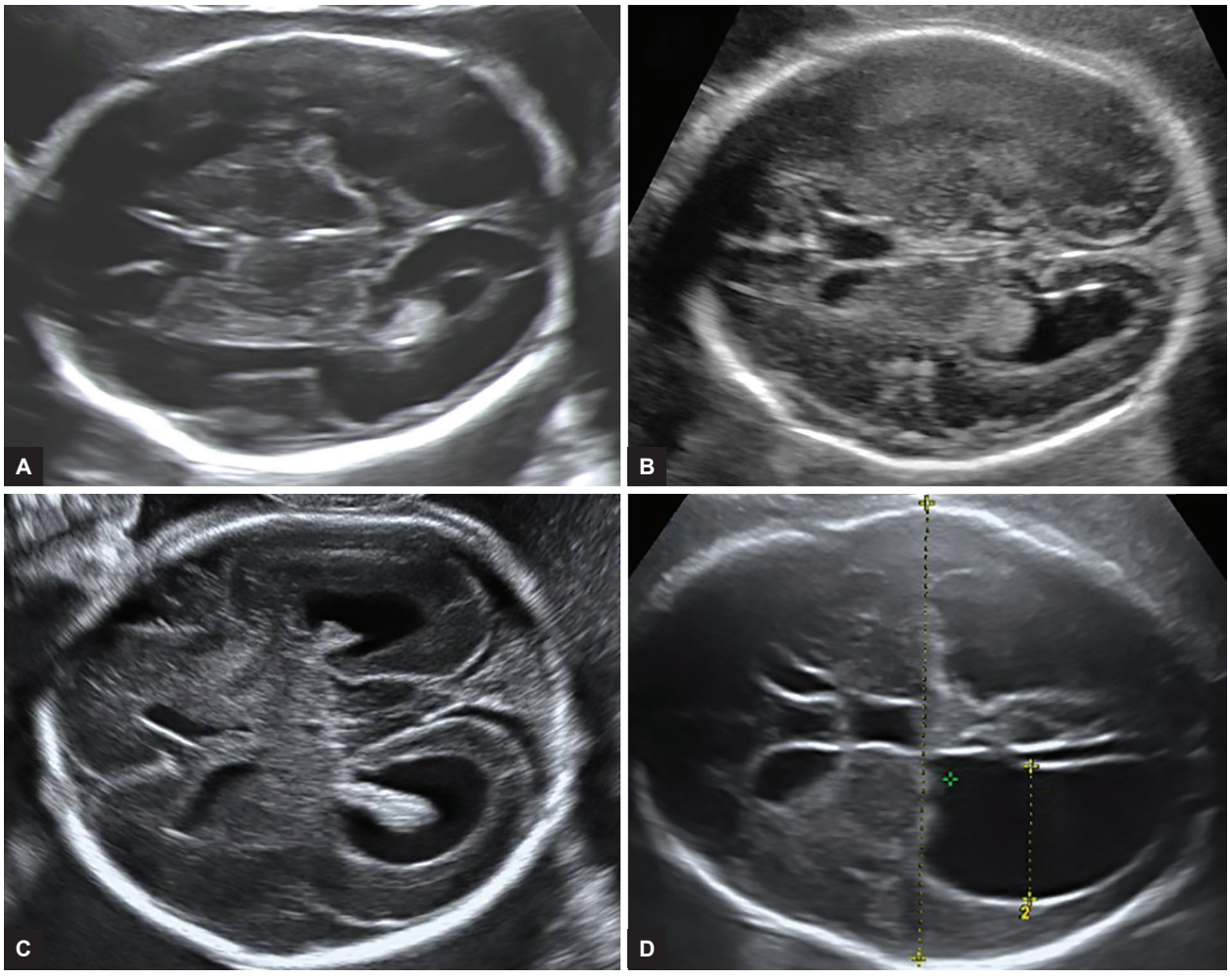
Corresponding Author: Vincenzo D'Addario, Professor Department of Obstetrics and Gynecology, University of Bari Bari, Italy, e-mail: daddariov@alice.it

PRENATAL DIAGNOSIS

The ultrasonic prenatal diagnosis of fetal VM relies on the measurement of the atrial width, which is routinely performed during the second trimester screening. The measurement is done on the transventricular plane at the level of the atria of the lateral ventricles filled by the echogenic choroid plexuses. The calipers are positioned at the internal margin of the medial and lateral wall of the atria, perpendicularly to the inner and outer borders of the ventricles.[1-3] An atrial width is considered normal if <10 mm. Ventriculomegaly is diagnosed when the width of one or both lateral ventricles, measured according to standard criteria, is ≥10 mm. The most frequently used terminologies are "mild or borderline VM," defined as atrial measurements of 10 to 15 mm, and "severe VM," when atrial width is >15 mm. These terms will be used in this study. Some authors divide the group of mild VM into two subgroups: "milder VM" (10–12 mm) and "moderate VM" (12.1–15 mm; Fig. 1).

Ventriculomegaly can be bilateral or unilateral. Usually in the screening ultrasound examinations, only the lateral ventricle distal to the transducer is measured since the proximal one is obscured by reverberation artifacts. Efforts should be made in order to visualize both ventricles and recognize unilateral and bilateral VM; a useful scanning plane is the coronal one on the posterior horns on the lateral ventricles (Fig. 2).

The sensitivity of ultrasound in screening for VM is controversial. The largest multicenter study in Europe (eurofetus)[4] reported a sensitivity of 93.5%. However, this apparently good result refers to the severe forms of VM and also includes cases diagnosed in the third trimester. Before 24 gestational weeks, the sensitivity



Figs 1A to D: Atrial width in cases of normal ventricle (A), mild VM (B), moderate VM (C) and severe VM (D)

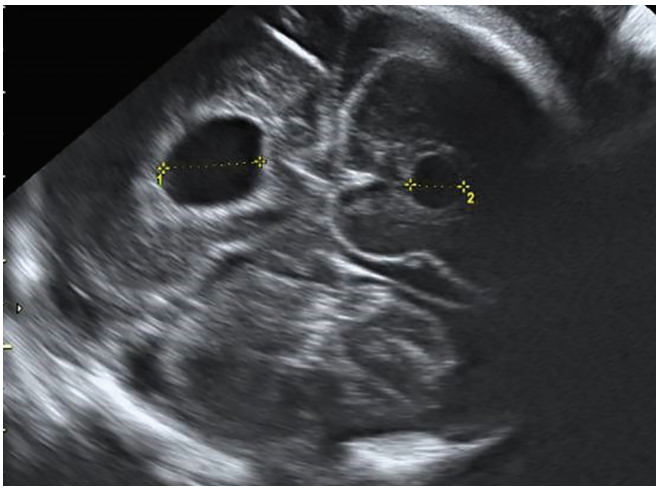


Fig. 2: Unilateral VM assessed on the coronal plane of the occipital lobes

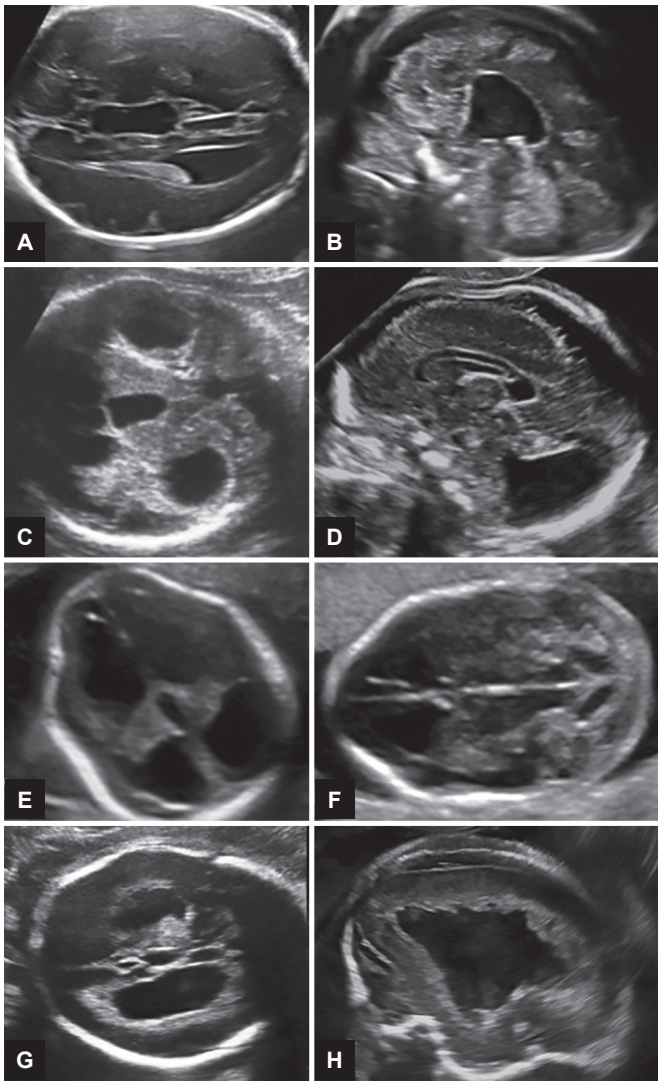
drops to 35%, probably reflecting the natural history of the disease, rather than a measurement error. Central nervous system (CNS) lesions that could be misdiagnosed as VM by unexperienced operator include holoprosencephaly, hydranencephaly, porencephaly, and various cystic lesions, such as arachnoid cysts.

DIAGNOSTIC WORKUP

Once the diagnosis of VM is confirmed, a careful evaluation of the whole fetal anatomy should be performed by an experienced sonographer in order to rule out for CNS and extra-CNS anomalies. The associated anomalies are more frequent in cases of severe VM and have been reported in up to 65%.[5,6] The rate of association between structural abnormalities with mild VM varies widely with an average value of 41.4%.[7]

A comprehensive examination of the CNS is mandatory and should include a detailed evaluation of the lateral, third and fourth ventricles, corpus callosum, thalami, germinal matrix region, posterior fossa, brain cortex, and pericerebral spaces with the aim to differentiate truly isolated VM from VM associated with other CNS abnormalities.[8-10]

The list of brain abnormalities associated with VM is wide: agenesis of corpus callosum, aqueductal stenosis, Chiari II malformation, Dandy-Walker malformation, cortical malformations, heterotopias, occupying space lesions (cysts, tumors), and many others. Some examples are reported in Figure 3.



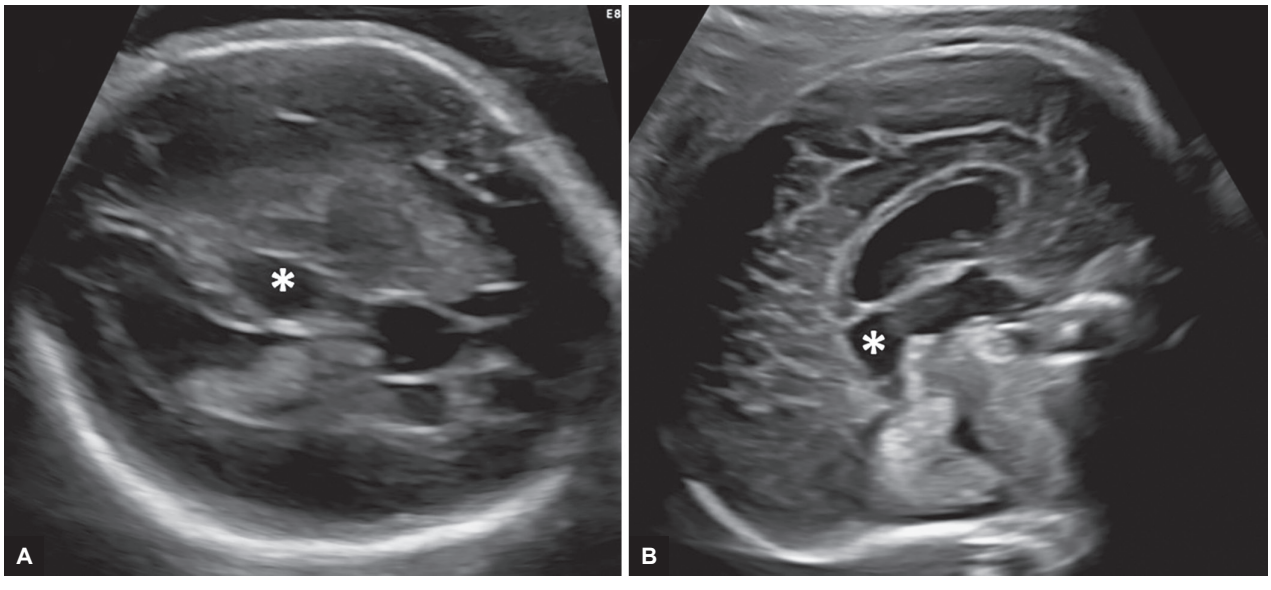
Figs 3A to H: Examples of brain malformations associated with VM: (A and B) Agenesis of corpus callosum with cystic dilatation of the third ventricle; (C and D) Dandy–Walker malformation; (E and F) Chiari II malformation; (G) microlissencephaly; and (H) periventricular heterotopia

In case of obstructive VM downstream to the third ventricle, an early sign can be the identification of an interhemispheric cyst referring to a dilated suprapineal recess[11] (Fig. 4). With the progression of ventricular dilatation in the most severe forms, a barotraumatic lesion may cause fenestration of the cavum septi pellucidi with wide communication between the two ventricles[12] (Fig. 5). A further sign of obstructive VM is the reduction of the pericerebral spaces.

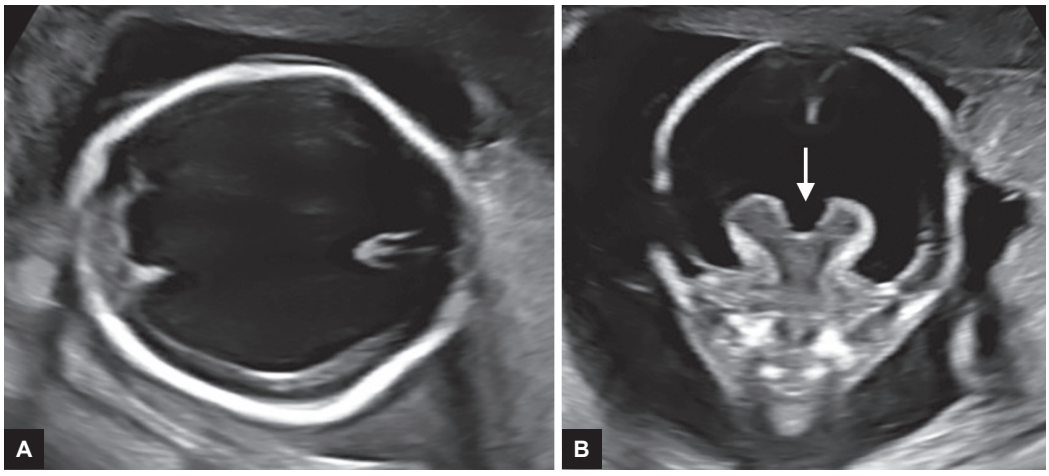
Intraventricular hemorrhage can be a further cause of VM. In this case, the VM may be unilateral or asymmetrical, blood clots may be recognized in the dilated ventricles which also show hyperechoic walls (Fig. 6). A search of alloimmune thrombocytopenia is indicated.[13]

Sonographic signs suggestive of infections are periventricular microcalcifications and small subependymal pseudocysts (Fig. 7). Infections are more frequently found in cases of severe VM, which develop in late pregnancy. The rate of infection is 10 to 20% in severe and 1 to 5% in mild VM.[14]

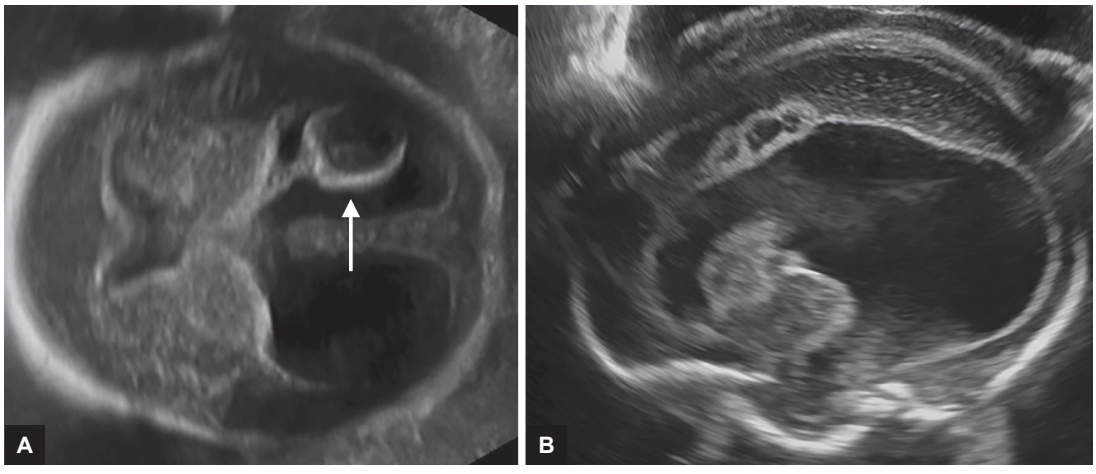
In order to improve the diagnostic accuracy in recognizing associated anomalies, the use of magnetic MRI has been advocated. In a study on 214 fetuses with VM, Levine et al[15] noted that MRI led to a change in the diagnosis in around 23% of cases identified as abnormal at ultrasound, a change in counseling in around 41%, and a change in patient management in 13.5%. Morris et al[16] reported excellent results with MRI, which added useful findings to achieve the correct final diagnosis in 50% of cases with sonographically detected VM. The same group stressed the role of MRI in the correct evaluation of the shape of the lateral ventricles, reporting an "angular" shape in cases of associated spinal defects and a disproportionate enlargement of the occipital horns with or without abnormal orientation of the frontal horns in cases



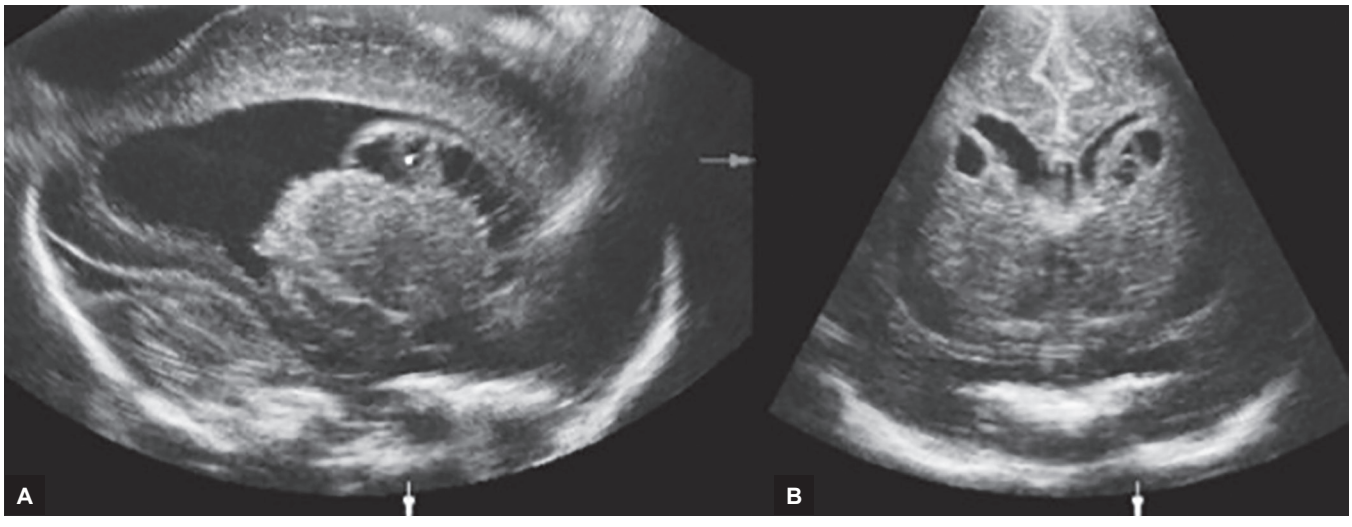
Figs 4A and B: Dilatation of the suprapineal recess (*) as early sign of obstructive VM downstream to the third ventricle



Figs 5A and B: Severe bilateral VM with fenestration of the Cavum Septi Pellucidi (CSP) due to (A) Siencephalosynapsis; and (B) aqueductal stenosis (arrow)



Figs 6A and B: Posthemorrhagic VM. A blood clot (arrow) may be recognized in the dilated ventricles which also show hyperechoic walls



Figs 7A and B: Ventriculomegaly and multiple small subependymal pseudocysts

of associated agenesis of the corpus callosum. However, these morphological findings may also be visualized by a dedicated neurosonography.[17] The brain pathologies associated with VM that could be missed by ultrasound and could be recognized by MRI are mainly represented by neuronal migration disorders, delayed sulcation and gyration, heterotopias, and intraparenchymal hemorrhage.[18-20] Since most of these pathologies develop late

in pregnancy, the appropriate time to perform MRI is the late second or third trimester. It must be done by experienced operators in referral centers, following an accurate neurosonography.

The diagnostic workup of a VM should also include the evaluation of the fetal karyotype. The incidence of chromosomal abnormalities is high (>15%) in both mild and severe VM in the presence of an associated structural anomaly.[21] The incidence of abnormal karyotype in fetuses with isolated mild VM is a controversial issue: Three meta-analyses report an incidence of abnormal karyotype in isolated mild VM of 2.8%,[7] 5%,[22] and 4.6%[23] respectively. The variation in results may depend on the prevalence of trisomies in the studied population, which in turn depends on previously applied screening programs.

OUTCOME

The outcome of fetuses with VM mainly depends on the cause of the ventricular dilatation and the presence of associated anomalies or chromosomopaties or infections. The severity of ventricular dilatation is less important for the determination of the postnatal outcome. When a cause is diagnosed, it is relatively simple to counsel the parents, even though there are some associated anomalies that can carry an extremely variable prognosis, such as agenesis of corpus callosum. On the contrary, counseling is difficult in cases of isolated VM. Studies on the long-term outcome of fetuses with VM (both severe and mild) are limited: Most of them are retrospective studies with different modalities of follow-up. Three studies[5,6,24] on the follow-up of fetuses with isolated severe VM report a normal neurological outcome in 62.5, 11, and 12.5% respectively. This wide variation in results may depend on the different length of follow-up and different modalities of the neurological evaluation: Breeze et al[6] used the modified Amiel Tison mode at 4 months after delivery; Graham et al[24] used the Clinical Adaptive Test and the Clinical Linguistic and Auditory Milestone Scale at 48 months from delivery. These results, based on objective evaluations, are probably more reliable than the good results reported by Gaglioti who conducted interviews with parents at 24 months, which can sometimes be subjective.

The neurological outcome of fetuses with prenatal diagnosis of isolated mild VM also varies widely across studies. The incidence of neurodevelopmental delay ranges widely from 0 to 28.6%. The three already cited meta-analyses by Melchiorre et al,[7] Devaseelan et al,[22] and Pagani et al[23] report an incidence of neurodevelopmental delay of 10.9, 12 and 7.6%. Some authors have considered the neurological outcome in relation to the degree of borderline VM: The mean rate of neurodevelopmental delay is higher in moderate VM 12.0 to 15.0 mm (17.1%) compared with mild VM 10.0 to 11.9 mm (5%).

A factor which can significantly influence the prognosis is the progression of the VM in the ongoing pregnancy. Ventriculomegaly progresses in 15.7% of cases and these cases present the worst prognosis. The neurodevelopmental delay in cases of isolated progressive VM is 16.7%; in the group of fetuses with progressive VM, there is also the highest incidence of chromosomal abnormalities (22.2%) and associated anomalies (71.4%); the overall abnormal outcome is 44.4%.[9]

CONCLUSION

Ventriculomegaly is an easily recognizable sonographic finding requiring an accurate diagnostic workup in order to counsel the parents properly. Indipendently of the degree of VM (mild or severe), an accurate search for CNS and extra-CNS anomalies must be made. The evaluation of fetal karyotype is recommended. A search for fetal infections should also be performed. Even in the presence of normal karyotype, absence of infection, and apparently normal fetal anatomy, when counseling the parents one should be aware of the limited accuracy of ultrasound in distinguishing isolated from nonisolated VM. Furthermore, the possibility of progression of the VM and of late-onset brain anomalies should be taken into account. For this reason, serial ultrasound examinations have to be planned and the possibility of fetal MRI in the third trimester should be considered. Even in cases of apparently normal findings, the parents must be informed about the possibility that some anomalies or syndromes cannot be diagnosed before birth.

REFERENCES

1. Pilu G, Reece EA, Goldstein I, Hobbins JC, Bovicelli L. Sonographic evaluation of the normal developmental anatomy of the fetal cerebral ventricles: II. The atria. Obstet Gynecol 1989 Feb;73(2):250-256.
2. Farrell TA, Hertzberg BS, Kliewer MA, Harris L, Paine SS. Fetal lateral ventricles: reassessment of normal values for atrial diameter at US. Radiology 1994 Nov;193(2):409-411.
3. Guibaud L. Fetal cerebral ventricular measurement and ventriculomegaly: time for procedure standardization. Ultrasound Obstet Gynecol 2009 Aug;34(2):127-130.
4. Grandjean H, Larroque D, Levi S. The performance of routine ultrasonographic screening of pregnancies in the Eurofetus Study. Am J Obstet Gynecol 1999 Aug;181(2):446-454.
5. Gaglioti P, Oberto M, Todros T. The significance of fetal ventriculomegaly: etiology, short- and long-term outcomes. Prenat Diagn 2009 Apr;29(4):381-388.
6. Breeze ACG, Alexander PMA, Murdoch EM, Missfelder-Lobos HH, Hackett GA, Lees CC. Obstetric and neonatal outcome in severe ventriculomegaly. Prenat Diagn 2007 Feb;27(2):124-129.
7. Melchiorre K, Bhide A, Gika AD, Pilu G, Papageorghiou AT. Counseling in isolated mild fetal ventriculomegaly. Ultrasound Obstet Gynecol 2009 Aug;34(2):212-224.

8. International Society of Ultrasound in Obstetrics & Gynecology Education Committee. Sonographic examination of the fetal central nervous system: guidelines for performing the "basic examination" and the "fetal neurosonogram". Ultrasound Obstet Gynecol 2007 Jan;29(1):109-116.
9. D'Addario V, Rossi AC. Neuroimaging of ventriculomegaly in the fetal period. Semin Fetal Neonatal Med 2012 Dec;17(6):310-318.
10. Guibaud L, Lacalm A. Etiological diagnostic tools to elucidate 'isolated' ventriculomegaly. Ultrasound Obstet Gynecol 2015 Jul;46(1):1-11.
11. Azzi C, Giaconia MB, Lacalm A, Massoud M, Gaucherand P, Guibaud L. Dilatation of the supra-pineal recess on prenatal imaging: early clue for obstructive ventriculomegaly downstream of the third ventricle. Prenat Diagn 2014 Apr;34(4):394-401.
12. Cagneaux M, Vasiljevic A, Massoud M, Allias F, Massardier J, Gaucherand P, Guibaud L. Severe second trimester ventriculomegaly revealing obstruction related to pathologies of rhombencephalic, mesencephalic and diencephalic differentiation. Ultrasound Obstet Gynecol 2013 Nov;42(5):596-602.
13. Martillotti G, Rypens F, David M, Catalfamo N, Dubé J, Taillefer C, Lachance C, Audibert F. Association between fetal cerebral ventriculomegaly and platelet alloimmunisation. Fetal Diagn Ther 2017 Aug;42(1):35-41.
14. Gaglioti P, Danelon D, Bontempo S, Mombrò M, Cardaropoli S, Todros T. Fetal cerebral ventriculomegaly: outcome in 176 cases. Ultrasound Obstet Gynecol 2005 Apr;25(4):372-377.
15. Levine D, Barnes PD, Robertson RR, Wong G, Mehta GS. Fast MR imaging of fetal central nervous system abnormalities. Radiology 2003 Oct;229(1):51-61.
16. Morris JE, Rickard S, Paley MNJ, Griffiths PD, Rigby A, Whitby EH. The value of in-utero magnetic resonance imaging in ultrasound diagnosed foetal isolated cerebral ventriculomegaly. Clin Radiol 2007 Feb;62(2):140-144.
17. Malinger G, Ben-Sira L, Lev D, Ben-Aroya Z, Kidron D, Lerman-Sagie T. Fetal brain imaging: a comparison between magnetic resonance imaging and dedicated neurosonography. Ultrasound Obstet Gynecol 2004 Apr;23(4):333-340.
18. Benacerraf BR, Shipp TD, Bromley B, Levine D. What does magnetic resonance imaging add to the prenatal sonographic diagnosis of ventriculomegaly? J Ultrasound Med 2007 Nov;26(11):1513-1522.
19. Manganaro L, Savelli S, Francioso A, Di Maurizio M, Coratella F, Vilella G, Noia G, Giancotti A, Tomei A, Fierro F, et al. Role of fetal MRI in the diagnosis of cerebral ventriculomegaly assessed by ultrasonography. Radiol Med 2009 Oct;114(7):1013-1023.
20. Rossi AC, Prefumo F. Additional value of fetal magnetic resonance imaging in the prenatal diagnosis of central nervous system anomalies: a systematic review of the literature. Ultrasound Obstet Gynecol 2014 Oct;44(4):388-393.
21. Nicolaides KH, Berry S, Snijders RJM, Thorpe-Beeston JG, Gosden C. Fetal lateral cerebral ventriculomegaly: associated malformations and chromosomal defects. Fetal Diagn Ther 1990;5(1):5-14.
22. Devaseelan P, Cardwell C, Bell B, Ong S. Prognosis of isolated mild to moderate fetal cerebral ventriculomegaly: a systematic review. J Perinat Med 2010 Jul;38(4):401-409.
23. Pagani G, Thilaganathan B, Prefumo F. Neurodevelopmental outcome in isolated mild fetal ventriculomegaly: systematic review and meta-analysis. Ultrasound Obstet Gynecol 2014 Sep;44(3):254-260.
24. Graham E, Duhl A, Ural S, Allen M, Blakemore K, Witter F. The degree of antenatal ventriculomegaly is related to pediatric neurological morbidity. J Matern Fetal Med 2001 Aug;10(4):258-263.