Unilateral ventricular dilatation. Follow-up during the first two years of life

Adrian Ioan Toma[1,2,3], Aura Irina Cuzino[1], Alexandra Cozinov[1], Raluca-Gabriela Olteanu[1], Gabriela Corina Zaharie[4], Vlad Dima[5], Roxana-Elena Bohîlțea[6,7]

1. Department of Neonatology, Life Memorial Hospital, Bucharest, Romania

2. Department of Pediatric Neurology, Life Memorial Hospital, Bucharest, Romania

3. Department of Neonatology, "Titu Maiorescu" University of Medicine, Bucharest, Romania

4. Department of Neonatology, "Iuliu Haţieganu" University of Medicine and Pharmacy, Cluj-Napoca, Romania

5. Department of Neonatology, "Filantropia" Clinical Hospital of Obstetrics and Gynecology, Bucharest, Romania

6. Department of Obstetrics and Gynecology, "Filantropia" Clinical Hospital of Obstetrics and Gynecology, Bucharest, Romania

7. Department of Obstetrics and Gynecology, "Carol Davila" University of Medicine and Pharmacy, Bucharest, Romania

Corresponding author:
Vlad Dima
E-mail: dima.vlad@yahoo.com

Abstract

Objective. *To investigate if the unilateral ventricular dilatation detected by fetal and neonatal ultrasound is associated with neurological abnormalities during the first two years of life.* ***Materials and method.*** *A number of 1319 neonates were examined by head ultrasound on the first and third days of life. Prenatal histories and ultrasound were collected in all cases. There were selected the cases with unilateral ventricular dilatation that were examined by head ultrasound at one, two, four and six months and by clinical and neurologic examination and, if needed, using specific imaging and neurologic investigations at one, two, four, six, twelve months and at two years.* ***Results.*** *There were detected the dilatation of the left ventricle (18 cases), posterior horn of the left ventricle (88 cases), and posterior horn of the right ventricle (12 cases). All these cases were asymptomatic during the neonatal period and only six out 88 cases with left posterior horn dilatation and one of the 12 the cases with right posterior horn dilatation developed neurologic abnormalities. All these cases were identified before delivery by fetal ultrasound. The abnormalities identified were: tonus abnormalities – hypotonic at 4 and 6 months with normalization at 12 months in three out of 88 cases with left posterior horn dilatation and one out of 12 cases with dilatation of the posterior horn of the right ventricle. There were delays in the fine motor skills in all the six symptomatic cases with left ventricular dilation and in one out of 12 cases with right ventricular dilation.* ***Conclusions.*** *Unilateral ventricular dilatation detected by neonatal ultrasound is usually asymptomatic. The symptomatic cases are characterized by transient tonus abnormalities and abnormalities in the fine motor skills.*

Keywords: *unilateral ventricular dilatation, ultrasound, outcome, neurologic, fine motor*

Rezumat

Obiectiv. *A investiga dacă dilatația ventriculară unilaterală detectată prin ecografie fetală și neonatală este asociată cu anomalii neurologice în primii doi ani de viață.* ***Materiale și metodă.*** *Un număr de 1319 nou-născuți au fost examinați prin ecografie a capului în zilele 1 și 3 de viață. În toate cazurile, au fost recoltate datele de istoric prenatal și ecografie. Au fost selectate cazurile cu dilatare ventriculară unilaterală care au fost examinate prin ecografia capului la una, două, patru și șase luni și prin examen clinic și neurologic și, la nevoie, utilizând investigații imagistice și neurologice specifice la una, două, patru, șase și 12 luni și la doi ani.* ***Rezultate.*** *S-au depistat dilatarea ventriculului stâng (18 cazuri), a cornului posterior al ventriculului stâng (88 de cazuri) și a cornului posterior al ventriculului drept (12 cazuri). Toate aceste cazuri au fost asimptomatice în perioada neonatală, și doar șase din 88 de cazuri cu dilatarea cornului posterior stâng și unul din 12 cazuri de dilatație a cornului posterior drept au dezvoltat anomalii neurologice. Toate aceste cazuri au fost identificate înainte de naștere prin ecografie fetală. Anomaliile identificate au fost: anomalii de tonus – hipotonic la 4 și 6 luni cu normalizare la 12 luni în trei din 88 de cazuri cu dilatarea cornului posterior stâng și în unul din cele 12 cazuri cu dilatarea cornului posterior al ventriculului drept. Au existat întârzieri ale abilităților motorii fine în toate cele șase cazuri simptomatice cu dilatare ventriculară stângă și la unul din cele 12 cazuri cu dilatare ventriculară dreaptă.* ***Concluzii.*** *Dilatația ventriculară unilaterală detectată prin ecografie neonatală este de obicei asimptomatică. Cazurile simptomatice se caracterizează prin anomalii tranzitorii ale tonusului și prin anomalii ale motricității fine.*

Cuvinte-cheie: *dilatare ventriculară unilaterală, ecografie, rezultat, neurologic, motricitate fină*

Submission date:
4.12.2021
Acceptance date:
10.12.2021

Ventriculomegalia unilaterală. Monitorizare pe parcursul primilor doi ani de viață

Suggested citation for this article: Toma AI, Cuzino AI, Cozinov A, Olteanu RG, Zaharie GC, Dima V, Bohîlțea RE. Unilateral ventricular dilatation. Follow-up during the first two years of life. Ginecologia.ro. 2021;34(4):52-57.

Introduction

Fetal ultrasound examination is now part of the routine management of the pregnancy[1-3] and the examination of the fetal brain is a standard part of this procedure[1-3]. The dilatation of the lateral ventricles is one of the commonest findings (1-2% of all ultrasound examinations in pregnancy)[5,6] and could be determined after 20 weeks of gestation[4,5].

The main issue in the case of discovering a dilatation of the lateral ventricles (either unilateral, or bilateral) is represented by anticipating the outcome of the lesion[4,5].

The confirmation of the dilatation of the lateral ventricles after delivery is usually done by postnatal head ultrasound[4,5]. The measurement of the lateral ventricles in the newborn uses different landmarks and diameters than the ones used in the fetus: the Levene index[6] is

considered the most appropriate[7], but is related to the anterior horns, the ventricular index, the anterior horn width and the thalamo-occipital distance[8]. For these measurements, specific nomograms have been developed in the case of preterm[7,9] and term[8,10,11] newborns.

In case of the severe ventriculomegaly diagnosed antenatally, the prognosis is unfavorable. In a series of 20 cases of antenatal ventricular dilatation[5], all the children but one had severe neurologic disability. The rate of neurodevelopmental delay in infants with isolated mild ventriculomegaly is reported to be around 11%, and it is unclear whether this is increased over that in the general population[7]. The most important prognostic factors are the association with other abnormalities undetected at the time of the first diagnosis and the progression of the ventricular dilatation[7].

Aim

The aim of our study was to investigate if the unilateral ventricular dilatation detected by neonatal ultrasound was associated with neurological abnormalities during the first two years of life. There was also investigated if the cases with neurologic and neurobehavioral abnormalities could be identified without neonatal ultrasound (i.e., only by fetal ultrasound and neonatal neurologic examination).

Materials and method

Population studied

There were included in the study 1319 neonates, born in the same hospital, in a period of 24 months. They were term and preterm neonates (with gestational ages between 41 and 35 weeks). The patients were included in the study after obtaining the informed consent from the families.

Prenatal and neonatal periods

The obstetric history was obtained before delivery (around 37 weeks at the prenatal neonatal consultation) and when the delivery occurred before the prenatal consult to take place, the file was filled after delivery, when the status of the mother allowed this. There were obtained information about the gestational age, due date, prenatal ultrasound scans (and MRI scans when done) and the abnormalities diagnosed at these scans (both cerebral and other organs). The study did not interfere with the protocol of follow-up of the pregnancy.

All the neonates had a clinical and neurological evaluation on the first and the third days of life. The neurologic examination was performed according to Amiel-Tison neurologic examination chart[12]. The abnormalities of posture, tone (active and passive) and reflexes were noted. There was also noted the gestational age, birth weight, head circumference, presence of other abnormalities and malformations.

The ultrasound examinations were performed by two neonatologists with competency in head ultrasound on day 1-3 of life. The examination file contained data about: appearance of cerebral parenchyma, cerebral ventricles, posterior fossa, and presence of hemorrhages or other abnormalities. In the case of the cerebral ventricles, there were measured: the ventricular index (VI) (Figure 1) for the anterior horn[6,8], and the thalamo-occipital distance (TOD)[8] (Figure 2) for the occipital horn. The normal values were reported for gestational age as a percentile of the normal and there were used the curves from references 8 and 11.

There were noted the cases in which ventricular dilatation was observed (either bilateral, or unilateral dilatation). The ventricular dilatation was considered when either VI or TOD were above the 95th percentile for the gestational age.

Follow-up of the cases

The cases in which ventricular dilatation was noted were followed-up for a period of two years. The follow-up visits occurred at one, two, four, six, 12 and 24 months.

During the visits at one, two, four and six months, there were performed a clinical examination, a neurologic examination, according to the Amiel Tison[13] exam, and a head ultrasound, in which the same measurements of the ventricles were performed (VI and TOD). The

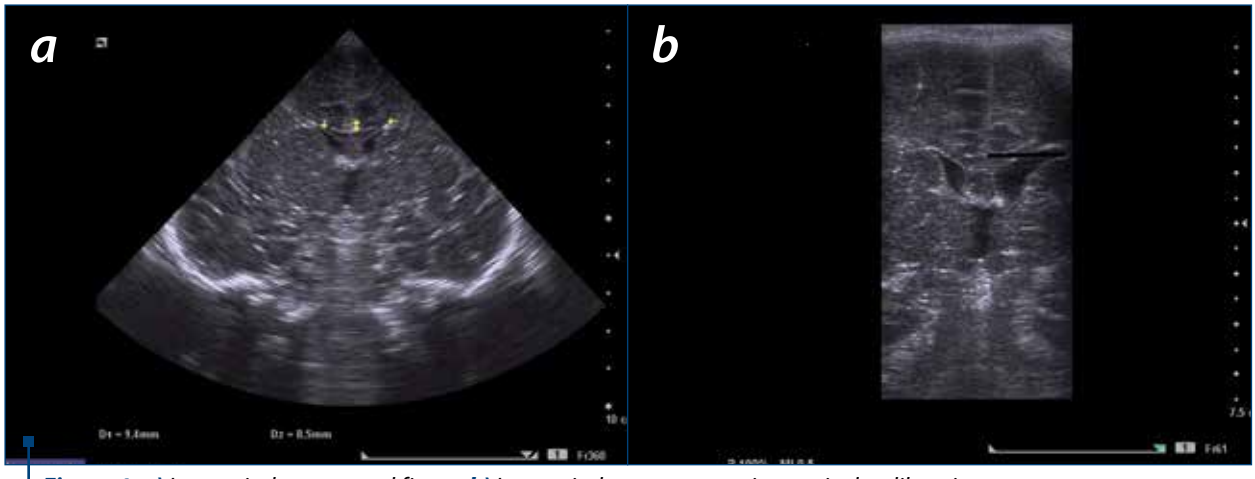

Figure 1. a) *Levene index – normal figure;* ***b)*** *Levene index – asymmetric ventricular dilatation*

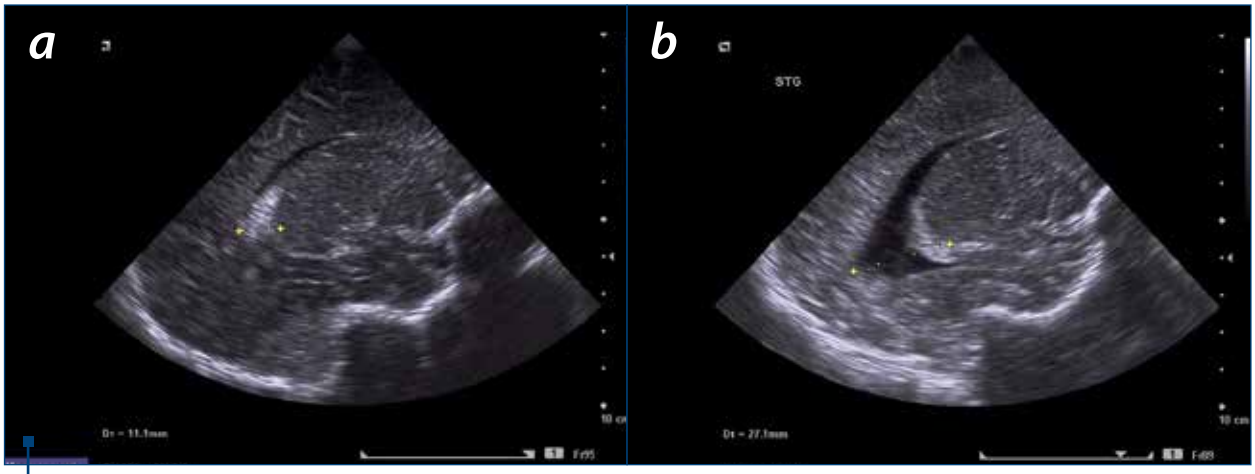

Figure 2. a) *Thalamo-occipital distance – normal;* ***b)*** *Thalamo-occipital distance – ventricular dilatation*

results of the neurologic examination and the ultrasound measurements were noted.

At the visits at 6, 12 and 24 months, there were performed a neurologic examination according to the same protocol and a Bayley 3 test[14] (cognitive, communication and motor subsets). The results of the neurologic examination, and the score at the different subsets and at different items of the tests were noted.

The patients with abnormalities noted at the neurologic examination or Bayley test entered in an early intervention program.

Results

Neonatal period

Out of the 1319 neonates examined, 1102 had normal ultrasound examinations. Out of the 217 cases with abnormalities, unilateral ventricular dilatation was noted in 118 cases (18 cases with dilatation of the left ventricle, 88 cases with dilatation of the posterior horn of the left ventricle and 12 cases with dilatation of the posterior horn of the right ventricle) – Table 1.

All the neonates with unilateral ventricular dilatation were normal on the neurologic examination performed in the neonatal period. The head circumference was in the normal limits in all the neonates with unilateral ventricular dilatation found on ultrasound.

Follow-up

From the cases with ventricular dilatation, six out of 88 cases with left posterior horn dilation and one out of 12 of the cases with right posterior horn dilation developed neurologic abnormalities at follow up (Table 1). There were two types of neurologic abnormalities: abnormalities of the items regarding the passive tonus, and abnormalities regarding the control of the head (active tonus).

The passive tonus abnormalities were present in four cases: three cases with dilatation of the posterior horn of the left ventricle, and one case with dilatation of the posterior horn of the right ventricle. In three of the cases there was noted an abnormal scarf sign, bilateral, and in two cases an abnormal popliteal angle at the examination at two, four and six months, but the neurologic examination became normal at 12 months.

Table 1 Cases with ventricular dilatation. Results of the ultrasound and neurologic examinations

Ultrasound findings	Total number	Normal neurologic exam – neonatal/ total of cases	Abnormal neurologic examination – neonatal/total of cases	Abnormal neurologic findings follow-up/total of cases
Dilation of the left ventricle	18	18/18	0/18	0/18
Dilation of posterior horn – left ventricle	88	88/88	0/88	6/88 ■ Transient hypotonia – 3/88 ■ Delay in head control – 4/88
Dilation of posterior horn – right ventricle	12	12/12	0/12	1/12 ■ Transient hypotonia – 1/12

Regarding head control, this milestone was not achieved by four of the patients with left posterior horn dilatation at two months. The patients presented also with abnormal head control at four months, but the head control was good in all the infants at the six-month examination.

Abnormalities at the neurobehavioral test (Bayley Test) were noted in the subset of items regarding fine motor skills. The abnormalities were observed in seven cases at the age of 6 months old, and in five cases at the age of 12 months old. The patients had normal results at the examination at 24 months (Table 2).

The abnormalities were noted at specific items (Table 3). Item 13: block series – reaches for block; item 14: block series – touches block; item 15: block series – whole hand grasp in the test performed at five months; item 22: block series – thumb fingertip grasp; item 24: food pellet series – partial thumb opposition; item 26: food pellet series – thumb-fingertip grasp.

Role of the neonatal head ultrasound in the detection of cases with neurologic abnormalities

The cases of ventricular dilatation that manifested with neurologic abnormalities were all detected as ventricular dilatation by fetal ultrasound. The neonatal ultrasound identified 10 more cases of left posterior horn dilation and one extra case of bilateral ventricular dilatation and right posterior horn dilatation. Those cases did not manifest with neurological abnormalities after the neonatal period (Table 4).

Discussion

Our group aimed to offer evidence-based data in order to counsel families of the children with unilateral ventricular dilation in order to anticipate the prognosis.

The presence of the unilateral ventricular dilatation on a fetal ultrasound raises important issues regarding the counseling of the families. In order to assess

Table 2 Abnormalities of the fine motor skills

Ultrasound findings	Total number	Fine motor 6 months – abnormal/total	Fine motor 12 months – abnormal/total	Fine motor 24 months – abnormal/total
Dilatation of the left ventricle	18	0/18	0/18	0/18
Dilatation of posterior horn – left ventricle	88	6/88	5/88	0/88
Dilatation of posterior horn – right ventricle	12	1/12	0/12	0/12

Table 3 Fine motor skills. Specific items at the 6-month and 12-month examinations

Item	Left ventricular dilatation – Number abnormal/total	Right ventricular dilatation – Number abnormal/total
Test at 6 months	6/88	1/12
13. Block series: reaches for block	6/88	1/12
14. Block series: touches block	6/88	1/12
15. Block series: whole hand grasp	6/88	0/12
Test at 12 months		
22. Block series: thumb-fingertip grasp	5/88	0/12
24. Food pellet series: partial thumb opposition	5/88	0/12
26. Food pellet series: thumb-fingertip grasp	5/88	0/12

Table 4 Cases of abnormal development that could be missed without neonatal ultrasound

Ultrasound findings	Abnormal neuro-developmental findings on follow-up	Abnormal neurologic examination – neonatal	Abnormalities identified in the fetal life (imaging/fetal well-being)	Total cases with neurological abnormalities identified with abnormalities other than neonatal ultrasound	Cases that would have been missed without an ultrasound in the neonatal period
Dilatation of the left ventricle	0/18	0/18	17/18	0/18	0
Dilatation of posterior horn – left ventricle	6/88	0/88	78/88	6/6	0
Dilatation of posterior horn – right ventricle	1/12	0/12	1/12	1/1	0

this issue, there are two methodological problems: poor standardization of the tests[8], and length of the follow-up studies[15].

Most of the studies followed this category of infants for a few months to one year[15]. We followed-up the patients until the age of 2 years old, in order to find the complications on mid-term. In another study, the outcomes were abnormal in a third of the patients (cases of mild ventriculomegaly, both unilateral and bilateral), even though all the patients were asymptomatic during the neonatal period[16]. This finding underlines the importance of at least a medium time follow-up (two years of follow-up of the cases).

Regarding the same topic, the prognosis, there is a concern that the children with this pathology would have other developmental complications as they grow[7,17]. There are reports about the presence of ventriculomegaly in persons with schizophrenia, but no association was found for the moment between fetal and neonatal ventriculomegaly and psychosis. There are, however, speculations regarding this issue[18]. Our study did not address this fact, but this could be a future direction for research, giving the possible implications.

The unilateral ventricular dilation was found in 8.9% of the examined cases. In literature, milder asymmetry in ventricular size could be found in four out of ten neonates[19]. An important finding is that the most frequent abnormality is represented by the dilatation of the left posterior (occipital) horn (88 cases out of 118). This is in agreement with other studies[19,20]. As a whole, unilateral left ventricular dilatation (occipital horn and whole ventricle) is more frequent than asymmetric right ventricular dilatation. There is no clear explanation for this fact[19]. This could be influenced by the position of the head (the ventricle on the side on which the infant is lying may be larger)[19,21], or there could be other causes, as in the case of neuroectodermal disorders[19]. A tempting hypothesis, on which we could speculate, is that there is a correlation between the vascularization of the brain and the more frequent occurrence of the left ventricular dilatation, as it is the case with the more frequent occurrence of the neonatal arterial ischemic infarction on the left sylvian artery[22,23]. This is, however, another issue to be demonstrated by further studies.

The incidence of the abnormalities observed was 7/118 in the case of the tone abnormalities and 7/118 in the case of the fine motor skills. In total, 10 cases out of 118 presented with transitory neurologic abnormalities (8.47% of cases). This value is around the figures found in the literature in case of moderate ventriculomegaly (11%)[4,24].

We could classify the abnormalities as abnormalities of the active and passive tone, and abnormalities of the fine motor skills.

The outcome at two years in the case with abnormalities is good, the neurologic and neurobehavioral examination of the patients being normal at two years, but this should be regarded in the setting of a follow-up program, with rapid intervention when the abnormalities were noted. We could not speculate that the outcome would be worse in the case of no intervention, but this potential bias should be considered. Nevertheless, the patients would not be part of a follow-up program in the situation the ventricular dilation were not found during the fetal (and neonatal) ultrasound examination. This should underline the importance of a good program of follow-up of the pregnancy.

Coming back to this issue, one important message from this study is that the cases that would cause symptoms would have been found prenatally and, from the cases discovered only at the postnatal examination, no case was associated with neurologic abnormalities.

It is our belief, however, that we need a longer follow-up period in order to affirm the normality for all the patients with moderate unilateral ventriculomegaly, and this could be the topic of a further study.

Conclusions

Unilateral ventricular dilatation detected by neonatal ultrasound is mainly asymptomatic. The abnormalities are encountered more often in the cases with unilateral left ventricular dilatation than in those with right ventricular dilatation.

The symptomatic cases are characterized by transient tone abnormalities (hypotonia) and transient abnormalities in the fine motor skills. The antenatal ultrasound predicted the appearance of the abnormalities. No case with abnormal development would have been missed without head ultrasound in the neonatal period. ■

Conflicts of interests: The authors declare no conflict of interests.

References

1. ACOG. Ultrasonography in pregnancy. ACOG Technical bulletin, 1993, Washington DC:187.
2. AIUM. Practice guideline for the performance of an antepartum obstetric ultrasound examination. J Ultrasound Med. 2003;22:1116–25.
3. International Society of Ultrasound in Obstetrics and 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;29:109–16.
4. Melchiorre K, Bhid A, Gika AD, Pilu G, Papageorghiou AT. Counseling in isolated mild fetal ventriculomegaly. Ultrasound Obstet Gynecol. 2009;34: 212–24.
5. Breeze ACG, Alexander PMA, Murdoch EM, Missfelder-Lobos HH, Hackett GA, Lees CC. Obstetric and neonatal outcomes in severe fetal ventriculomegaly. Prenat Diagn. 2007;27(2):124–9.
6. Levene MI. Measurement of the growth of the lateral ventricles in preterm infants with real-time ultrasound. Arch Dis Child. 1981;56:900–4.
7. Wyldes M, Watkinson M. Isolated mild fetal ventriculomegaly. Arch Dis Child Fetal Neonatal Ed. 2004;89(1):F9-F13.
8. Brouwer MJ, de Vries LS, Pistorius L, Rademaker KJ, Groenendaal F, Benders MJ. Ultrasound measurements of the lateral ventricles in neonates: why, how and when? A systematic review. Acta Paediatrica. 2010;99(9):1298–306.
9. Davies MW, Swaminathan M, Chuang SL, Betheras FR. Reference ranges for the linear dimensions of the intracranial ventricles in preterm neonates. Arch Dis Child Fetal Neonatal Ed. 2000;82(3):F218–F223.
10. Liao MF, Chaou WT, Tsao LY, Nishida H, Sakanoue M. Ultrasound measurement of the ventricular size in newborn infants. Brain Dev. 1986;8(3):262–8.
11. Sondhi V, Gupta G, Gupta PK, Patnaik SK, Tshering K. Establishment of nomograms and reference ranges for intracranial ventricular dimensions and ventriculo-hemispheric ratio in newborns by ultrasonography. Acta Paediatr. 2008;97(6):738–44.
12. Amiel Tison CI. Neurologie perinatale. Ed Masson, Paris, 2002.
13. Gosselin J, Amiel-Tison CL. Evaluation neurologique de la naissance a 6 ans, Ed Masson Paris, 2007.
14. Bayley N. Bayleyscales of infant and toddler development. 3th Ed. Technical Manual. Hartcourt Assessment Inc, San Antonio, Texas, USA, 2006.
15. Benacerraf BR. Unilateral cerebral ventriculomegaly is one better than two? J Ultrasound Med. 2001;20(3):179–81.
16. Bloom SL, Bloom DD, Dellanebbia C, Martin LB, Lucas MJ, Twickler DM. The developmental outcome of children with antenatal mild isolated ventriculomegaly. Obstet Gynecol. 1997;90(1);93–7.
17. Arora A, Bannister CM, Russell S, et al. Outcome and clinical course of prenatally diagnosed cerebral ventriculomegaly. Eur J Pediatr Surg. 1998;8(Suppl 1):63–4.
18. Gilmore JH, van Tol JJ, Streicher HL, et al. Outcome in children with mild fetal ventriculomegaly: a case series. Schizophr Res. 2001;48(2-3):219–26.
19. Govaert P, de Vries L. An atlas of neonatal brain sonography. 2nd ed, Mac Keith Press, 2010.
20. Shen EY, Huang FY. Sonographic finding of ventricular asymmetry in neonatal brain. Arch Dis Child. 1989;64(5):730-2.
21. Koeda T, Ando Y, Takashima S, Takeshita K, Maeda K. Changes in the lateral ventricle with the head position: ultrasonographic observation. Neuroradiology. 1988;30:315-8.
22. Govaert P, Ramenghi L, Taal R, J Dudink1, Lequin M. Diagnosis of perinatal stroke II: mechanisms and clinical phenotypes. Acta Paediatrica. 2009;98(11):1720–6.
23. Govaert P, Ramenghi L, Taaal L, De Vries L, de Veber G. Diagnosis of perinatal stroke I: definitions, differential diagnosis andregistration. Acta Paediatrica. 2009;98(10):1556–7.
24. Pilu G, Falco P, Gabrielli S, Perolo A, Sandri F, Bovicelli L. The clinical significance of fetal isolated cerebral borderline ventriculomegaly: report of 31 cases and review of the literature. Ultrasound Obstet Gynecol. 1999;14(5):320–6.