ISSN : (Online): 3008-038X
Abbreviation: J Derm Cse Rep
DOI: 10.61705/jdcr.18.2.2025.194.202

Journal of Dermatological Case Reports

Severity of Ventriculomegaly and its Associated Finding using Antenatal Ultrasound Scan at a Tertiary Care Hospital

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Keywords:

Fetal ventriculomegaly, antenatal ultrasound, CNS anomalies, laterality, pregnancy outcome.

Abstract:

Background: Fetal ventriculomegaly is a common antenatally detected central nervous system abnormality with diverse etiologies and outcomes. The severity and laterality of ventriculomegaly, along with associated anomalies, play a critical role in determining prognosis. This study aimed to assess the severity-wise distribution of ventriculomegaly, its correlation with gestational age, laterality, associated structural anomalies, and postnatal outcomes using antenatal ultrasound in a tertiary care setting.

Methods: This retrospective cross-sectional study was conducted at a tertiary care hospitals, including 137 singleton pregnancies diagnosed with fetal ventriculomegaly between 18 and 36 weeks of gestation from January 2020 to December 2023. Antenatal ultrasound data were analyzed to classify ventriculomegaly as mild (10–12 mm), moderate (13–15 mm), or severe (>15 mm). Laterality, associated anomalies, follow-up progression, and pregnancy outcomes were recorded and statistically analyzed using Chi-square tests.

Results: Mild, moderate, and severe ventriculomegaly were observed in 40.8%, 29.2%, and 30.0% of cases, respectively. Bilateral involvement was significantly associated with severe cases (85.4%, $p < 0.001$), while unilateral ventriculomegaly predominated in mild cases (73.2%). Structural anomalies were present in 57.7% of fetuses, with hydrocephalus (15.3%) and cardiac defects (13.1%) being the most common. The incidence of associated anomalies increased significantly with severity ($p < 0.001$). On follow-up, 43.9% of mild cases resolved, while severe cases showed a higher rate of progression and termination of pregnancy (28.9%, $p < 0.001$). Live births with normal outcomes were highest in the mild group (41.5%).

Conclusion: The severity and laterality of ventriculomegaly are significant predictors of associated anomalies and fetal outcomes. Mild, isolated, unilateral ventriculomegaly is associated with favorable prognosis, whereas severe and bilateral forms often correlate with CNS anomalies and adverse outcomes. Detailed anomaly evaluation and longitudinal follow-up are essential for prognostication and counseling.

Received : 25-05-2025 **Revised : 30-05-2025** **Accepted: 06-06-2025** **Published : 09-08-2025**

ISSN : (Online): 3008-038X
Abbreviation: J Derm Cse Rep
DOI: 10.61705/jdcr.18.2.2025.194.202

Journal of Dermatological Case Reports

Introduction

Ventriculomegaly is one of the most common central nervous system (CNS) anomalies identified during routine second-trimester antenatal ultrasonography, with an estimated incidence of 0.3 to 1.5 per 1,000 live births globally [1]. It is defined as the dilation of the lateral cerebral ventricles, specifically measured at the level of the atrium, with a transverse diameter of ≥10 mm being considered abnormal [2]. Based on sonographic measurements, ventriculomegaly is classified into three categories: mild (10–12 mm), moderate (13–15 mm), and severe (>15 mm) [3]. The detection of ventriculomegaly serves as an important marker for a wide spectrum of fetal abnormalities and is often an indication for targeted neurosonography and further investigations such as fetal MRI, TORCH screening, and genetic testing [3].

The clinical significance of ventriculomegaly varies according to its severity and associated findings. Isolated mild ventriculomegaly has a favorable prognosis, with approximately 85–90% of affected fetuses having normal neurodevelopmental outcomes [4]. However, moderate to severe ventriculomegaly or cases associated with other CNS or extracranial anomalies carry a significantly increased risk of neurodevelopmental delay, intellectual disability, epilepsy, or hydrocephalus, with adverse outcomes reported in up to 75% of severe cases [5,6].

Antenatal detection rates of ventriculomegaly have improved considerably with high-resolution ultrasound, particularly during the mid-trimester anomaly scan performed between 18 and 22 weeks of gestation [7]. However, the prevalence and spectrum of associated anomalies differ across geographical regions, influenced by maternal infection rates, genetic factors, consanguinity, and availability of prenatal diagnostic services [8]. In developing countries an incidence of ventriculomegaly of 1.2 per 1,000 pregnancies, with approximately 40% of cases showing additional structural or chromosomal abnormalities [9].

In many developing countries, including India, late presentation for anomaly scans, limited access to fetal neuroimaging, and underreporting hinder comprehensive evaluation and management of ventriculomegaly. Tertiary care centers serve as referral hubs for high-risk pregnancies, making them ideal for analyzing the true burden and spectrum of fetal ventriculomegaly [1,9]. Despite its importance, there is a paucity of region-specific data from Indian tertiary care institutions on the grading of ventriculomegaly and its associations with other antenatal anomalies [9].

The present study aimed to evaluate the severity of fetal ventriculomegaly diagnosed on antenatal ultrasound and to determine the frequency and types of associated sonographic findings in a tertiary care hospital setting. The outcomes of this study will help clinicians improve prenatal counseling, optimize follow-up strategies, and contribute to the national database on congenital CNS anomalies.

Material and methods

Study Design and Setting

This was a hospital-based, cross-sectional observational study conducted in the Department of Radiodiagnosis in collaboration with the Department of Obstetrics and Gynaecology at a tertiary care teaching hospitals. The study was carried out over a period of 24 months, from January 2023 to December 2024. Prior to initiation, the study protocol received approval from the Institutional Ethics Committee, and written informed consent was obtained from all participating pregnant women.

Study Participants

The study included pregnant women who underwent routine second-trimester anomaly scans or targeted fetal neurosonography between 18 and 36 weeks of gestation and were diagnosed with fetal ventriculomegaly. Gestational age was determined using first-trimester ultrasound dating or last menstrual period. Inclusion criteria consisted of singleton pregnancies with sonographically confirmed ventriculomegaly, defined as an atrial diameter of the lateral ventricles measuring ≥10 mm. Exclusion criteria included multiple gestations, inadequate visualization due to oligohydramnios or maternal obesity, intrauterine fetal demise, and cases with prior confirmed chromosomal or syndromic diagnoses based on karyotyping or fetal MRI before recruitme

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Ultrasound Examination Protocol

All ultrasound scans were performed using a high-resolution ultrasound machine (GE Voluson E8 or equivalent) equipped with a 3.5–5 MHz convex transducer. The ventricular measurement was taken at the level of the atrium of the lateral ventricles, visualized in the axial transventricular plane at the level of the cavum septum pellucidum and thalami. The diameter was measured from the inner margin of the medial ventricular wall to the inner margin of the lateral wall. Three measurements were taken and the average value was recorded. Ventriculomegaly was graded based on the atrial diameter as mild (10–12 mm), moderate (13–15 mm), and severe (>15 mm). The presence of unilateral or bilateral ventriculomegaly was also documented. Following identification of ventriculomegaly, a systematic evaluation of the fetal central nervous system was undertaken, focusing on the detection of associated anomalies such as agenesis of the corpus callosum, posterior fossa malformations, cerebellar hypoplasia, neural tube defects, and hydrocephalus. Extra-CNS anomalies were also screened, including cardiac, renal, facial, gastrointestinal, and skeletal abnormalities. In cases with suspected anomalies, targeted imaging and additional investigations like TORCH screening, amniocentesis for fetal karyotyping, or fetal MRI were advised, wherever indicated.

Data Collection

All enrolled patients underwent a non-contrast MRI of the brain using a 1.5 Tesla scanner (Siemens Magnetom Avanto or equivalent). The standard imaging protocol included axial and sagittal T1-weighted sequences, axial T2-weighted sequences, fluid-attenuated inversion recovery (FLAIR), diffusion-weighted imaging (DWI), and susceptibility-weighted imaging (SWI). Particular attention was given to the FLAIR and T2 sequences for the detection of white matter lesions. MRI scans were performed within four weeks of clinical evaluation to ensure contemporaneity of clinical and radiological findings.

Statistical Analysis

All collected data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables such as maternal age and ventricular width were summarized as mean ± standard deviation (SD), while categorical variables such as ventriculomegaly grade, laterality, and type of associated anomalies were expressed as frequencies and percentages. The Chi-square test or Fisher's exact test was used to evaluate the association between severity of ventriculomegaly and presence of associated anomalies. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 137 pregnant women with fetal ventriculomegaly were evaluated, with a mean maternal age of 25.8 ± 4.3 years. Nearly half were primigravida (49.6%), and the majority of diagnoses were made between 23–28 weeks of gestation (43.1%). Consanguinity was reported in 22.6% of cases. Most referrals were made during routine anomaly scans (64.2%), while 35.8% were referred for targeted neurosonography. The male-to-female ratio among fetuses was 1.36:1, with 57.7% being male. TORCH serology was performed in 46 cases, of which 15.2% tested positive (Table 1).

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Table 1: Demographic and Clinical Characteristics of Study Participants.

Variable	Frequency (%)/Mean ± SD
Maternal Age (years)	25.8 ± 4.3
Gravida	
Primigravida	68 (49.6%)
Multigravida	69 (50.4%)
Gestational Age at Diagnosis (weeks)	
18–22	41 (29.9%)
23–28	59 (43.1%)
29–36	37 (27.0%)
Consanguinity	31 (22.6%)
Referral Indication	

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Routine Anomaly Scan	88 (64.2%)
Targeted Neurosonography	49 (35.8%)
Fetal Gender	
Male	79 (57.7%)
Female	58 (42.3%)
TORCH Seropositivity (tested n = 46)	
Positive	7 (15.2%)
Negative	39 (84.8%)

TORCH = Toxoplasmosis, Rubella, CMV, Herpes.

Among the 137 fetuses diagnosed with ventriculomegaly, CNS anomalies were identified in 41.2%, with hydrocephalus (15.3%), agenesis of the corpus callosum (8.8%), and Dandy–Walker malformation (6.6%) being the most common. Extra-CNS anomalies were present in 30.6%, including cardiac defects (13.1%), renal anomalies (7.3%), and gastrointestinal malformations (4.4%). Overall, 79 fetuses (57.7%) had at least one associated anomaly. Mild ventriculomegaly was observed in 56 cases (40.8%), moderate in 40 (29.2%), and severe in 41 (30.0%). Laterality was nearly equally distributed, with 68 unilateral (49.6%) and 69 bilateral (50.4%) cases. Among fetuses with anomalies, moderate ventriculomegaly was most frequently associated (80.0%), followed by severe (63.4%) and mild (37.5%). Similarly, anomalies were more prevalent in bilateral ventriculomegaly (73.9%) compared to unilateral cases (41.2%) (Table 2).

Table 2: Distribution of Associated Anomalies in Fetuses with Ventriculomegaly (n = 137).

Anomaly Type	**Frequency (%)**
CNS Anomalies	
Agenesis of Corpus Callosum	**12 (8.8%)**
Dandy–Walker Malformation	**9 (6.6%)**
Hydrocephalus	**21 (15.3%)**
Neural Tube Defects	**8 (5.8%)**
Posterior Fossa Cyst	**6 (4.4%)**
Extra-CNS Anomalies	
Cardiac Defects (e.g., VSD)	**18 (13.1%)**
Renal Anomalies	**10 (7.3%)**
Facial Clefts	**5 (3.6%)**
GI Malformations	**6 (4.4%)**
Skeletal Dysplasia	**3 (2.2%)**
Severity of Ventriculomegaly	
Mild (10–12 mm)	**56 (40.8%)**
Moderate (13–15 mm)	**40 (29.2%)**
Severe (>15 mm)	**41 (30.0%)**
Laterality of Ventriculomegaly	
Unilateral	**68 (49.6%)**
Bilateral	**69 (50.4%)**
Total with ≥1 anomaly	**79 (57.7%)**
Severity of Ventriculomegaly*	
Mild (10–12 mm)	**21 (37.5%)**

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Moderate (13–15 mm)	**32 (80.0%)**
Severe (>15 mm)	**26 (63.4%)**
Laterality of Ventriculomegaly*	
Unilateral	**28 (41.2%)**
Bilateral	**51 (73.9%)**

CNS = Central Nervous System; GI = Gastrointestinal; VSD = Ventricular Septal Defect; VM = Ventriculomegaly; *With ≥1 Anomaly; Laterality and severity classification based on ultrasound measurements. Mild ventriculomegaly was most commonly diagnosed between 23–28 weeks (44.6%), whereas severe cases were more frequent in the later gestational age group of 29–36 weeks (34.2%). The difference in distribution by gestational age was statistically significant ($p = 0.042$). Unilateral ventriculomegaly was predominantly associated with mild cases (73.2%), while bilateral involvement was strongly associated with severe ventriculomegaly (85.4%) ($p < 0.001$). Regarding anomaly profile, isolated ventriculomegaly was more frequent in mild cases (62.5%), whereas the majority of severe cases were associated with CNS anomalies alone (73.2%). Cases with both CNS and extra-CNS anomalies were most commonly observed in moderate ventriculomegaly (42.5%). The association between anomaly type and ventriculomegaly severity was highly significant ($p < 0.001$) (Table 3).

Table 3: Variables Associated with Severity of Ventriculomegaly (n = 137).

Variables	Severity of Ventriculomegaly [Frequency (%)]			p value
	Mild (10–12 mm, n = 56)	Moderate (13–15 mm, n = 40)	Severe (>15 mm, n = 41)	
Gestational Age				
18–22 weeks (n = 41)	**21 (37.5%)**	**9 (22.5%)**	**11 (26.8%)**	**0.042**
23–28 weeks (n = 59)	**25 (44.6%)**	**18 (45.0%)**	**16 (39.0%)**	
29–36 weeks (n = 37)	**10 (17.9%)**	**13 (32.5%)**	**14 (34.2%)**	
Laterality of Ventriculomegaly				
Unilateral (n = 68)	**41 (73.2%)**	**21 (52.5%)**	**6 (14.6%)**	**<0.001**
Bilateral (n = 69)	**15 (26.8%)**	**19 (47.5%)**	**35 (85.4%)**	
Anomaly				
Isolated (n = 47)	**35 (62.5%)**	**10 (25.0%)**	**2 (4.9%)**	**<0.001**
With CNS Anomalies (n = 42)	**4 (7.1%)**	**8 (20.0%)**	**30 (73.2%)**	
With Extra-CNS Anomalies (n = 12)	**2 (3.6%)**	**5 (12.5%)**	**5 (12.2%)**	
With Both CNS & Extra-CNS (n = 36)	**15 (26.8%)**	**17 (42.5%)**	**4 (9.7%)**	

χ^2 = Chi-square test; Significance set at $p < 0.05$; There was a statistically significant association between the severity of ventriculomegaly and the likelihood of associated anomalies ($p < 0.001$), with severe ventriculomegaly showing the highest proportion of CNS anomalies.

Follow-up outcomes varied significantly with the severity of ventriculomegaly ($p < 0.001$). Resolution was observed in 43.9% of mild cases, compared to 20.0% of moderate and only 2.6% of severe cases. Progression occurred in 17.5% of moderate and 13.2% of severe cases, but only 4.9% of mild cases. Regarding pregnancy outcomes, the rate of termination increased with severity: 4.9% in mild, 15.0% in moderate, and 28.9% in severe cases ($p < 0.001$). Intrauterine fetal demise (IUFD) occurred exclusively in moderate and severe groups (5.0% and 15.8%, respectively). Among live births, normal neonatal outcomes were most frequent in the mild group (41.5%), while liveborn infants with anomalies were more common in moderate (22.5%) and severe (26.3%) groups (Table 4).

Table 4: Follow-up and Pregnancy Outcome Based on Severity of Ventriculomegaly (n = 119).

ISSN : (Online): 3008-038X
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DOI: 10.61705/jdcr.18.2.2025.194.202

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Variables	Severity of Ventriculomegaly [Frequency (%)]			p value
	Mild (10–12 mm, n = 41)	Moderate (13–15 mm, n = 40)	Severe (>15 mm, n = 38)	
Follow-up				
Resolved (n = 27)	18 (43.9%)	8 (20.0%)	1 (2.6%)	<0.001
Persistent (Stable) (n = 23)	12 (29.3%)	8 (20.0%)	3 (7.9%)	
Progressed (n = 14)	2 (4.9%)	7 (17.5%)	5 (13.2%)	
Pregnancy Outcome				
Termination (n = 19)	2 (4.9%)	6 (15.0%)	11 (28.9%)	<0.001
IUFD (Intrauterine Fetal Demise) (n = 8)	0 (0%)	2 (5.0%)	6 (15.8%)	
Normal neonate (n = 28)	17 (41.5%)	8 (20.0%)	3 (7.9%)	
Liveborn with anomaly (n = 21)	2 (4.9%)	9 (22.5%)	10 (26.3%)	

χ^2 = Chi-square test; Significance set at $p < 0.05$; IUFD – Intrauterine Fetal Demise; follow-up data based on serial scans and institutional birth record.

Discussion

Ventriculomegaly remains one of the most frequently detected fetal central nervous system (CNS) anomalies on antenatal ultrasonography, with variable prognosis depending on severity, laterality, associated anomalies, and gestational age at diagnosis. In our study of 137 fetuses with ventriculomegaly, the majority of diagnoses (43.1%) occurred between 23–28 weeks of gestation, which corresponds to the timing of routine anomaly scans in Indian obstetric practice [10,11]. This observation is in line with previous studies such as those by Yehudit et al., and Leiroz et al., who reported that mid-trimester ultrasound remains the most effective screening tool for detecting CNS abnormalities [12,13].

A key finding in our cohort was the significant association between the severity of ventriculomegaly and gestational age ($p = 0.042$). Mild ventriculomegaly was more frequently detected during the 23–28-week window (44.6%), while severe cases showed an increasing trend toward later gestation, with 34.2% identified between 29–36 weeks. This suggests the possibility of progressive ventricular dilatation as gestation advances, a phenomenon similarly documented by Syngelaki et al., and Albu et al., who reported worsening grades of dilation in up to two fifth of fetuses with mild ventriculomegaly on serial follow-up [14,15].

Our findings reinforce that laterality strongly correlates with severity, with unilateral ventriculomegaly predominantly observed in mild cases (73.2%), whereas severe cases were mostly bilateral (85.4%) ($p < 0.001$). Several previous studies Siddesh et al., and Krishnan et al., have highlighted this pattern, where bilateral ventriculomegaly was significantly associated with poor neurological outcomes and had a higher likelihood of structural CNS malformations [16,17]. Similarly, Breeze et al., suggested that bilateral involvement is more likely to be pathological and necessitates a more aggressive diagnostic approach, including fetal MRI and genetic evaluation [18,19].

A noteworthy 57.7% of our cohort had one or more associated structural anomalies. CNS anomalies were the most prevalent, led by hydrocephalus (15.3%), agenesis of the corpus callosum (8.8%), and Dandy–Walker malformation (6.6%). Extra-CNS anomalies, particularly cardiac defects (13.1%) and renal malformations (7.3%), were also notable. The prevalence of associated anomalies increased

ISSN : (Online): 3008-038X
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DOI: 10.61705/jdcr.18.2.2025.194.202

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significantly with the severity of ventriculomegaly resolve and result in normal neonatal outcomes, whereas severe and bilateral ventriculomegaly are often markers of underlying CNS or systemic pathology, with significantly poorer prognoses. These findings highlight the importance of timely detection, comprehensive anomaly screening, and individualized counseling based on detailed antenatal assessment.

($p < 0.001$), with 62.5% of mild cases being isolated, compared to 73.2% of severe cases associated with CNS anomalies. These trends are consistent with the large cohort studies by Sohret et al., and Wang et al., where the rate of associated malformations rose from 16% in mild cases to over 70% in severe ventriculomegaly [20,21]. Lok et al., similarly emphasized that the likelihood of chromosomal or syndromic association increases proportionally with the degree of ventricular dilation [22].

When stratified by outcome, our results further underscore the prognostic value of severity grading. Resolution was observed in 43.9% of mild cases, but only in 20.0% of moderate and a mere 2.6% of severe cases ($p < 0.001$). Comparable findings were reported by Davutoglu et al., and Tonni et al., who observed resolution in nearly half of mild isolated cases, but far fewer in cases with associated anomalies or greater severity [23,24]. Additionally, termination of pregnancy (TOP) was significantly higher in severe ventriculomegaly (28.9%) than in mild (4.9%) or moderate (15.0%) cases, and intrauterine fetal demise (IUFD) occurred exclusively in the moderate and severe categories. This gradient in adverse outcomes has been consistently reported in a review by Patel et al., adverse outcomes including neurodevelopmental delay, IUFD, and neonatal death were significantly associated with ventriculomegaly >15 mm and presence of additional malformations [25].

Among live births in our study, 41.5% of mild cases resulted in normal neonates, while anomaly-associated live births were more common in moderate (22.5%) and severe (26.3%) categories. These outcomes validate the prognostic model wherein mild, isolated ventriculomegaly carries a favorable prognosis, whereas bilateral, progressive, or severe forms necessitate guarded counselling [26].

In the Indian context, where routine fetal MRI or chromosomal microarray testing may not be widely available, structured serial neurosonography and multidisciplinary fetal medicine input remain vital [27,28,29].

Conclusion

Our study demonstrates that severity and laterality of ventriculomegaly are robust predictors of associated anomalies and fetal outcomes. Mild, isolated, and unilateral cases are more likely to resolve and result in normal neonatal outcomes, whereas severe and bilateral ventriculomegaly are often markers of underlying CNS or systemic pathology, with significantly poorer prognoses. These findings highlight the importance of timely detection, comprehensive anomaly screening, and individualized counseling based on detailed antenatal assessment.

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