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Gestational Maturity and Gender Distribution in Children with Congenital Hydrocephalus Undergoing Ventriculoperitoneal Shunt Surgery: A Prospective Hospital-Based Study in Bangladesh

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Abstract

Background: Congenital hydrocephalus is a birth-onset neurological disorder that disproportionately affects children in low- and middle-income countries. Identifying the demographic profile of patients particularly gestational age at birth and sex distribution is fundamental for understanding disease heterogeneity, counseling families, and planning community-level screening programs. **Objective:** The purpose of the present study was to assess the distribution of gestational age at birth and gender distribution among children with congenital hydrocephalus undergoing ventriculoperitoneal shunt surgery at a tertiary referral hospital in Bangladesh. **Methodology:** This was a descriptive cross-sectional study was conducted in the Department of Neurosurgery, Chittagong Medical College Hospital, Bangladesh, between January 2022 and June 2023. Purposive sampling was used to enroll 40 children (<18 months) diagnosed with congenital hydrocephalus and treated with VPS. Gestational age was classified as preterm (<37 weeks) and term (≥37 weeks). Gender was recorded as male or female following physical examination. **Results:** A total number of 40 children were recruited for this study after inclusion and exclusion criteria, 4(9.5%) expired during the 6-month follow-up, leaving 36 children for analysis. Males comprised 16(44.4%) and females 20(55.6%), yielding a female-to-male ratio of 1.3:1. Fourteen children (38.9%) were born preterm (<37 weeks) and 22(61.1%) were born at term (≥37 weeks). **Conclusion:** Female preponderance and a high prevalence of preterm birth characterize this cohort of children with congenital hydrocephalus, consistent with regional reports but warranting attention in maternal-neonatal risk counseling. Despite delays between symptom onset and surgical intervention, ventriculoperitoneal shunting significantly reduced cranial vault dimensions and achieved measurable, early improvements in gross motor function. *[Journal of National Institute of Neurosciences Bangladesh, July 2025;11(2):110-113]*

Keywords: Congenital hydrocephalus; Gestational Maturity; Ventriculoperitoneal shunt; LMIC

Introduction

Hydrocephalus affects approximately 1.1 per 1000 live births globally, with the greatest burden concentrated in low- and middle-income countries, where maternal fetal factors and perinatal infections drive a higher-than-average incidence[1]. Pre-natal evaluation by intrauterine ultrasound can identify ventricular dilatation in the fetus, and the severity of hydrocephalus (estimated using ventricular width and cortical mantle thickness) directly informs prognosis[2].

Recognized demographic determinants include sex of the child, gestational age at birth, age at symptom onset, age at diagnosis, and age at surgical intervention[3]. The present analysis separates the demographic profile from functional outcome by reporting gestational maturity and sex distribution within a prospectively enrolled

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Bangladesh cohort. Female predominance among hydrocephalic children has been reported in several African and Asian series including a 2020 series from Nouakchott, where females were likewise overrepresented[4].

The neonatal period of the preterm brain is particularly vulnerable to germinal matrix hemorrhage and post-hemorrhagic ventricular dilatation, contributing to a disproportionate share of congenital hydrocephalus among infants delivered before 37 weeks of gestation[5]. Although exposure to hydrocephalus in infancy carries a substantial risk of cerebral palsy, seizure disorder, and developmental delay, the baseline demographic characteristics of affected children have been underreported in South Asian literature [5,6,13].

The purpose of the present study was to assess the distribution of gestational age at birth and sex distribution among children with congenital hydrocephalus undergoing ventriculoperitoneal shunt surgery at a tertiary referral hospital in Bangladesh.

Methodology

Study settings and Population: This descriptive cross-sectional study was conducted in the Department of Neurosurgery at Chittagong Medical College Hospital, Bangladesh, from January 2022 to June 2023. During this period, children admitted with congenital hydrocephalus were screened. Using purposive sampling, 40 infants younger than 18 months with confirmed congenital hydrocephalus and scheduled for right-sided, medium-pressure ventriculoperitoneal shunt (VPS) surgery were enrolled. Infants with secondary neural tube defects, acquired causes, multiloculated ventricles, or other life-threatening anomalies were excluded.

Study Procedure: After obtaining written informed consent from the parents or legal guardians, relevant baseline information was collected for each enrolled child using a structured data collection approach. The recorded variables included biological sex and gestational age at birth, which was categorized as either preterm or term. In addition, key chronological milestones related to the clinical course of congenital hydrocephalus were documented, including the age at first appearance of symptoms, age at diagnosis, and age at ventriculoperitoneal shunt surgery. For analysis, these age-related variables were grouped into three predefined categories: less than 1 month, 1 to 3 months, and more than 3 months.

Statistical analysis: Data was analyzed using SPSS version 23. Categorical variables were presented as percentages or proportions.

Ethical considerations: The study protocol was approved by the Ethical Review Committee of Chittagong Medical College. Written informed consent was obtained from the parents or legal guardians following a detailed explanation of the study objectives, procedures, risks, and benefits.

Results

A total of 50 patients were admitted and 40 of them were found to fulfill the eligibility criteria for the study. Four patients expired, and excluded from the analysis. So, 36 patients were included in the final analysis. Among the 36 participants, 14 (38.9%) were born before 37 weeks of gestation (<37 weeks), while 22 (61.1%) were born at or after 37 weeks (≥37 weeks). Overall, the total number of participants was 36 (100.0%), indicating that the majority were born at term (≥37 weeks) (Table 1).

Table 1: Distribution of Study Population according to Gestational Age at Birth (n = 36)

Gestational Age at Birth	Frequency	Percent
<37 weeks	14	38.9
≥37 weeks	22	61.1
Total	**36**	**100.0**

The onset of first symptoms of hydrocephalus appeared occurred within the first three months of life for the vast majority of patients (80.6%), with 15(41.7%) experiencing symptoms between 1 and 3 months of age, and 14(38.9%) showing symptoms at less than 1 month. Only 7(19.4%) of the children had their first symptoms appear after 3 months of age (Table 2).

Table 2: Distribution of the study Population based on the age when their first symptoms of hydrocephalus appeared (n = 36)

Age at Hydrocephalus Appeared	Frequency	Percent
Less than 1 month	14	38.9
1 to 3 months	15	41.7
More than 3 months	7	19.4

The majority of patients were diagnosed between 1 and 3 months of age (38.9%, n = 14), closely followed by those diagnosed after 3 months of age (36.1%, n = 13). Exactly 25.0% (n = 9) of the children received their diagnosis early, at less than 1 month of age (Table 3).

A substantial majority of the patients (66.7%) had their surgery after 3 months of age. Exactly 25.0% of the children underwent surgery between 1 and 3 months of age, while only a small minority (8.3%) received

surgical intervention early, at less than 1 month of age (Table 4).

Table 3: Distribution of the Study Sample According to the Age Diagnosed with Hydrocephalus (n = 36)

Age at Diagnosis	Frequency	Percent
Less than 1 month	9	25.0
1 to 3 months	14	38.9
More than 3 months	13	36.1

Table 4: Distribution of the Study Sample According to the Age at Surgery (n = 36)

Age at Surgery	Frequency	Percent
Less than 1 month	3	8.3
1 to 3 months	9	25.0
More than 3 months	24	66.7

Biological sex distribution showed a female-to-male ratio of 1.3:1, with females accounting for 55.6% (n=20) and males accounting for 44.4% (n=16) of the study sample (Figure 1).

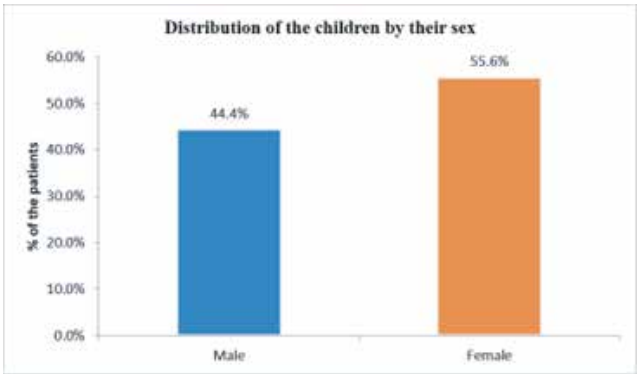

Figure I: Distribution of the Study Sample by gender(n=36)

Discussion

Within this prospective cohort of children with congenital hydrocephalus treated by VPS at Chittagong Medical College Hospital, the female-to-male ratio of 1.3:1 closely aligns with the Nouakchott series described by Salem-Memou et al[4] which identified a predominantly female population of newborns and infants with hydrocephalus[4]. Comparable female preponderance has been documented in Indian and African surgical cohorts, suggesting that biological factors notably the protective effect of X-linked L1CAM mutations in male fetuses leading to fetal wastage may shift the survivor population toward females[6]. Approximately 39.0% of this series was preterm, considerably higher than the World Health Organization estimate of 10.0% to 15.0% preterm births in South Asian populations.

This overrepresentation mirrors the predominant contribution of prematurity-related intracranial events (germinal matrix hemorrhage, ventriculitis, and congenital aqueductal anomalies presenting early) to the etiology of congenital hydrocephalus in preterm infants[1-2]. The result is consistent with the Indonesian series of intrauterine-suspected hydrocephalus, which similarly identified a high proportion of preterm deliveries in their cohort[7,11-13]. The numerator data also underscores the relationship between gestational age and the timing of the clinical course. With 38.9% symptom onset before one month of age, 38.9% of diagnoses occurring between one and three months, and 66.7% of surgical procedures performed after three months, this Bangladeshi cohort appears to reflect a definite delay between diagnosis and surgical intervention a pattern also described elsewhere in the South Asian literature, largely attributable to late referral, financial constraints, and limited availability of pediatric neurosurgical services in rural areas[6,8,9,13].

Shunt surgery was associated with restoration of cortical afferent and efferent connections, which underpins the rationale for early surgical intervention even among preterm infants with substantial disease severity[5]. The International Society for Pediatric Neurosurgery guidelines, as summarized in Greenberg's handbook, similarly emphasize that delay in surgical intervention beyond the window of cortical reconstitution is associated with poorer outcomes[6].

There are some limitations of this study. This study was conducted in a single tertiary-level hospital; therefore, the findings cannot be generalized to all children with congenital hydrocephalus in Bangladesh. Demographic variables relied in part on parent-reported gestational age, introducing the potential for recall bias.

Conclusion

In conclusion, this hospital-based study demonstrates a slight female preponderance and a notable mortality rate during early post-surgical follow-up among children with congenital hydrocephalus in Bangladesh. While the clinical onset of symptoms occurred within the first three months of life for the vast majority of infants, formal diagnosis lagged slightly behind. Consequently, a substantial management delay was observed, with two-thirds of the patients not undergoing ventriculoperitoneal shunt surgery until after three months of age. These chronological gaps highlight a critical need for enhanced maternal-neonatal screening and efficient regional

referral networks. Ultimately, improving public health infrastructure to facilitate earlier surgical intervention remains paramount to mitigating chronic axonal injury and optimizing neurodevelopmental recovery in these children.

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Uddin K, Islam KS, Rahman MA, Hoq MZ: Data curation, Methodology
Islam KS, Rahman MA, Hoq MZ, Arifin MS: Data Analysis, Investigation
Hossain A, Begum KN: Manuscript Review
All authors read and approved the final manuscript.

Data Availability
The datasets generated and analyzed during this study are not publicly available due to patient confidentiality and institutional data protection policies. However, anonymized data may be made available from the corresponding author upon reasonable request, subject to approval by the institutional ethics committee.

Ethics Approval and Consent to Participate
Ethical approval for the study was obtained from the Institutional Review Board. As this was a prospective study the written informed consent was obtained from all study participants. All methods were performed in accordance with the relevant guidelines and regulations.

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