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Epidemiological, Clinical and Therapeutic Aspects of Hydrocephalus in Children Under the Age of 18 at the Neurosurgery Department of The Ziguinchor Regional Hospital

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Abstract

Introduction: *Hydrocephalus is a multifactorial condition with various causes and is common in pediatric practice. No study has previously examined the profile of children admitted for hydrocephalus. We therefore decided to conduct this study to evaluate the management of hydrocephalus in children aged 0 to 18 years in the neurosurgery department of the Ziguinchor Regional Hospital Centre.*

Materials and Methods: *This was a retrospective study (covering the period from 1 July 2019 to 31 December 2020), prospective (from 1 January 2021 to 30 March 2023), descriptive, cross-sectional study conducted over a period of 45 months (3 years and 8 months), including children aged 0 to under 18 years admitted for hydrocephalus. We collected data from clinical observation forms and registers. Data analysis and statistical analysis were performed using Sphynx and Excel 2016 software.*

Results: *We identified 51 cases of hydrocephalus with a sex ratio of 1.125. Its incidence is 1.01%, and the average annual rate is 13.88 cases per year, corresponding to an average monthly rate of 1.13 cases. The mean age was 22 months. A history of consanguinity was found in 20 cases (39.2%). The diagnosis was made antenatally in 17.7% of cases. Postnatally, the diagnosis was confirmed on the basis of clinical findings, brain CT scans and transfontanellar ultrasound (TFU). The clinical signs were dominated by macrocephaly (86.3%), psychomotor developmental delay, intracranial hypertension and sunset gaze. Hydrocephalus was congenital in 72.5% of cases, with Sylvius aqueduct stenosis being the most common cause at 59.4%, followed by Dandy-Walker malformation (16.2%) and spina bifida (13.4%). The cause was identified in 19.6% of cases, with tumor-related hydrocephalus accounting for 50%, followed by post-meningitis hydrocephalus in 30% of cases and cases of undetermined cause in 7.8% of cases. Thirty-four (34) children, representing 66.7% of cases, underwent surgery consisting of a ventriculoperitoneal shunt*

(VPS). An external shunt was performed in only one patient and subsequently converted to a VPS following treatment for meningitis. The 17 patients who did not undergo surgery are broken down as follows: 10 deaths prior to surgery, 3 cases of discharge against medical advice, and 4 cases ineligible for surgery. Post-operative complications were mechanical in nature (23% of the 34 patients who underwent surgery) and infectious, notably including 5 cases of post-operative meningitis. Long-term follow-up revealed 9 cases of intellectual disability with behavioral disorders, 2 cases of bilateral blindness and 6 cases of epileptic seizures.

***Conclusion:** Hydrocephalus is one of the most common neurological conditions in pediatric neurosurgery. It affects not only the functional prognosis but also the patient's survival, hence the need for a rapid and appropriate diagnosis and management.*

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Introduction

Hydrocephalus is defined as a disorder of cerebrospinal fluid (CSF) hydrodynamics, leading to progressive distension of the cerebral ventricles and, in some cases, the cisterns and pericerebral subarachnoid spaces, associated with increased CSF pressure **[1].**

This disorder leads to ventriculomegaly, which occurs either at the expense of the cerebral parenchyma, which is compressed, or concomitantly with the expansion of the skull, depending on the stage of life at which it occurs. Hydrocephalus may occur before birth (antenatal) or after (postnatal). It may be communicating or non-communicating **[2].**

Hydrocephalus is a multifactorial condition with various causes and is common in pediatric practice. Its prevalence is thought to be higher in developing countries than in developed countries. Thus, its annual incidence is estimated at 3 children per 1,000 live births worldwide, 600 to 800 in France, and 2,000 in the United States **[2,3].**

These figures do not account for acquired hydrocephalus, which is thought to remain significant in Africa, where we have no data on the incidence of the condition. The causes vary by region; in developed countries, they are predominantly due to malformations, neonatal hemorrhages and tumors, where early and high-quality care leads to a better prognosis. In developing countries such as ours, infections continue to play a significant role in the causes of hydrocephalus. In Africa, delays in treatment due to a shortage of qualified staff, poor-quality medical facilities, the high cost of care and a lack of public understanding of the condition have, to date, made it a debilitating condition for society.

Despite advances in the management of the condition, post-operative complications such as mortality (17%), and in particular motor sequelae (46.5%) and cognitive sequelae (47.5%), remain high **[4,5].**

In Dakar, two studies on pediatric hydrocephalus were conducted in the neurosurgery department of the FANN University Hospital Centre (CHU) in 2015 and again in 2021. The results of these studies do not reflect the actual incidence in the general population, whereas in Ziguinchor, no study has yet examined the profile of children admitted for hydrocephalus. We therefore decided to conduct this study to assess the management of hydrocephalus in children aged 0 to 18 years in the neurosurgery department of the Ziguinchor Regional Hospital.

Methodology:

This was a retrospective (from 1 July 2019 to 31 December 2020), prospective (from 1 January 2021 to 30 March 2023), descriptive, cross-sectional study conducted over a period of 45 months (3 years and 8

months).

Our study focused on children aged 0 to 18 years admitted for hydrocephalus to the neurosurgery department of Ziguinchor Regional Hospital. Data were collected from patient records, consultation registers and surgical reports from the neurosurgery department. Data analysis was performed using Sphinx software, and the tables and graphs of the results were produced in Excel.

Results

We identified 51 cases of hydrocephalus, comprising 27 boys and 24 girls, with a sex ratio of 1.125. The incidence rate was 1.01%, and the average annual incidence was 13.88 cases per year, corresponding to an average monthly incidence of 1.13 cases. The mean age was 22 months, with a predominance among newborns, accounting for 51% of cases **(Figure 1).**

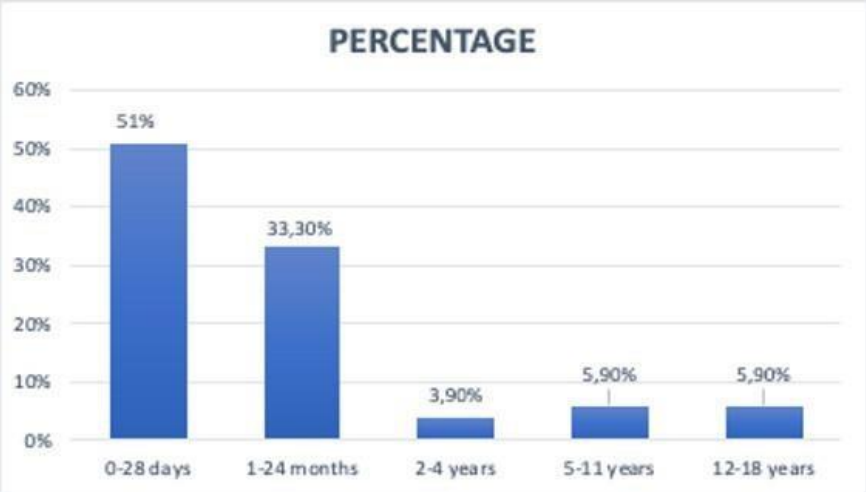

Figure 1: Distribution of cases by age

Consanguinity was found in 20 cases, or 39.2%. The predominant age group among mothers was 20–30 years, accounting for 62.5% of the total sample, with a mean age of 27.13 years. The mothers were housewives and had not attended school in 76.5% and 52.9% of cases, respectively.

Analysis of the pregnancies showed that 88.2% of the women were regularly monitored at a maternal and child health center or in the obstetrics and gynecology department of a hospital. Ultrasound scans were performed in only 9 mothers (17.6%); medication or toxic substances (herbal remedies) were used by 5 women (9.8%); there were 3 cases of preterm birth (5.9%) and 5 cases of post-term pregnancy (9.8%). Toxoplasma and CMV serology tests were not performed on any of the mothers. There was also 1 case of hypertension and 3 cases of gestational diabetes in the mothers. With regard to personal history, a neonatal infection was identified in 5 children; macrosomia and neonatal asphyxia occurred with equal frequency, 7 cases of each, representing 13.7% **(Table 1).**

Table I: Distribution of Patients by Personal History

Personal History	Effective	Percentage
Macrosomia	7	13,7
Asphyxia	7	13,7
Neonatal Infection	5	9,8
Polymalformation syndrome	5	9,8
Prématurity	3	5,9
Intrauterine growth restriction	3	5,9
Méningitis	1	2,0
Schizencephaly	1	2,0
Traumatic brain injury	1	2,0

The diagnosis was made antenatally in 17.7% of cases. Postnatally, the clinical presentation was generally characterized by a more or less complete combination of three types of symptoms: macrocephaly (the most common finding, 44 cases, or 86.3%), neurological signs **(Table 2)** and ocular signs **(Table 3).**

Table 2: Prevalence of Neurological Signs

Neurological signs	Effective	Percentage
Axial hypotonia	37	72,5
Regression or delay in psychomo-tor development	21	41,2
HTIC syndrome	14	27,5
Agitation	10	19,6
Seizures	8	15,7
Motor deficit	5	9,8
Hypertonia	4	7,8
Signs of pyramidal tract irritation	2	3,9

Table 3 : Frequency of Ocular Signs

Ocular signs	Effective	Percentage
Sunset gaze	33	64,7
Absence of eye tracking	31	60,8
Strabismus	3	5,9
Blindness	3	5,9
Reduced visual acuity	2	3,9

Apart from the classic triad, other signs were noted, such as an infectious syndrome (4 cases), incessant crying and refusal to feed (9 cases) and sphincter disorders in one patient. ETF performed in 20 children (39.6%) and brain CT scans in 34 children showed bi-ventricular, tri-ventricular and quadri-ventricular dilatation. None of the children in our series underwent MRI (magnetic resonance imaging), EEG (electroencephalogram) or cerebral angiography. Serological tests for toxoplasmosis and CMV were not performed in the children.

A lumbar and/or ventricular puncture was performed either preoperatively or postoperatively, in the absence of contraindications, in 21 patients (41.8%). The incidence of meningitis was 38% (8 cases), including 3 pre-operative cases where meningitis was identified as the cause of hydrocephalus. The most commonly

identified organisms were Staphylococcus aureus (23.8%), Enterobacteriaceae, Klebsiella pneumoniae and Streptococcus pneumoniae.

Hydrocephalus was congenital in 72.5% of cases, with stenosis of the aqueduct of Sylvius being the most common cause at 59.4%, followed by Dandy-Walker malformation (16.2%) and spina bifida (13.4%). It was acquired in 19.6% of cases, predominantly due to tumor-related hydrocephalus (50%), followed by post-meningitic hydrocephalus in 30% of cases and cases of undetermined cause in 7.8% (Table 4).

Table 4: Different Causes of Malformation-Related Hydrocephalus

Etiologies	Effective	Percentage
Sylvius aqueduct stenosis	22	59,4
Dandy-Walker Syndrome	6	16,2
Spina bifida	5	13,5
Arachnoid cysts	2	5,4
Other	2	5,4

Thirty-four (34) children, representing 66.7% of cases, underwent surgery consisting of a ventriculoperitoneal shunt (VPS). An external shunt was performed in only one patient and subsequently converted to a VPS following treatment for meningitis. The 17 patients who did not undergo surgery are broken down as follows: 10 deaths prior to surgery, 3 cases of discharge against medical advice, and 4 cases ineligible for surgery. In our series, no patient had undergone ventriculocisternostomy (VCS) or ventriculo-atrial shunting.Post-operative complications were mechanical (23%) and infectious, notably including 5 cases of post-operative meningitis. Long-term follow-up revealed 17 cases of psychomotor retardation with behavioral disorders, 2 cases of bilateral blindness and 6 cases of epileptic seizures. No post-operative deaths were observed.

Discussion

Hydrocephalus is a common condition, and its incidence varies from country to country. In Dakar (Senegal), in an initial series of 253 children, collected at the Fann University Hospital over a six-year period (2007–2012), the average annual frequency was estimated at 50.6 cases per year. However, these studies do not reflect the actual incidence in the general population. The age of onset of hydrocephalus depends on the etiology [6]. Thus, malformative and hemorrhagic causes appear during the neonatal period. Infectious causes are more common in infants, and tumor-related causes in older children. This would explain the mean age of 22 months in our study, as the vast majority of etiologies are congenital, followed by tumor-related and idiopathic causes, which are not insignificant in our series. Consanguinity is known to be a predictive factor for the development of hydrocephalus, as demonstrated by the majority of studies. In our series, consanguinity was present in 39.2% of cases. Routine ultrasound monitoring of all pregnancies now makes it possible to detect antenatal hydrocephalus at an early stage. The diagnosis may be suspected as early as the 15th week of gestation (WG) and confirmed by the 20th WG [7,8,9]. Data from the literature confirm the importance of ultrasound and fetal MRI in antenatal diagnosis. Macrocephaly is often associated with a bulging fontanelle and is the most common symptom. This increase in head circumference was present in 44 cases in our series, representing 86.3%. This finding is consistent with data from several studies in the literature, such as that by Sokar in 85.7% of cases, Sidibé in 80.8% of cases, and Sayad in 89.47% of cases. The sunset gaze is characteristic of PARINAUD syndrome due to compression of the upper brainstem by the dilated third ventricle [10,11]. In the literature, CT remains the first-line investigation, as it can clarify the etiology of hydrocephalus. It is the gold standard for the management of hydrocephalus. Thus, tri-ventricular and tetra-ventricular hydrocephalus predominated in our study, accounting for 55.9% and 38.2% respectively.

MRI is superior to CT scanning for the investigation of hydrocephalus, particularly in cases of communicating hydrocephalus; however, in our series, MRI was not performed on any of our patients due to the unavailability of this examination in the Ziguinchor region. With regard to congenital hydrocephalus, genetic, hereditary or sporadic mutational, teratogenic and infectious factors have been implicated [12]. In our series, among malformative hydrocephalus cases, stenosis of the aqueduct of Sylvius accounted for the vast majority of cases and was identified in 59.4% of patients (Table 5).

Table 5: Breakdown of Congenital Causes by Author

Etiologies	Zouaghi [13]	Tabarki et al. [14]	Dénou [8]	Diawo [6]	Notre étude
Aqueductal stenosis	1,28 %	42,8 %	10 %	12,64 %	59,4 %
Spina bifida	48,71 %	15,7 %	12,5 %	2,76 %	13,5 %
Dandy- Walker Syndrome	5,12 %	25,7	15 %	20,94 %	16,2 %
Congenital toxoplasmosis	0 %	-	12,5 %	-	0 %
Arnold Chiari Malformation	11,5 %	5 cas	2,5 %	5 cas	0 %
Arachnoid cysts of the posterior fossa				03 cas	5,4 %

Acquired hydrocephalus is predominantly caused by tumors (50%), most commonly found in children over the age of five. However, Sokar reported a much lower percentage of 15.9% [10]. Meningitis ranks second as an acquired cause, with a rate of 30%. Some authors have found similar results, such as Sidibé with 21.2% and Sylla with 30.76%, whilst Nathalie et al found only 3.30% [15,16,17]. In developed countries, studies have revealed a low incidence of post-infectious hydrocephalus [18]. This is thought to be due to poor living conditions, delayed diagnosis and inadequate or delayed treatment of any infection in children; this is despite the meningitis vaccination programme. Several surgical techniques exist; however, ventriculo-peritoneal shunting was the most commonly used surgical technique in our study, performed in 66.7% of cases (34/51). Of these 34 patients, only one underwent a ventriculo-encephalic shunt (VES) prior to ventriculo-peritoneal shunting (VPS). VPD is by far the most common technique for the symptomatic management of hydrocephalus, as shown by the majority of studies: Sokar with 81.35%, Sidibé with 92.3%, Sylla with 95.38% and Nathalie et al with 100%[10,15,16,17]. In our series, 82.3% of our patients had uncomplicated postoperative outcomes. This result is similar to the data found in the literature. In the immediate postoperative period, among the 34 patients who underwent VPD, we had 5 cases of meningitis (14.7%) who were placed on antibiotic therapy and made a good recovery, and 1 case of self-resolving abdominal distension.Compared with other studies, the rate of post-operative meningitis found in our study is lower than the 6% reported by Sokar. These differences may be linked to the intraoperative precautions taken, the duration of patient follow-up, and the types of valves used. Mechanical complications appear to be the most common in all series. At 3 months of post-operative follow-up, we observed a 50% rate of psychomotor developmental delay [10]. Death is the fatal outcome that may occur in cases of hydrocephalus, whether valve-related or not. However, in recent decades, mortality has fallen, with rates below 2% in most series [19]; this is due to advances in and the quality of early management. Postoperative mortality (POM) was zero in our study. However, the pre-operative mortality rate was 19.6%, representing 10 deaths. This is explained, on the one hand, by the delay in parents bringing their children for consultation and, on the other hand, by infection, which was both a barrier to surgery and the cause of death in most cases.

Conclusion

Hydrocephalus is one of the most common neurological conditions in pediatric neurosurgery. It affects not only the functional prognosis but also the patient's survival. Early diagnosis is important in order to provide appropriate and effective management and to prevent complications and neurological sequelae, which are often disabling.

Conflicts of Interest

The authors declare no conflicts of interest.

Authors' Contributions

All authors have read and approved the final version of the manuscript.

Ethical Considerations

All case records were used in strict compliance with confidentiality requirements

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