



# Evaluation of academic performance and social integration of children operated for hydrocephalus in Cameroon

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## Abstract

**Background** Low intelligence quotient (IQ) and delayed psychomotor development (DPD) are formidable complications of hydrocephalus. The aim of this study was to evaluate the academic performance and social integration of children operated on for hydrocephalus in Cameroon.

**Method** The authors present a cross-sectional study with retrospective data collection from January 2010 to May 2020. All children less than 10 years of age who had undergone surgery for a ventriculo-peritoneal shunt indicated for hydrocephalus with a post-operative evolution of 7 to 10 years and who were attending school were included. Academic performance was assessed using the Wechsler Intelligence Scale for Children IV (WISC IV), and social integration was assessed using the Vineland II score.

**Results** Of the 45 children aged 7 to 10 years who attended school and were followed-up, the sex ratio was 1.25 in favor of males. 77.8% of these children had a malformation with paralysis being the most common functional sequela (29%). 73.3% of our patients had good social integration. Fifty-three percent of patients had reduced academic performance, with non-verbal performance being the most frequent (62.2%). Long-term memory was the most impaired, with 73.3% having a very low speed of information processing. Non-verbal performance was the most affected (62.2%) particularly long-term memory. Forty percent had an IQ below 70. The statistically significant determinants of social integration were age, sex, malformative etiology, and good psychomotor development, and the statistically significant determinants of educational delay were age, malformative etiology, IQ below 70, and time to care. Academic performance was reduced in more than half of our patients, but most of them had good social integration.

**Conclusion** Early diagnosis and management improve the chances of good psychomotor development and IQ.

**Keywords** Hydrocephalus · Academic performance · Social integration · Children · Intelligence quotient · Cameroon

## Introduction

Hydrocephalus is defined as an abnormal accumulation of cerebrospinal fluid (CSF) in the craniospinal enclosure under a regime of elevated pressure at a given time in its

evolution [1]. Hydrocephalus is a common condition in pediatric neurosurgical practice. It is the most common cause of brain surgery in children. The intelligence quotient, or IQ, is the result of a psychometric test intended to provide a standardized quantitative indication of human intelligence. Ventriculo-peritoneal shunt (PVS) is the drainage of excess CSF from the cerebral ventricles into the peritoneal cavity. It is the standard treatment for hydrocephalus and by far the most widely used in sub-Saharan Africa.

In the United States, the rate is between 4 and 10 per thousand live births [2]. In France, it is estimated at 1 in 2000 births [3]. In Yaounde, Cameroon, there are about 1.1 cases of congenital hydrocephalus due to malformation per 1000 births [4].

Intellectual complications and difficulties in social adaptation are among the most serious complications. However, in our country, data on these complications are scarce. The aim of this study was to evaluate the academic performance

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and social integration of children operated on for hydrocephalus at the Yaounde Central Hospital after a post-operative period of 7 to 10 years.

### Method

Data were collected from 2 main sources: operating theatre registers and medical records from the neurosurgery department. Included in the study were hydrocephalic children aged ≤ 10 years, with a minimum post-operative period following VPS of 7 years and attending school.

The parents were contacted by telephone and appointments were scheduled. During these meetings, the parent/child pairs were invited to take part in the study by means of an assessment of academic performance using the WISC IV scale and an assessment of social integration using the Vineland II scale after obtaining informed consent from the parents and assent from the children. For data analysis, quantitative variables were described by the mean and standard deviation. Measures of association were expressed in terms of odds ratio (OR). The results of the statistical tests were considered significant for a *p* value < 0.05 and a 95% confidence interval and presented in table form.

### Results

We examined 45 children. We had 25 boys (56%) and 20 girls (44%) per group, giving a male–female sex ratio of 1.25. In our sample of 45 patients, 56% were aged 10 years and 44% were aged 7 years. Table 1 shows the demographic and social distribution of the parents of children operated on for hydrocephalus.

In our study, the most common cause of hydrocephalus was malformation (77.8%) (Table 2).

**Table 1** Distribution of patients according to place of residence, mother's level of education, and mother's profession

Variables	Frequency (N = 45)	Percentages (%)
Place of residence	32	71.1
<b>Urban</b>	13	28.9
<b>Rural</b>	8	17.8
Mother's level of education	25	55.6
<b>Primary</b>	11	24.4
<b>Secondary</b>	1	2.2
<b>University</b>	12	26.7
<b>Not attending school</b>	13	28.9
Mother's profession	1	2.2
<b>Civil servant</b>	19	42.2
<b>Trader</b>		
<b>Farmer</b>		
<b>Unemployed</b>		

**Table 2** Distribution according to etiology

Etiology of hydrocephalus	Frequency (N = 45)	Percentages (%)
Infectious	8	17.8
Malformative	35	77.8
Tumoral	0	0
Subarachnoid hemorrhage	0	0
Traumatic	0	0
Idiopathic	2	4.4
Total	45	100

Tetra-ventricular hydrocephalus was the most common, with a rate of 64.4%. Most of our cases were referred late (42.2%). Trans-fontanelar ultrasound was the most commonly used imaging test, at 53.3%.

Regarding social integration, the assessment of our study population showed that 25 of our patients (55.6%) were in good general condition, compared with 44.4% who were ill. Regarding patient autonomy, 55.6% of our patients were autonomous. Regarding the socialization of our patients, 32 of them (71.1%) had adequate socialization.

Regarding schooling, most of our patients were behind in their studies, and primary (class) 2 was the class most frequently repeated (24.4%), 15.6% had a normal education, and 4.4% had already reached secondary school (Table 3).

Most of our patients, 53.3%, had repeated more than 2 years. According to the WISC IV test, 51.1% of patients had poor verbal reasoning. Perceptual reasoning was poor in 62.2% of cases. 48.9% had very poor working memory. 73.3% had very poor processing speed. In 22.2% of patients, the verbal comprehension index was normal; the perceptual reasoning index was low at 17.8%. The working memory index was normal in 13.3% and the processing speed index in 15.6%. 33.3% of our patients had an IQ > 90, and 40% an IQ < 70 (Table 4).

A delay of more than 4 months in treatment was associated with academic delay and was statistically significant (*p* = 0.001). Age was statistically significantly associated with academic delay, while there was no association between gender and academic delay (OR 0.38, (0.09–1.66),

**Table 3** Distribution of our patients by educational background

Class	Frequency (N = 45)	Percentages (%)
<b>Nursery</b>	3	6.7
<b>Class 1</b>	8	17.7
<b>Class 2</b>	11	24.4
<b>Class 3</b>	5	11.1
<b>Class 4</b>	7	15.6
<b>Class 5</b>	2	4.4
<b>Class 6</b>	7	15.6
<b>College/High school</b>	2	4.4

**Table 4** Distribution of factors associated with educational delay

Variables	School delay		OR (IC 95%)	p value
	Yes	No		
<b>Time limit before treatment</b>				
Inf. 4 months	14 (70)	6 (30)		
Sup. 4 months	20 (80)	5 (20)	0.58 (0.15–2.29)	0.001
<b>Age</b>				
Equal to 7 years	10 (83.33)	2 (16.67)	1.88 (0.34–10.27)	0.003
Equal to 10 years	24 (72.73)	9 (27.27)	0.22 (0.05–0.89)	0.004
<b>Gender</b>				
Male	17 (68)	8 (32)	0.38 (0.09–1.66)	0.287
Female	17 (85)	3 (15)		
<b>Etiology of hydrocephalus</b>				
Malformation	24 (70.59)	10 (29.41)	0.24 (0.03–2.13)	0.002
Infectious	10 (90.91)	1 (9.09)		
<b>Type of hydrocephalus</b>				
Tetra-ventricular	22 (75.86)	7 (24.14)	1.05 (0.25–4.32)	0.949
Tri-ventricular	12 (80.0)	3 (20.0)	1.46 (0.32–6.53)	0.726
Biventricular	0 (0)	1 (100)	-	0.244
<b>IQ</b>				
Inferior to normal	18 (100)	0 (0)	-	<b>0.001</b>
Mean	16 (59.26)	11 (40.74)		

$p=0.287$ ). There was an association between malformation and educational delay ( $p=0.002$ ).

Tetra-ventricular hydrocephalus was not associated with the risk of educational delay (OR 1.05, (0.25–4.32),  $p=0.949$ ). IQ below 70 was significantly associated with educational delay ( $p=0.001$ ).

For the significance threshold that we defined in our study population for the  $p$  value  $<0.05$ , it occurs that a time limit before treatment of less than 4 months was associated with good social integration ( $p=0.006$ ).

Age was also associated with good social integration; this association was statistically significant. There was a statistically significant association between malformative etiology and social integration ( $p=0.004$ ). Long-term complications were associated with poor social integration ( $p=0.001$ ). Delayed psychomotor development was contributive to poor social integration with a relative risk of 6, and this association was statistically significant ( $p=0.005$ ) (Table 5).

## Discussion

The male predominance classically described in literature [5–7] was found in 56% of cases, with a sex ratio of 1.25. This predominance can be explained by the probable lethality of female fetuses linked to Bicker-Adam syndrome, which is transmitted in a recessive Mendelian manner linked to the X chromosome. In fact, when the female fetus

survives, the girl who is born will carry the gene that she will pass on to her boys.

At the time of surgery, most of our patients were less than 6 months old. The early expression of malformative diseases such as hydrocephalus would explain the preponderance of this age group. These age groups are also found in literature through the work carried out by Kante et al. in Mali [8] and Djientcheu et al. in 2011 in Cameroon [9]. At the time of data collection, our patients were aged 7 and 10 years, the ideal age for assessing the performance of a child with hydrocephalus [10].

In our study, 71.1% of patients lived in urban areas. This predominance of urban children may be explained by the fact that people living in large cities have easy access to healthcare.

Although most of the literature describes brain scans as the most commonly performed radiological investigation [11, 12], trans-fontanellar ultrasound was the main investigation performed in our study to confirm the diagnosis involving 24 children (53.3%). This result can be explained by the fact that most of the children who were less than 6 months old at the time of surgery had an open anterior fontanel and could therefore benefit from this examination. In addition, given its low cost, complete safety, and easy handling, this examination was more accessible. Gathura et al. [13] in Kenya found this to be the case. In our study, hydrocephalus originated from malformation in 77.8% of cases, followed by infectious causes in 17.8% of cases. The non-respect of folic acid prophylaxis and genetic mutations could explain

**Table 5** Breakdown of factors associated with social integration

Variables	Social integration		OR (CI 95%)	p value
	Good	Bad		
<b>Time limit before treatment</b>				
Inf. to 4 months	13 (65.0)	7 (35.0)	1.46 (0.43–4.90)	0.006
Sup. to 4 months (56.0)	14	11 (44.0)		
<b>Age</b>				
Equal to 7 years	4 (33.33)	8 (66.67)	0.22 (0.05–0.89)	0.041
Equal to 10 years	23 (69.70)	10 (30.30)	0.24 (0.03–2.13)	0.005
<b>Gender</b>				
Male	16 (64.00)	9 (36.00)	1.46 (0.44–4.84)	0.540
Female	11 (55.00)	9 (45.00)		
<b>Etiology of hydrocephalus</b>				
Malformative	23 (67.65)	11 (32.35)	3.66 (0.88–15.19)	0.004
Infectious	4 (36.36)	7 (63.64)		
<b>Evolution</b>				
Short-term complication	0 (0)	1 (100)		0.400
Long-term complication	8 (72.73)	3 (27.27)	2.11 (0.48–9.33)	0.001
<b>Psychomotor development</b>				
Good	19 (79.17)	5 (20.83)	6.18 (1.65–23.15)	<b>0.005</b>
Bad	8 (38.10)	13 (61.90)		

the dominance of malformative etiologies. These findings are similar to those of Djientcheu et al. and Mouafo et al. [4, 14]. In contrast, European authors reported a predominance of congenital causes, followed by hemorrhage, then tumor and infectious meningitis. This difference is thought to be linked to the still high prevalence and inadequate management of meningitis in Africa.

The outcome of children with hydrocephalus depends on several factors, among which the time limit before treatment. As has been shown in literature, early treatment before severe irreversible cerebral lesions set in, and before damage caused by intracranial hypertension, is conducive to a good prognosis. In a study by Topczewska-Lach in Poland [15], the aim was to analyze the long-term outcome of children with shunt-treated hydrocephalus, with emphasis laid on their psychomotor development. The later revealed that 30% of the children had an IQ above 90, 24% between 70 and 90, 26% between 50 and 70, and 20% below 50. About general condition, 44.4% of our patients remained sick; our results contradict those of Broalet et al. at Ivory Coast in 2017, who found only 18.4%. These differences may be explained by the delay in management observed in our study, unlike their study where management was earlier [11].

Regarding sociability, 71.1% of our patients were well integrated into society, a result obtained using the Vineland II scale, which is also used by other authors with almost similar results. Hommet et al. in 1999 in France [16] found that the greater majority of their patients had a good social adaptation. Fletcher et al. in the United States also used the Vineland II scale and obtained similar results [17]. These

generally good results, despite the cognitive and motor impairments observed in these patients, may be explained by the fact that young children with hydrocephalus are in phase with their development in terms of general social skills; indeed, Rourke et al. in 1994 and Holler et al. in 1995 in the United States [18, 19] demonstrated that older children are more vulnerable than younger children in terms of their adaptive and social behaviors. Older children have more behavioral problems and less developed social skills than younger children. These findings support the idea that as children with hydrocephalus grow older, problems with their ability to manage their behavior and conform to acceptable norms become more apparent.

Concerning the working memory index, 48.9% of our patients obtained a very poor score, 37.8% obtained a poor score, and only 13.3% obtained a normal score. Christine Cull and colleagues in 2008 in Canada [20] also used the Wechsler intelligence scale and obtained similar results: 50.1% had a low capacity for retaining information. Another study using a tool other than the Wechsler intelligence scale also obtained a low result. According to Wanters and Wanters, these results depend on the ability to use semantics to encode and retain information. These results can be attributed to the fact that hydrocephalus patients are affected by amnesic disorders due to lesions of the temporal lobe similar to those found in amnesic patients [21, 22].

Concerning the processing speed index, 73.3% of our patients had a very low data processing speed. Cull et al. in their 2008 study using the same tool found 61.1%. These results may be explained by the fact that hydrocephalus

patients process visual-spatial information more slowly [20]. These results may also be explained by the fact that 40% of our patients had an IQ below 70; Dennis et al., 1981 in Canada [10], obtained a better result (21%) because only patients with an IQ above 90 were included in their study.

Regarding IQ, 40% of our patients had an IQ below 70. These results are similar to those of Soare et al. who found a rate of 37% [23], and in contradiction with the results of Billard in 2008 who found a rate of 75% [24] also, Casey et al. in London [25] found that 53% of their patients had an IQ above 80; Hoppe-hirsch et al. in France [26] found 32% with an IQ above 90. These discrepancies can be explained by the fact that the neuropsychological study highlights frequent IQ heterogeneity due to deficits in constructive cognitive skills such as visuo-spatial skills, the presence of epilepsy, and the cause of the hydrocephalus. Post meningeal and post hemorrhagic neonatal hydrocephalus are often considered to have the worst intellectual prognosis. Similarly, in the case of fetal hydrocephalus, the intellectual prognosis is more severe because of cerebral atrophy caused by prolonged distension or because of associated lesions [24].

## Conclusion

The long-term academic performance of these children depends on how early they are diagnosed, how early they receive treatment, the quality of the treatment, the etiology of the hydrocephalus, associated malformations, and their parents' income and level of education.

Non-verbal performance was the most affected and was due to lesions of the white matter of the right hemisphere or to surgical maneuvers. As for verbal performance, our patients' language was fluent, with a rich vocabulary and good syntax; however, it was poorly adapted.

Primary two was the most repeated class; very few of them had a normal curriculum and were already in secondary school. The verbal reasoning index, perceptual reasoning index, working memory index, and processing speed index were normal in a quarter of our patients.

The IQ was below 70 in 40% of our patients, due to the attention, cognitive, and visuo-spatial difficulties observed in these patients and to poor non-verbal performance. Delay in treatment, age, malformative etiology, and IQ were determinants that increased the risk of educational delay, with a statistically significant difference. Similarly, age, malformative etiology, and delayed psychomotor development had a significant influence on social integration.

**Author contribution** Haman Oumarou was the study designer and manuscript writer. Ndomé Toto: data collection and statistics analysis. Bello Figuim: Data interpretation. Djientcheu Vincent: Supervisor of the study.

**Data availability** No datasets were generated or analyzed during the current study.

## Declarations

**Conflict of interest** The authors declare no conflict of interest.

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