International Journal of Neurosurgery
2021; 5(1): 42-46
http://www.sciencepublishinggroup.com/j/ijn
doi: 10.11648/j.ijn.20210501.20
ISSN: 2640-1940 (Print); ISSN: 2640-1959 (Online)

Obstructive Hydrocephalus in Children: Predictive Factors of Ventriculocisternostomy Dysfunction at the University Hospital Center of Conakry

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To cite this article:

Ibrahima Sory Souare, Mohamed Lamine Sylla, Hugues Ghislain Atakla, Ibrahima Sory Junior Souaré, Mohamed Cherif, Seylan Diawara, Beavogui Luc Kezely. Obstructive Hydrocephalus in Children: Predictive Factors of Ventriculocisternostomy Dysfunction at the University Hospital Center of Conakry. *International Journal of Neurosurgery*. Vol. 5, No. 1, 2021, pp. 42-46. doi: 10.11648/j.ijn.20210501.20

Received: February 12, 2021; **Accepted**: February 26, 2021; **Published**: June 21, 2021

Abstract: The treatment of hydrocephalus is surgical and uses two (2) main methods to date: ventriculoperitoneal shunt (DVP) and endoscopic ventriculocisternostomy (VCS). The latter offers the advantage of avoiding the implantation of a foreign body (valve) in the body. However, there are sometimes dysfunctions that can lead to the evolutionary continuation of hydrocephalus. The objective of this study is to identify factors predictive of VCS dysfunction in cases of obstructive hydrocephalus in children at the University Hospital Center (CHU) in Conakry. This is a mixed analytical study of 32 cases of children aged 0-15 years who received VCS during the study period. Outcomes were evaluated according to Drake and Canadian Pediatric Neurosurgery Group clinical criteria. The hospital frequency was 17% and a sex ratio (M/F) of 1.13. Clinical signs were dominated by progressive macrocraniality (93.8%), bulging fontanel (84.4%), ectasia of scalp veins (68.8%). CSF leakage (9.4%) was the most frequent post-operative complication. We recorded one case of death. The success rate of CSF according to Drake's criteria was 56%. The factors often associated with the dysfunction of the VCS found in this study are essentially: age, bulging fontanelle, ectasia of the scalp veins, arachnoid adhesions, closure of the Sylvius aqueduct and pulsation of the bottom of the 3rd V. In the absence of a statistically significant relationship, it would be useful to analyse these parameters closely on a much larger sample.

Keywords: Obstructive Hydrocephalus, Child, Ventriculocisternostomy, Conakry

1. Introduction

For a long time, cerebrospinal fluid (CSF) bypass valves were the only treatment for hydrocephalus. The development of neuro-endoscopy has brought other possibilities in the treatment of this pathology. Endoscopic ventriculocisternostomy (VCS) of the third ventricle (3rd V) is now considered the standard treatment for non-communicating hydrocephalus, whether congenital or secondary to an obstructive lesion [1-3]. This pathology, which is frequent in the pediatric environment, recognizes a multitude of etiologies, most often malformative and haemorrhagic in the neonatal period, post-meningitis in infants and tumours in older children [4-6]. Macrocrania is the main clinical manifestation in children. [7]. Since its advent, VCS has been a reliable alternative to the ventriculoperitoneal shunt (DVP). It considerably reduces the number of re-interventions [8]. The objective of this study is

to identify factors predictive of VCS dysfunction in cases of obstructive hydrocephalus in children at the University Hospital Center (CHU) in Conakry.

2. Materials and Methods

This study was previously submitted to the ethics committee for approval and confidentiality was maintained throughout the study period. Informed consent of patients and/or responsible persons was obtained for all patients. Thumbprints were used instead of signatures for parents with low or no literacy skills.

This was a mixed study of an analytical type involving 32 records of children aged 0 - 15 years who had received VCS in the Neurosurgery Department of Conakry University Hospital during the period from July 2015 to May 2020.

The sample size was obtained from the number of cases recorded during the survey. The parameters studied included epidemiological; clinical; paraclinical (tri ventricular dilatation, tetra ventricular dilatation); etiological (congenital, infectious, tumor); endoscopic findings (hemosiderin deposits, choroid plexus reshaping, pulsation of the 3rd V fundus, arachnoid adhesions, hypothalamic adhesions, closure of the Sylvius aqueduct, narrow retroclival space, venous bleeding); post-operative complications (simple, CSF leakage, death) and post-operative evaluation (favorable; unfavorable). We used a KARL STORZ® flexible endoscope. The evaluation of the results was done according to the clinical criteria of Drake and the Canadian Pediatric Neurosurgery Group [9] which considered as successful (favorable), all patients who showed lasting clinical improvement after CSF without the need for valving.

Epi Data 3.1 software was used for data entry and R software for statistical analyses. Proportions were calculated for the qualitative variables. Quantitative variables were expressed as mean ± standard deviation. The Chi2 test or exact Fisher test was used to compare proportions. The Wilcoxon test was used to compare means. The significance threshold was set at risk alfa=0.05.

3. Results

During the study period 32 cases of VCS were completed, mostly children. The mean age with standard deviation at diagnosis was 13.84 ± 23.03 with extremes from 28 days to 180 months. The age range from 0 to 30 months was the most affected (87.5%) with a male predominance (sex ratio of 1.13). Progressive macrocraniality (93.8%), bulging fontanelles (84.4%), ectasia of scalp veins (68.8%) were the main clinical signs (Table 1).

Neuroimaging characteristic of obstructive hydrocephalus, represented by the tri ventricular and tetra ventricular dilatations. In 62.5% of cases (20 patients) congenital etiology was the most common, followed by infectious etiology in 25% (8 patients) and tumor in 12.5% (4 patients).

The endoscopic finding revealed a choroid plexus reshaping in 29 patients, or 90.6%, and the thinning of the 3rd V fundus was found in 18 patients, or 56.3%. Haemosiderin deposition and pulsation of the bottom of the 3rd V were recorded in equal proportions, i.e. in 15 patients (46.9%). Closure of the mesencephalic aqueduct, arachnoid adhesions and narrow retroclival space were observed in 13 patients (40.6%), 12 patients (37.5%), and 11 patients (34.4%), respectively. Furthermore, hypothalamic adhesions and venous bleeding were found separately in equal proportions in 4 patients (12.5%).

Table 1. *Distribution of patients according to clinical signs, paraclinical signs and etiologies.*

Features	Staff N=32	Percentage (%)
Clinical Signs		
Evolutionary macrocrania	30	93,8
Bulging of the fontanelles	27	84,4
Ectasia of scalp veins	22	68,8
Sunset gaze	11	34,4
Vomiting, Refusing to suckle	10	31,3
Seizures	5	15,6
Psychomotor deceleration	5	15,6
Disconnection of the skull sutures	3	9,4
Visual disturbance	2	6,3
Signs of Brain CT		
Triple ventricular dilatation	24	75
Tetra ventricular dilatation	8	25

Post-operatively, there were 26 patients (81.3%) without complications, while 6 other patients (18.8%) had complications of the order: leakage of CSF and death, distributed respectively in the following proportions: 5 patients (15.6%); 1 patient (3.1%) Table 2.

Table 2. *Breakdown of patients according to post-operative outcomes, post-operative complications and post-operative evaluation N=32.*

Features	Effectif	Pourcentage (%)
Surgical suites		
Simple	26	81,3
Complicated	6	18,8
Post-operative complications		
CSF leakage	5	15,6
Death	1	3,1
Post-operative evolution		
Favorable	18	56,3
Unfavourable	14	43,7

We had performed an analysis of the impact of clinical parameters and endoscopic findings on the outcome of VCS and this allowed us to note the dysfunction of VCS in the children who clinically presented the bulging of the fontanelles and the ectasia of the scalp veins distributed respectively in the following proportions: 13 (92.86%); 11 (78.57%). In addition, dysfunction of VCS was noted in a proportion of children with choroid plexus reshaping, hemosiderin deposits and arachnoid adhesions, represented respectively in the following proportions: 13 (92.86%), 6 (42.86%), 8 (57.14%); (Table 3).

Table 3. *Analysis of the impact of clinical parameters and endoscopic findings on VCS outcome and progression.*

FEATURES	VENTRICULO-CISTERNOSTOMY		P-value
	Dysfunction	Seccess	
CLINICAL SIGNS			
Bulging of the fontanelles			0.50
Yes	13 (92.86)	14 (77.78)	
No	1 (7.14)	4 (22.22)	
Ectasia of scalp veins			0.50
Yes	11 (78.57)	11 (61.11)	
No	3 (21.43)	7 (38.89)	
Sunset gaze			0.81
Yes	4 (28.57)	7 (38.89)	
No	10 (71.43)	11 (61.11)	
Wider separation of skull sutures			0.81
Yes	2 (14.29)	1 (5.56)	
No	12 (85.71)	17 (94.44)	
ENDOSCOPIC DISCOVERIES			
Hemosiderin deposits			0.96
Yes	6 (42.86)	9 (50,00)	
No	8 (57.14)	9 (50.00)	
Choroid plexus reshaping			1.00
Yes	13 (92.86)	16 (88.89)	
No	1 (7.14)	2 (11.11)	
3rd V Bottom Pulse			0.44
Yes	5 (35.71)	10 (55.56)	
No	9 (64.29)	8 (44.44)	
Arachnoid Adhesions			0.09
Yes	8 (57.14)	4 (22.22)	
No	6 (42.86)	14 (77.78)	
Hypothalamic adhesions			1.00
Yes	2 (14.29)	2 (11.11)	
No	12 (85.71)	16 (88.89)	
Closure of the Sylvius Aqueduct			0.38
Yes	4 (28.57)	9 (50.00)	
No	10 (71.43)	9 (50.00)	

Based on age, VCS was successful in 16 infants (55.2%) and dysfunction in 13 (44.8%), while 2 children (66.7%) were successful in VCS versus 1 (33.3%) in dysfunction (Table 4).

Table 4. *Analysis of VCS Outcome by Child's Age.*

VCS	Age		P-value
	Infant	Child	
Success	16 (55,2%)	2 (66,7%)	1,00
Dysfunction	13 (44,8%)	1 (33,3%)	

Based on clinical criteria from Drake and the Canadian Pediatric Neurosurgery Group, we considered the success rate for VCS to be 56% and 43.7% unfavourable.

4. Discussion

We conducted a mixed study of 32 cases of hydrocephalus in which an endoscopic ventriculocisternostomy (VCS) was performed. As the dilated aspect of the 3rd V was, among other things, the main indication for this surgical technique, we were able to observe in practice the often unexpected dysfunction of this internal shunt after it was actually placed in some of the patients. The objective of this study was to identify the predictive factors that could influence the outcome of CNS, based on objective criteria, both anthropometric and endoscopic.

The criteria that we focused our attention on following the results of the R-analysis using the confidence interval are:

1. Clinical criteria: age, sex, cranial perimeter (CP), existence or not of certain clinical signs such as: sunset gaze, bulging of the fontanelles, ectasia of the scalp veins, disjunction of the skull sutures;
2. Neuroimaging criteria: tri-ventricular dilatation, tetra-ventricular dilatation;
3. Criteria of endoscopic findings: choroid plexus reshaping, hemosiderin deposits, pulsation of the 3rd V fundus arachnoid adhesions, hypothalamic adhesions, closure of the Sylvius aqueduct;

We found a male predominance of 53.1% with a sex ratio (M/F) of 1.13. Several studies have shown a predominance of the male sex, this predominance would be linked in part to the fact that congenital hydrocephalus can be transmitted in a sex-linked recessive mode [9; 10]. The age of the children ranged from 28 days to 180 months (15 years) with a mean of 13.84 ± 23.03 months. The 0-30 month age group was the most represented with a proportion of 85%. The delay in medical consultations with modern medicine is due to ignorance and lack of knowledge of the disease, a consequence of the dominant traditional beliefs of the parents.

With regard to age, the proportion of VCS dysfunction is higher in infants than in children, but this difference is not statistically significant. In the literature, there is debate about the influence of age, the causes of hydrocephalus or both (2) on the success of VCS. Drake and colleagues conclude in agreement with other authors that the success of VCS depends essentially on the age of the patients [11]. Salvador S. F. et al. found in 2012 at the São João Hospital Center (CHSJ) in Porto, Portugal, that age is a predictive factor of endoscopic ventriculocisternostomy dysfunction [12]. Although the statistical test does not show a significant difference between success and failure; however, the confidence intervals do not overlap, this difference can be considered significant.

Clinical signs were dominated by progressive macrocraniality followed by bulging fontanelles and ectasia of scalp veins with proportions of 93.8%; 84.4% and 68.8% respectively. These signs reflect a compression of the cerebral parenchyma and also the consequences of the delay in specialist consultation.

Cerebral computed tomography (CT) scan without injection of the contrast agent was performed on all patients; it revealed the obstructive etiology. Thus, in our series we found tri-ventricular dilatation in 24 cases, i.e. 75%, and tetra-ventricular dilatation in 8 cases, i.e. 25%. The same signs were found but in variable proportions in a series carried out in Morocco in 2012, where it was reported: tri-ventricular dilatation in 98 cases, i.e. 80.4%, and tetra-ventricular dilatation in 24 cases, i.e. 19.6% [9].

The etiological diagnosis of hydrocephalus was based on clinical findings, patient history, and brain scan data without injection of the contrast agent. Congenital hydrocephalus was

the most represented with 62.5% of cases, followed by infectious and tumor hydrocephalus with 25% and 12.5% of cases respectively.

Intraoperatively, choroid plexus reshaping was the most common endoscopic finding with 90.6%. The expansive effect of the CSF in the ventricles due to the increased pressure in the skull could explain this result. In our series, the postoperative outcome was simple in 26 cases (81.3%). Leakage of CSF through the operative scar was reported in 5 cases or 15.6% and we noted one case of death. This leakage of CSF through the operative scar is the most frequent post-operative complication found in the literature; according to Bouras T. in his meta-analysis, the incidence of this complication varies between 0-5.2% with an average of 1.7% [13]. We believe that the thinner skin and immaturity of the subarachnoid spaces in children could be related to this result in our observation. Patients without a bottom V pulsation showed a higher proportion of ventriculocisternostomy dysfunction compared to those with a bottom 3rd V pulsation, but this difference is not statistically significant.

In the post-operative clinical evaluation of the outcome of the operation (VCS) 56.3% of cases were favorable while 43.7% of cases were unfavorable. The regular and rigorous post-operative follow-up of children after initial management could be related to this result. Opinions differ as to the definition of success of endoscopic ventriculocisternostomy (VCS). The success rate of endoscopic ventriculocisternostomy (VCS) in our series was 56%. VCS dysfunction in our series was found in 44% of patients.

Statistical analysis using R software with the following factors: age, sex, bulging fontanelles, sunset gaze, ectasia of scalp veins, skull suture disjunction, hemosiderin deposits, choroid plexus reshaping, 3rd V bottom pulsation, arachnoid adhesions, hypothalamic adhesions and Sylvius aqueduct closure did not show a statistically significant difference in VCS dysfunction. However, among all the factors analyzed, the impact of a few seemed to be preponderant: age, sex, arachnoid adhesions, closure of the Sylvius aqueduct and pulsation of the 3rd V bottom.

The existence of arachnoid adhesions in patients shows a higher proportion of VCS dysfunction compared to the absence of this abnormality but this difference is not statistically significant. This finding may be related to the presence of fibrinous deposits in the subarachnoid spaces responsible for blocking and clogging the flow and resorption pathways of cerebrospinal fluid (CSF), resulting in ventricular dilatation by accumulation of upstream CSF.

The limitation of this study is related to the smaller sample size, which would necessitate the continuation of similar studies in order to analyze these factors on a much larger sample.

5. Conclusion

Taking into account the results of this work and data from the current literature, we can conclude that endoscopic ventriculocisternostomy remains an effective surgical technique in the treatment of obstructive hydrocephalus. However, its performance has not been established in infants, with 44.8% of VCS dysfunction in subjects of this age in this series. In addition, our observations reveal that factors such as age, bulging fontanelle, ectasia of scalp veins, arachnoid adhesions, closure of the Sylvius aqueduct and pulsation of the 3rd V bottom and haemosiderin deposits are often associated with VCS dysfunction.

Declaration of Interest

All the authors do not have any possible conflicts of interest.

Authors' Contributions

All authors contributed to this work.

Acknowledgements

The authors would like to thank the patients and their parents and the ethics committee for consenting to this study.

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