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Hydrocephalus cases in Ghana: a six-year (2007-2012) review of computed tomography (CT) radiological reports

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Abstract

Hydrocephalus is a common neurological disorder where an excess amount of cerebrospinal fluid (CSF) accumulates in the ventricular system of the brain. It can be diagnosed through clinical evaluation or radiological imaging modalities. This study aimed to establish the prevalence and characteristics of hydrocephalus cases reported at a diagnostic centre in Ghana. A cross-sectional retrospective study was carried out to evaluate all reports of computed tomography (CT) head scans produced in a diagnostic imaging centre between 2007 and 2012. The reports were purposively sampled manually; sorted according to clinical history; and analysed by an independent consultant radiologist. Confirmed hydrocephalus cases were categorised according to the type and analysed using SPSS v20. During January 2007 to December 2012, 6550 CT scan examinations (53.4% male and 46.6% female) were performed in the department. Of these, 251 (3.8%) were hydrocephalus cases (60.1% female and 39.9% male). The prevalence ranged between 2.5-6.7%. Twenty percent (20%) of the infants <5 years who had presented for CT examinations were diagnosed as hydrocephalus: representing 47.4% of the recorded cases. Communicating hydrocephalus was most common, 123 (49.0%), with ex-vacuo being the least, 1 (0.4%). Statistically significant relationships were found between gender, age and the development of hydrocephalus (χ^2 = 19.17, $p \leq 0.001$) and (χ^2 = 500.49, $p \leq 0.001$) respectively. The overall prevalence of hydrocephalus recorded was high. An extensive nationwide study needs to establish the prevalence and facilitate the management of hydrocephalus in Ghana.

Keywords cerebrospinal fluid (CSF), medical imaging, ex-vacuo hydrocephalus

Introduction

Hydrocephalus is regarded as an abnormal disorder where an excess amount of cerebrospinal fluid (CSF) accumulates in the ventricular system of the brain.[1] The condition can be congenital; i.e. present at birth or acquired after birth.[2,3] It is mainly caused by congenital conditions: aqueductal stenosis, spina bifida and acquired conditions like brain tumours, for example.[4,5] CSF is produced in cavities of the brain called the ventricles by choroid plexuses.[6] Hydrocephalus is characterised by disturbances in absorption or production of CSF resulting in excess accumulation of fluid which leads to an increased pressure build-up of the fluid level; causing the ventricles to dilate as the brain pushes against the skull, damaging the brain tissue.[7] CSF is a clear colourless fluid, with approximately 500ml produced each day in the human body.[8] Its basic functions include acting as a cushion and shock absorber for the brain against any adverse impact.[8] CSF also acts as a vehicle for delivering nutrients to the brain and compensates for changes in intracranial blood volume by improving blood perfusion to prevent brain ischemia.[8-10]

Hydrocephalus can be considered mainly as communicating/non-obstructive and non-communicating/obstructive.[11,12] The former describes the condition where CSF re-absorption into subarachnoid space is impaired, whereas the latter refers to the condition where the flow of CSF from ventricles to subarachnoid space is obstructed.[5] Normal pressure hydrocephalus (NPH) is another form of hydrocephalus which occurs in elderly patients aged over 60 years.[13] NPH presents clinically with an enlargement of the ventricles with no apparent increase in CSF production.[14] It is associated with symptoms such as abnormality of gait, dementia and urinary incontinence.[14-16] Another subtype of hydrocephalus is ex-vacuo hydrocephalus. This occurs where there is loss of brain tissue due to stroke and brain injury.[17]

Hydrocephalus can be diagnosed through clinical evaluation or radiological imaging modalities including computed tomography (CT), magnetic resonance imaging (MRI), ultrasonography, and pressure-monitoring techniques.[8,19] Currently, hydrocephalus is treated by surgically inserting a shunt system, or performing a neuro-endoscopic procedure. The shunt system diverts the flow of CSF from the central nervous system (CNS) to other areas of the body where it can be absorbed as part of the normal circulatory process.[20] The National Institute of Neurological Disorders and Stroke (NINDS) of Canada estimated that 1-2 of every 1,000 babies are born with hydrocephalus every day.[21] The burden of infant hydrocephalus in east Africa is more significant, with over 6000 recorded new cases annually.[22] Similarly, recorded new infant hydrocephalus cases in sub-Saharan Africa is between 100,000-200,000 annually.[23]

Anecdotal evidence suggests that hydrocephalus, which is one of the highly rated neurological dysfunctions in paediatrics neurology, is among the least researched

conditions in Ghana. This leads to stigmatisation of persons affected with hydrocephalus. The unavailability of data on the prevalence of hydrocephalus in Ghana is worth investigating. The aim of this study therefore was to carry out a six-year review of CT radiological reports of patients who presented for head and brain examinations in order to determine the prevalence and patterns of hydrocephalus in Ghana.

Method

A cross-sectional retrospective study was conducted at the radiology department of the Korle-Bu Teaching Hospital (KBTH) in Ghana to evaluate all radiological reports of brain and head CT scans conducted between 2007 and 2012. The KBTH was chosen because it is the biggest and the leading referral hospital in Ghana. Ethics approval was sought and obtained from the Ethics and Protocol Review Committee of the School of Biomedical and Allied Health Committee of the University of Ghana. Permission to use the facility for the study was also sought from the authorities of the KBTH. CT reports of all head and brain CT examinations, from January 2007 to December 2012, were retrieved for analysis by an independent consultant radiologist. Demographic data of the patient (age, gender), as well as clinical history, were recorded. Confirmed hydrocephalus cases were categorised according to the type (communicating, non-communicating, normal pressure or ex-vacuo). Data obtained were analysed using Statistical Package for Social Sciences (SPSS) version 20.

Results

During 2007 to 2012, 6550 CT head examinations were carried out; 251 (3.8%) were cases of hydrocephalus. The prevalence for respective years ranged from 2.5 to 6.7%. Out of the 251 hydrocephalus cases recorded within the 6-year period, 26.7% and 25.1% occurred in 2007 and 2009 respectively (Table 1).

The female-male rate of hydrocephalus was: females (151; 60.1%) and males (100; 39.9%). Table 2 presents the age distribution of CT examinations and hydrocephalus cases.

Communicating and non-communicating types of hydrocephalus recorded were 123 (49.0%) and 120 (47.8%) respectively. Two (0.8%) of the recorded hydrocephalus cases were congenital, five (2.0%) normal pressure, and one (0.4%) ex-vacuo. Most of the communicating hydrocephalus cases recorded were mild or moderate (51 and 52 respectively). The majority of the non-communicating hydrocephalus cases (85 out of 123) were severe and occured mostly in female patients. The grading of hydrocephalus was estimated using the standardised method employed by Choudhury in 1995.[24] In that method dilatation was determined using the ventricular/bi-parietal diameter (V/BPD) ratio on the axial CT scan at the mid-portion of the bodies of the lateral ventricles, where most dilatation occurred. Choudhury[24] classified hydrocephalus into four grades: mild (V/BPD ratio 0.26-0.40), moderate (V/BPD ratio 0.41-0.60), severe (V/BPD ratio 0.61-0.90), and extreme (V/BPD ratio 0.91-1). A V/BPD ratio of less than 0.26 was considered normal. Table 3 shows the types of hydrocephalus cases recorded in cross tabulation with gender.

Chi-square goodness of fit test was used to determine the association between gender and hydrocephalus. The null hypothesis was rejected because the p-value was less than 0.05; (χ^2 = 19.17, $p \leq 0.001$) suggesting a strong evidence of association between patients' gender and hydrocephalus. This association was significant (contingency coefficient (CC) = 0.054, $p \leq 0.001$). The test was also used to determine the association between age and hydrocephalus. The null hypothesis was rejected (χ^2 = 500.49, $p \leq 0.001$) with the result suggesting a strong evidence of association between patients' age and hydrocephalus. This association was significant (contingency coefficient (CC) = 0.27, $p \leq 0.001$).

Discussion

The following are discussed below: prevalence of hydrocephalus, distribution by types of hydrocephalus, and gender distribution of hydrocephalus.

- ***Prevalence of hydrocephalus***

The actual incidence of hydrocephalus in children in sub-Saharan Africa is not documented. The overall prevalence of hydrocephalus, recorded on brain CT scans for the six year period (3.8%), as well as the prevalence for respective years (2.5 to 6.7%) recorded in this study, is significant. However, further epidemiological studies will be required in order to compare data from other countries.[25-27] For example, in the United Kingdom (UK), reports suggest that for every 10,000 live births, only six cases of hydrocephalus were recorded resulting in a prevalence of 0.06%.[28] This is similar to that of China; seven per 10,000 live births (0.07%).[27] Hydrocephalus prevalence in developed countries ranges between 0.9-1.2%.[29] A study in Uganda[29] attributed high prevalence to the inability to manage hydrocephalus due to socio-economic constraints: poverty, lack of social amenities, and inability to access quality healthcare, which

Table 1. Distribution of examination types across years under review

YEAR	NUMBER OF CT EXAMINATIONS	CASE OF HYDROCEPHALUS RECORDED	PREVALENCE (%)	PERCENTAGE (%) WITHIN THE HYDROCEPHALUS
2007	1004	67	6.7	26.7
2008	424	15	3.5	6.0
2009	2515	63	2.5	25.1
2010	439	19	4.3	7.6
2011	1218	41	3.4	16.3
2012	950	46	4.8	18.3
Total	**6550**	**251**	**3.8**	**100.0**

Source: Field data, 2014

Table 2. Age distribution of CT examinations and hydrocephalus cases

AGE RANGE	TOTAL NUMBER OF CT EXAMINATIONS	NUMBER OF HYDROCEPHALUS CASES RECORDED	PERCENTAGE (%) OF HYDROCEPHALUS CASES OVER THE ENTIRE EXAMINATIONS	PERCENTAGE (%) WITHIN THE HYDROCEPHALUS
0 – 4	595	119	20.0	47.4
5 – 9	246	21	8.5	8.4
10 – 14	319	14	4.4	5.6
15 – 19	292	7	2.4	2.8
20 – 24	299	4	1.3	1.6
25 – 34	699	12	1.7	4.8
35 – 44	790	10	1.3	4.0
45 – 54	902	19	2.1	7.6
55 – 64	972	19	2.0	7.6
65 – 74	829	18	2.2	7.2
75 – 84	508	6	1.2	2.4
84+	99	2	2.0	0.8
Total	**6550**	**251**	**3.8**	**100.0**

Source: Field data, 2014

are all similar to the situation pertaining in Ghana. In this study 20% of the infants <5 years who presented for CT examinations were diagnosed as hydrocephalus and constituted 47.4% of the recorded hydrocephalus cases. This is consistent with other studies which suggest that hydrocephalus is very common in paediatric neurology.[1,30]

• ***Distribution by types of hydrocephalus***

Hydrocephalus cases were categorised into four types: communicating, non-communicating, normal pressure, and ex-vacuo. The radiological reports collated were also classified according to the inference made by the radiologist; i.e. mild, moderate and severe. Literature[12] suggests that communicating hydrocephalus is the most common. The current study however showed that communicating and non-communicationg types of hydrpocephalus were almost equally distributed: 123 (49%) and 120 (47.8%) respectively.

Hydrocephalus is also known to have equal dominance of gender with the exception of Bickers-Adams syndrome, and normal pressure hydrocephalus.[31,32] This is contrary to the findings of the current study which revealed female dominance as compared to the males in communicating hydrocephalus and non-communicating: 69 females versus 54 males, and 79 females versus 43 males. Obstructive or non-communicating hydrocephalus commonly results from blockages in the ventricular anatomy by intra-ventricular and extra-ventricular space occupying lesions in the brain, as well as from intraventricular extension of infections and cerebral haemorrhages.[5]

The prevalence of 0.8% congenital hydrocephalus recorded in this study is similar to those recorded in the United States and Europe (0.5-0.8%).[33] In Uganda, the issue of infant hydrocephalus is alarming: 6000 new cases estimated yearly.[29] This indicates that infants are most susceptible to hydrocephalus. Literature suggests that the black race is associated with higher infant mortality rates for both congenital and acquired hydrocephalus.[31] Ex-vacuo hydrocephalus is rarely recorded because it is linked to atrophy of the brain with increased CSF around the brain tissue. This explains recording of only one ex-vacuo case in this study. Normal pressure

Table 3. Category of hydrocephalus: gender of patients and type of hydrocephalus cross-tabulation

TYPE/CATEGORY OF HYDROCEPHALUS		GENDER OF PATIENTS (COUNT AND % WITHIN TYPE OF HYDROCEPHALUS)		TOTAL
		MALE	FEMALE	
Communicating	Mild	28 (54.9%)	23 (45.1%)	51 (100%)
	Moderate	20 (38.5%)	32 (61.5%)	52 (100%)
	Severe	6 (30.0%)	14 (70.0%)	20 (100%)
	TOTAL	**54 (43.9%)**	**69 (56.1%)**	**123 (100%)**
Non-communicating	Mild	21 (60.0%)	14 (40.0%)	35 (100%)
	Severe	20 (23.5%)	65 (76.5%)	85 (100%)
	TOTAL	**41 (34.2%)**	**79 (65.8%)**	**120 (100%)**
Congenital	Moderate	2 (100%)		2 (100%)
Normal pressure	Moderate	3 (60.0%)	2 (40.0%)	5 (100%)
Ex-vacuo	Moderate		1 (100%)	1 (100%)

hydrocephalus occurs in elderly patients (>60 years).[13] The study reported only five cases of normal pressure hydrocephalus (three males and two females). This result is consistent with a study[2] which indicated that males are known to have a preponderance in normal pressure hydrocephalus (NPH) compared with females.

The study also indicated that there was more non-communicating hydrocephalus (65) amongst patients aged 0-4 years than communicating hydrocephalus (52). In this study, NPH occurred mostly in patients aged 45-54 and 65-74 years; each age group recorded two cases. This result is slightly different from the assertion in the literature, namely that NPH has a peak onset age of 60 years and above;[13] and that it rarely occurs in patients <60 years old. Another survey estimated the prevalence of NPH to be about 0.5% in those over 65 years,[13] which is slightly lower than the prevalence recorded in this study for patients aged 65 years and above: 0.79% (2 out of 251).[13]

• ***Gender distribution of hydrocephalus***

The study indicated a significant association (χ^2 = 19.7, $p \leq 0.001$) in hydrocephalus between male and female patients. The study also revealed that the majority of hydrocephalus cases were females; contrary to the findings from other studies.[33] Hydrocephalus was also found to vary significantly among patients of different age groups (χ^2 = 500.49, $p \leq 0.001$).

Limitation and quality assurance issues

The year 2009 recorded the highest number (2515) of CT examinations. The data showed a persistent fluctuation in the overall CT examinations during the study period. There were declines in the total examinations in the years 2008, 2010, and 2012. Investigation suggested a persistent breakdown of equipment every other year; this thus suggests lack of quality assurance (QA) and periodic maintenance of the CT machine. CT machines in Ghana frequently breakdown because most of them are not regularly serviced as recommended by the manufacturers. Maintenance of imaging equipment is essential to ensure that it functions efficiently to ensure proper and effective clinical management of patients. Maintenance of CT machines should be carried out on a regular basis to prevent breakdowns. The literature has identified lack of QA systems, formal organisational structures, procedural protocols, operational manuals and exposure charts for diagnostic imaging in hospitals in Ghana.[35] The absence of effective QA practices and functional supervisory structures for diagnostic imaging services in Ghana could have adverse effects on quality service delivery and patient radiation protection, especially in CT examinations. There is therefore an urgent need for robust action to implement realistic QA programmes in hospitals in Ghana.[35]

Conclusion

The overall prevalence of hydrocephalus recorded was high compared to available data in developed countries. The high prevalence recorded in this study may be associated with socio-economic problems like poverty, lack of access to quality healthcare, and ignorance on the existence and management of hydrocephalus. An extensive nationwide study should therefore be conducted to establish the causes and prevalence of hydrocephalus to facilitate its management.

Conflict of interest

The authors have no conflict of interest in this study.

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Contribution of authors

EKO is responsible for the concept and design of the manuscript for intellectual presentation. He also contributed to the collection, management, analysis and interpretation of data and participated in the final editing of the manuscript. AOBG contributed to the collection, management, analysis and interpretation of data. KDT participated in data interpretation and analysis. EKB also participated in data interpretation and analysis. SKA contributed to the design of the manuscript and interpretation of data and also participated in the final editing of the manuscript. JO participated in data interpretation, analysis and manuscript preparation. All authors read and approved the final manuscript.

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