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Routine lumbar puncture in children with febrile seizures in Ghana: should it continue?

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Summary

Objectives: Performing routine lumbar punctures in children with febrile seizures has been controversial. This study aimed to determine the positive yield of lumbar punctures in a setting where routine lumbar puncture is routinely carried out and to determine if any other parameter could help differentiate bacterial meningitis from the various other diagnoses of children who presented with a febrile seizure.
Design: A prospective study was carried out among children aged three months to 15 years of age, hospitalized at the Komfo Anokye Teaching Hospital in Kumasi, Ghana, between July and August 2000.
Results: There was a 10.2% (*n* = 19) positive yield for bacterial meningitis with a case fatality rate of 36.8% (*n* = 7). Cerebral malaria, which is not easily distinguishable from bacterial meningitis, accounted for 16.1% (*n* = 30) of the children. Twenty percent of bacterial meningitis patients had a positive blood smear for malaria. The indication for doing a lumbar puncture was similar in both cerebral malaria and bacterial meningitis patients. Signs of meningism were not the primary reason for carrying out a lumbar puncture, even in the group of children who had bacterial meningitis.
Conclusion: Performing routine lumbar punctures may still have a role to play in the management of children with febrile seizures.
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Introduction

Febrile seizures in children are frightening and an experience never to be forgotten by parents and guardians.[1–3] For clinicians, however, there are divergent views on how these children should be managed. Children with febrile seizures account for up to 2% of emergency department visits.[4] Febrile seizures may occur in 2–5% of children between the ages of five months to five years[5–7] and are a common presentation of various diseases. Two very important differential diagnoses, among others, in Africa for a febrile child who convulses are cerebral malaria (CM) and acute bacterial meningitis (ABM). These are life-threatening illnesses which require prompt diagnosis and aggressive treatment.[8–11] Physicians, however, cannot easily distinguish between CM and ABM without cerebrospinal fluid (CSF) analysis.[8]

Definitive diagnosis of ABM requires microbiological and biochemical analysis of CSF, obtained by lumbar puncture (LP). Lumbar puncture is an invasive procedure that carries with it potential risks and should be carried out only when absolutely necessary. Herniation in children with raised intra-cranial pressure is one of the most feared and well-documented complications.[12,13] Some of the other feared complications of an LP include headache, leg numbness, paresthesia, cranial nerve palsies and iatrogenic meningitis. Despite the usefulness of lumbar puncture, there remains considerable debate as to whether LP should be systematically or selectively performed on all children who report to hospitals with febrile seizures.

Various authors have proposed guidelines for performing selective LPs, including whether the seizure is the first or second, the type and duration of seizure, age of patient, previous treatment, and clinical presentation.[14–18] The American Academy of Pediatrics recommends that:

- pediatricians strongly consider carrying out an LP in infants less than one year old who present with a first febrile seizure and
- pediatricians consider it in children between 12 and 18 months.[19]

This view is supported by many authors with minimal variation.[17,18,20–23] Obviously these guidelines are very helpful but may not apply in all regions, as different diseases that mimic meningitis and present with seizures have different incidence in various geographic locations. In the hospital where this study was perfomed, LP is carried out routinely for all children who are admitted with febrile convulsions for fear of missing a case of ABM. This study was therefore performed to determine the usefulness of routine LPs by assessing the positive yield of LPs and to find out if any other parameter could help identify the different diagnoses of children who presented with a febrile seizure.

Patients and method

This study was conducted at the pediatric unit of the Komfo Anokye Teaching Hospital (KATH), Kumasi, Ghana, where malaria is endemic. KATH serves the urban population of Kumasi and the surrounding towns and villages, a population of 1.5 million people. It serves also as a referral center for all district hospitals in the middle sector of Ghana. Children who had an LP on admission were recruited into this study, which took place between July and August 2000. The children ranged from ages three months to 15 years. Their physical examination findings at the time of the LP were recorded after obtaining their history. The doctor performing the LP stated the indication for which the LP was carried out and all laboratory findings were noted.

Patients who had repeated lumbar punctures, who were transferred to another unit or who left the hospital against medical advice were excluded from the study. Also excluded were known cases of meningitis who had had an LP elsewhere before they were referred to this teaching hospital. For the purposes of this study the following definitions were used:

Bacterial meningitis was defined as having a CSF white cell count of $>0.005 \times 10^9$/l, protein of >4 g/dl, CSF glucose of <1.0 mmol/l with or without bacteria seen on Gram stain or culture.

Cerebral malaria was defined as having positive peripheral blood film for malaria parasites and a modified Glasgow coma score <3. Also included in this group were children who had a negative blood film but responded clinically to quinine.

Severe malaria included all children with complications of malaria including severe anemia, hypoglycemia, prostration, and repeated convulsions. Simple malaria was defined as a child having a positive peripheral blood film for malaria parasites, or having a negative parasitemia and yet responding to antimalarial treatment.

Febrile convulsion was defined as a child with an age range of six months to six years, presenting with a febrile seizure for which there was no identifiable cause for the fever. Any other illness apart from those described above was classified as 'others'.

Table 1 Summary of data within the different diagnostic groups.

	All patients n (%)	Cerebral malaria n (%)	Severe malaria n (%)	Malaria n (%)	Febrile convulsion n (%)	Bacterial meningitis n (%)	Others n (%)
No of patients	186	30 (16.1)	34 (18.2)	31 (16.7)	29 (15.6)	19 (10.2)	43 (23.2)
Sex							
Male	103 (55.4)	17 (56.7)	20 (58.8)	15 (48.4)	16 (55.2)	9 (47.4)	26 (60.5)
Female	83 (44.6)	13 (43.4)	14 (41.2)	16 (51.6)	13 (44.8)	10 (52.6)	17 (39.5)
Age (yrs)							
<1	44 (23.6)	4 (13.3)	10 (29.4)	4 (12.9)	7 (24.1)	11 (57.8)	8 (18.6)
1−<5	110 (59.1)	15 (50.0)	19 (55.9)	24 (77.4)	18 (62.1)	4 (21.1)	30 (69.8)
5−<10	24 (12.9)	10 (33.3)	5 (14.7)	2 (6.5)	4 (13.8)	3 (15.8)	0
>10	8 (4.3)	1 (3.3)	0	1 (3.2)	0	1 (5.2)	5 (11.6)
Temp (°C)							
<37.5	71 (38.2)	7 (23.3)	13 (38.2)	4 (12.9)	3 (10.4)	5 (26.3)	39 (90.7)
>/=37.5	115 (61.8)	23 (76.7)	21 (61.8)	27 (87.1)	26 (89.6)	14 (73.7)	4 (9.3)
Mortality	31 (16.7)	4 (13.3)	2 (5.9)	1 (3.2)	0	7 (36.8)	17 (39.5)

Results

Of the total 608 admissions, 30.6% (186) patients had LPs. There was a slight male preponderance (55.4%) among the study group but there were no significant differences in the sex distribution within the various diseases (Table 1). At the time of presentation, 38.2% were not febrile although they gave a history of prior fever. The overall mortality was 16.7% and deaths were mostly concentrated in the group with ABM and 'others' (Table 1). There was no mortality in the group of children with febrile convulsion.

Figure 1 shows a breakdown of the various diagnoses of these children who had LP. ABM accounted for 10.2% (n = 19) of all patients. Collectively, malaria (including cerebral, severe and simple) formed 51% of all cases, with severe malaria having the highest number of malaria cases. Children who had multiple diagnoses, or who did not have a definite diagnosis at discharge or death were classified as 'others'. Also included in this group were children with septicemia, pneumonia and urinary tract infections. These made up about 23% of the children. Within all the disease groups, with the exception of ABM, children in the 1−<5 year age group had the highest numbers and the >10 year age group had the lowest numbers.

The majority (25%) of children less than one year of age had ABM (Table 2), while in the one to five year age group, ABM accounted for very few children. Cerebral malaria accounted for the majority (41.7%) in the five to ten year age group with ABM having 12.5%.

When comparing the characteristics of children with ABM versus CM (Table 3), the majority of the children who had ABM were under one year of age while most cases of CM were aged between one and five years. There was a significant difference between the coma scores observed in the ABM and CM cases. While most children with CM had a score of less than three (deep coma), children with ABM were not deeply unconscious ($P < 0.0001$, Fischer exact test). Twenty percent of ABM patients had a positive blood smear for *Plasmodium falciparum*. Neurological sequele and mortality were more frequently observed in ABM than in CM.

The coma scores shown in Figure 2 are the scores of the children at the time of the LP. Some of the CM children had initial coma scores of more than two, but deteriorated during admission. Two was the most common coma score for CM patients while ABM patients were mostly fully conscious.

Table 4 shows the CSF characteristics of the various groups. ABM was the only group that had white cells in their CSF. Again, the ABM group had
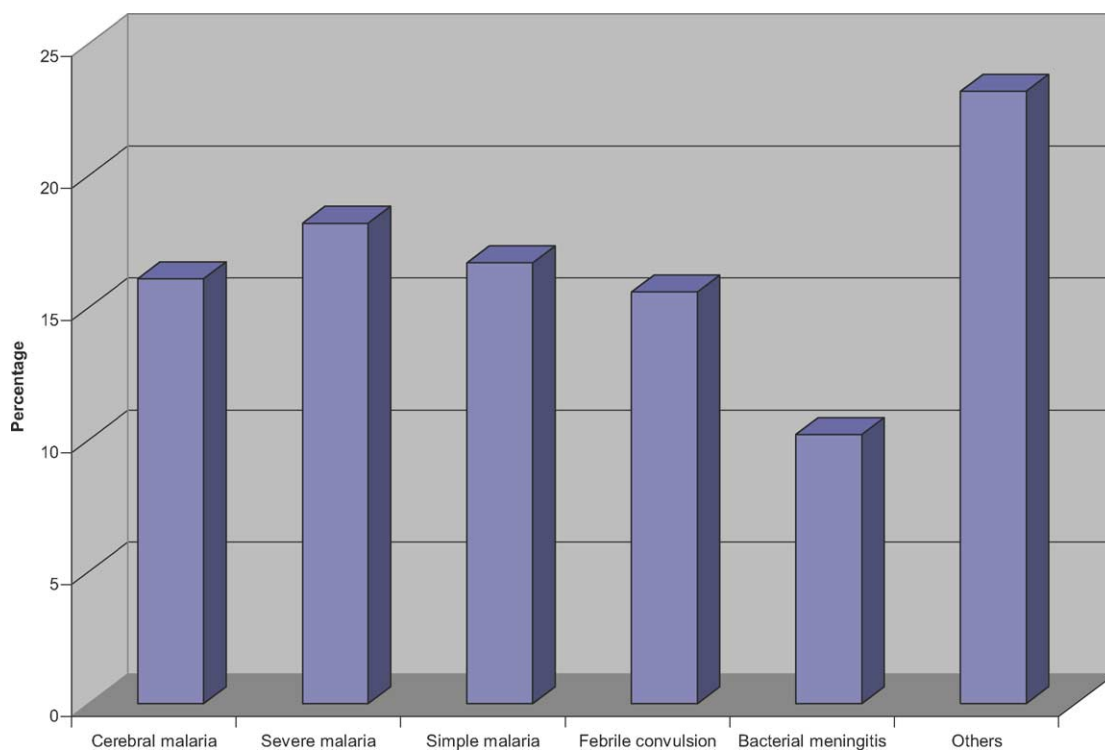
**Figure 1** Graph showing the diagnosis of children who had lumbar puncture.

Table 2 Distribution of various diagnoses by age.

Diagnosis	<1 yr n (%)	1—<5 yrs n (%)	5—<10 yrs n (%)	≥10 yrs n (%)
Bacterial meningitis	11 (25.0)	4 (3.7)	3 (12.5)	1 (12.5)
Cerebral malaria	4 (9.1)	15 (13.6)	10 (41.7)	1 (12.5)
Severe malaria	10 (22.7)	19 (17.2)	5 (20.8)	0
Simple malaria	4 (9.1)	24 (21.8)	2 (8.3)	1 (12.5)
Febrile convulsion	7 (15.9)	18 (16.4)	4 (16.7)	0
Others	8 (18.2)	30 (27.3)	0	5 (62.5)
Totals	44 (100)	110 (100)	24 (100)	8 (100)

Table 3 Comparison between children with bacterial meningitis and cerebral malaria.

	Meningitis (n = 19) n (%)	Cerebral malaria (n = 30) n (%)
Age		
<1 yr	10 (52.6)	4 (13.3)
1—5 yrs	2 (10.5)	18 (60.0)
>5 yrs	7 (36.8)	8 (26.7)
MGCS		
<3	3 (15.7)	25 (83.3)
3—5	16 (84.2)	5 (16.7)
Positive MPs	3/15 (20.0)	25 (83.3)
Outcomes		
Death	7 (36.8)	4 (13.3)
Neurological sequelae	5 (26.4)	1 (3.3)

MGCS: Modified Glasgow Coma Score. MPs: Malarial parasite screen.
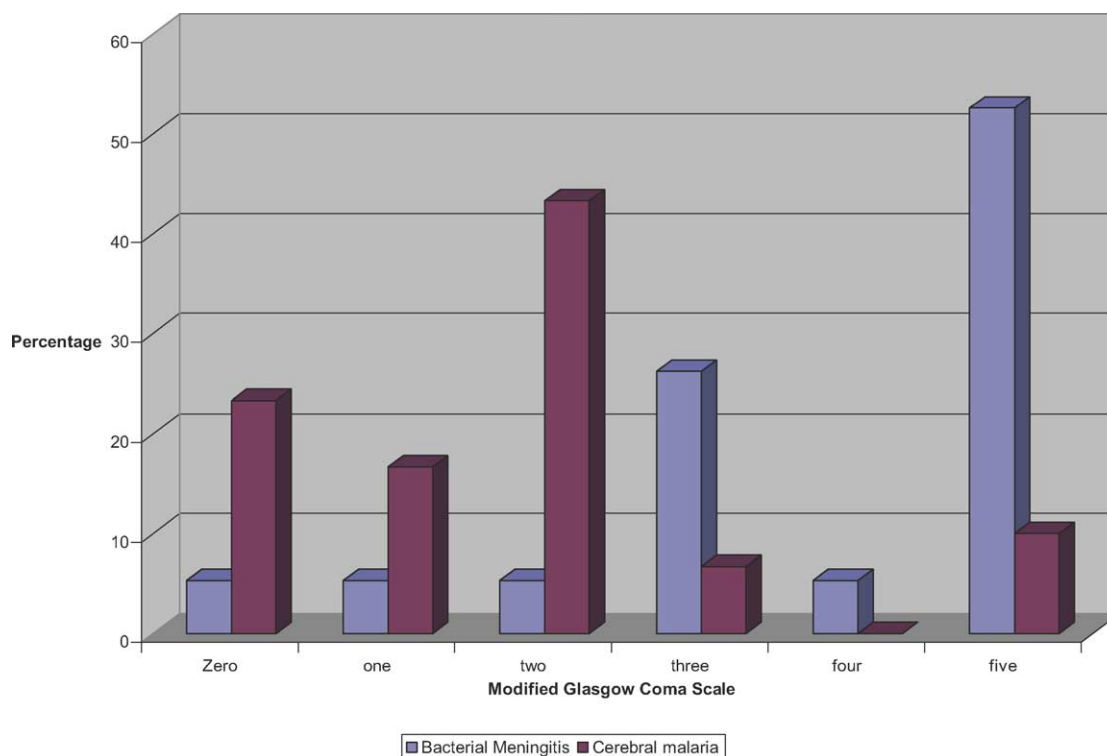
Figure 2 Comparison of Modified Glasgow Coma Scores between children with bacterial meningitis and cerebral malaria.

the highest CSF protein concentration and the lowest CSF glucose concentration. CSF glucose concentrations were normal in all the malaria groups and in the febrile convulsion group. CSF protein was also normal in all groups with cerebral malaria, having a mean that was on the upper border of the normal value.

The doctors gave a number of reasons, either singly or in combination, for carrying out the LP, but convulsion was the overall leading indication for both ABM and CM cases (Figure 3). The trend of indication for LP was similar for both groups with convulsion and unconsciousness being the two leading reasons for LP. Meningism accounted for 20% of the reasons in the ABM group and was four times that of the CM group. Lethargy and irritability were the least frequent reasons given for performing an LP.

When convulsion alone was the indication for an LP, febrile convulsion was the most common diag-

nosis and ABM was the least diagnosed (Table 5a). As expected, when the combination of convulsion and neck stiffness was the indication for LP, ABM was the leading diagnosis (Table 5c), while CM was diagnosed in more than half the cases that had convulsion and unconsciousness as the indication for carrying out an LP (Table 5d).

Discussion

Over the past few decades, the controversy of whether a febrile child who convulses warrants an LP has not been resolved. The initial evaluation of such patients presenting in a coma to hospitals in developing countries has traditionally included an LP.[8] Ideally each febrile child who convulses must be assessed on an individual basis by combining history

Table 4 CSF characteristics of the different groups.

Diagnosis	Protein (g/dl) Mean ± SEM	Glucose (mmol/L) Mean ± SEM	WBC count ($\times 10^9$/l) Mean ± SEM
Bacterial meningitis	2.90 ± 0.40	0.63 ± 0.19	1.272 ± 0.262
Cerebral malaria	0.40 ± 0.06	3.30 ± 0.25	0
Severe malaria	0.35 ± 0.09	3.87 ± 0.18	0
Simple malaria	0.19 ± 0.04	3.56 ± 0.21	0
Febrile convulsion	0.35 ± 0.08	3.47 ± 0.25	0
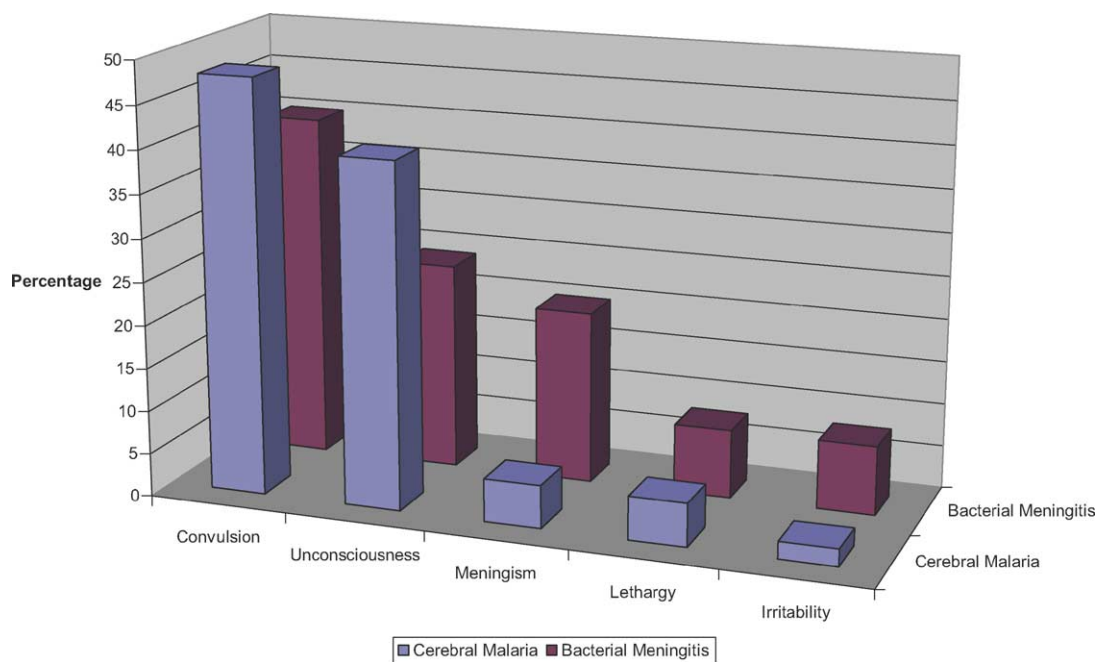
Figure 3 Indication for performing lumbar punctures in children with bacterial meningitis and cerebral malaria.

and physical examination findings and then determining whether an LP is warranted.

Duration of fever prior to hospitalization has been reported to be a useful clinical clue in diagnosis. Rougemont noted that, in West Africa, a temperature higher than 39 °C for less than three days without any other obvious cause was most likely due to malaria.[24] In this study, no correlation was found between degree of fever and diagnosis. Thirty eight percent of the patients were found not to have a

Table 5

Indication for LP	Diagnosis	Number of cases	Percentage (%)
(a) Diagnoses obtained when convulsion was the only indication for performing the LP			
	Severe malaria	4	8.9
	Febrile convulsion	15	33.3
	Simple malaria	10	22.2
	Others	13	28.9
	Bacterial meningitis	3	6.7
	Total	45	100
(b) Diagnoses obtained when convulsion and lethargy was the indication for performing the LP			
	Cerebral malaria	2	7.7
	Febrile convulsion	8	30.8
	Simple malaria	4	15.4
	Severe malaria	9	34.6
	Bacterial meningitis	3	11.5
	Total	26	100
(c) Diagnoses obtained when convulsion and neck stiffness was the indication for performing the LP			
	Cerebral malaria	2	28.6
	Bacterial meningitis	5	71.4
	Total	7	100
(d) Diagnoses obtained when convulsion and unconsciousness was the indication for performing the LP			
	Cerebral malaria	14	63.6
	Severe malaria	5	22.7
	Febrile convulsion	1	4.6
	Bacterial meningitis	2	9.1
	Total	22	100

high temperature on admission. In a study from Tanzania, 86.6% of parents first take antipyretic measures including sponging/ bath and antipyretics[35] before taking the children to hospital. This may explain why more than a third of patients in this study were not febrile at the time of presenting to the hospital.

Neck stiffness and positive Kernig's and Brudzinski's signs may be the classical signs of ABM but are not pathognomonic. In a study from northern Nigeria, 30.3% of ABM patients lacked typical signs of meningitis and 22.2% of those with other illnesses had signs of meningism.[26] Levy et al.[11] reported that 43% of patients with ABM had neck stiffness but 21% of those without ABM also had neck stiffness. A positive Brudzinski's sign was also two to three times more common in ABM than in other diagnoses.

An analysis of routine LP cases in Saudi Arabia obtained a positive yield of 6.3% for meningitis in children aged six months to six years who presented with a febrile seizure but had no signs of meningeal irritation.[27] A recent study which looked at clinical signs of meningitis in adults, showed that nuchal rigidity, Kernig's and Brudzinski's signs each had no more than a 30% positive predictive value and no more than a 70% overall diagnostic accuracy. Better bedside diagnostic signs are therefore needed as the three classical signs did not give a good diagnostic value.[28]

Meningeal signs are even less reliable in younger children and of negligible value in infants. These data further show the unreliability of depending solely on physical signs. If cases for LP are selected, many cases of ABM may be missed, lending credence to a liberal policy in the performing of LP in a febrile child who convulses, to reduce the risk of missed diagnosis.

The trend in this study shows that those who were deeply comatose were more likely to have CM than ABM. Mortality was however higher in ABM than CM and the risk for neurological sequelae is greater in ABM than CM (p = 0.0269). The mortality for CM in this study (13%) is similar to Wright's experience into Liberia[8] and falls within the range of CM mortality in Africa, which is 10—50%.[10,29—31] The infant age group had the highest rate of ABM and this trend is similar to a previous report.[11] The lower incidence of CM in this age group may be due to the passive immunity they obtained from their mothers thus making them less likely to have a severe form of malaria until the immunity recedes.

There are strong similarities between ABM and CM.[32] While in a few cases an experienced pediatrician may be able to distinguish between ABM and CM, it is generally difficult to exclude meningitis without an LP.[33] The problem of a lack of experi-enced pediatricians[34] to supervise junior colleagues, combined with the overwhelming number of patients, does not allow effective monitoring of patients who ideally must be monitored closely for signs of deterioration before carrying out an LP.[15] Patients rapidly deteriorate and die due to poor monitoring or observation. Also, in developing countries, most children are brought to the hospital when the child's disease is in an advanced state, resulting in most deaths occurring a few hours after admission.[8] For cases of ABM and CM, where early diagnosis and treatment are essential to avoid poor outcomes, any 'wait and see' attitude by doctors is detrimental.

Impaired consciousness associated with febrile convulsions is a common presentation of severely ill children to African hospitals and even with laboratory diagnosis it may be difficult to establish an exact diagnosis.[32] In the patients in this study with meningitis who had a blood film carried out for malaria parasites, 20% were positive. Positive parasitemia found in peripheral blood smear alone cannot distinguish childhood malaria from meningitis or any other febrile illness.[25] The finding of malaria parasites in the blood of an unconscious child in sub-Saharan Africa is not sufficient to establish a diagnosis of CM, and ABM must be actively excluded.[32]

In Africa, therefore, a complete blood count and a peripheral blood smear for malaria parasites, in children with febrile convulsion may be helpful but is not the best option and cannot be justified as the sole investigation. Indeed, routine evaluation of seizures does not include blood studies but determination of the cause of the fever may require a more extensive evaluation.[35] CSF analysis plays a vital role in the early differentiation of CM and ABM[8] and an LP is the most important investigation initially. In a study looking at the diagnosis of ABM in children at a district hospital in sub-Saharan Africa, it was observed that ABM could be missed in a third of cases without adequate and reliable laboratory resources.[36] In another study only about 60% of ABM patients were initially diagnosed without the help of an LP. The rest of the diagnosis could only be made after performing an LP.[8]

The main arguments against performing routine LPs have been a low yield of positive cultures from CSF and the risk of herniation. While low yield may generally be true for developed countries,[15,16] it is not true for developing countries where ABM is common. During an inter-epidemic period, 19.4% of children undergoing LPs had ABM.[26] This is twice what was observed in the present study.

Cerebral herniation is a real problem in meningitis but predicting the likelihood of its occurrence is

difficult. In a study involving children from Nigeria, 15% of patients presenting with meningitis already had evidence of herniation prior to having an LP[13] and when patients were classified into high versus low risk, there was no difference in the incidence of herniation. Outcomes are uniformly poor in meningitis patients whether LPs are deferred or not, but it has been suggested that increasing the LPs performed by including prostrated or convulsing children significantly increases the number of cases detected and improves prognosis.[37]

Summary and conclusion

This study suggests that clinical or laboratory parameters like degree of fever, depth of coma, signs of meningism and the presence of malaria parasites in blood films may be helpful but do not establish a definite diagnosis in febrile children who convulse. Clinicians are not in a position to clinically identify the cause of the convulsion because of the similarity in presentation between CM and ABM. Routine LPs had a positive yield of 10.2% for bacterial meningitis.

This study is by no means conclusive and many more detailed and larger studies are needed in developing countries to truly answer the question of whether routine or selective LPs should be carried out.

However, a policy of nonselective LP for febrile children who convulse remains an acceptable choice since delays in prompt diagnosis and treatment worsen prognosis. It is useful to carry out routine early LPs to avoid missing any cases of meningitis. This will ensure early appropriate treatment and thus reduce morbidity and mortality in ABM. In the Komfo Anokye Teaching Hospital, when patients cannot afford multiple laboratory investigations, LP is the single and most reliable test to carry out in the circumstance of a febrile child who has convulsed, since finding malaria parasites in the blood does not exclude ABM.

It is concluded that in countries where malaria is endemic and meningitis is common, routine lumbar puncture may generally have an important role to play in the management of children presenting with febrile seizures.

Acknowledgements

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