Calcium, magnesium, and glucose levels in blood and CSF of children with febrile convulsions

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Rutter, N., and Smales, O. R. C. (1976). *Archives of Disease in Childhood*, 51, 141. **Calcium, magnesium, and glucose levels in blood and CSF of children with febrile convulsions.** Levels of calcium, magnesium, and glucose were measured in the blood and cerebrospinal fluid (CSF) of children with febrile convulsions. Calcium and magnesium levels were within the normal range and the blood:CSF ratios were similar to those of normal subjects. Hyperglycaemia was a frequent finding and was reflected in raised CSF glucose levels. Blood glucose levels were only transiently raised and none of the children had diabetes mellitus.

Febrile convulsions remain one of the commonest and least understood disorders of childhood. Much interest has been shown recently in blood calcium and magnesium levels in newborn infants with convulsions, and both hypocalcaemia and hypomagnesaemia are common metabolic disturbances (Cockburn *et al.*, 1973). The aim of this study was to see how many among a large group of children with febrile convulsions exhibited similar changes in blood calcium and magnesium levels. Measurements of calcium and magnesium in cerebrospinal fluid (CSF) were also made in order to correlate them with blood levels.

Hyperglycaemia has been noted in children after convulsions (Spirer *et al.*, 1974). We decided to investigate the incidence of hyperglycaemia in our group of children and at the same time to correlate blood and CSF glucose levels.

Patients and methods

Over a period of 10 months 83 patients between the ages of 6 months and 6 years were studied after admission to Nottingham Children's Hospital with their first febrile convulsion. All the children had a typical history and all were febrile on admission. A clinical diagnosis of the cause of the fever was made when possible, and we tried to confirm the diagnosis by appropriate bacterial and viral cultures.

On admission blood was taken by venepuncture for full blood count and for measuring plasma glucose, calcium, and magnesium levels. Lumbar puncture was carried out in all cases according to our current policy for children with their first febrile convulsion. In

addition to the routine examinations CSF calcium and magnesium were measured in most patients. Blood glucose was again measured in over half the patients after the first overnight fast after their admission.

Calcium and magnesium levels in plasma and CSF were measured by atomic absorption spectrometry. Glucose levels were measured by a modification of the glucose oxidase method (Barham and Trinder, 1972).

Results

The causes of the fever are shown in the Table.

TABLE

Cause of fever in 83 children with febrile convulsions

Cause	No.	No. confirmed by culture
Upper respiratory tract infection	40	12
Tonsillitis	12	8
Pneumonia	3	0
Otitis media	3	1
Gastroenteritis	3	0
Urinary tract infection	3	3
Mumps	1	0
Measles	1	0
Undetermined	17	0
Total	83	24

In 66 (80%) of patients a clinical diagnosis of the cause was made and in 24 (36%) cases the diagnosis was confirmed by bacterial or viral cultures. The mean age of the patients was 23 months, and there were 41 girls and 42 boys.

The mean plasma calcium on admission in 82

patients was 9.6 ± 0.82 mg/100 ml (± 1 SD). Only 3 patients had plasma calcium levels below 8.5 mg/100 ml. The mean CSF calcium in 59 patients was 4.8 ± 0.48 mg/100 ml, which was half the plasma value. The mean plasma magnesium in 75 patients was 2.3 ± 0.2 mg/100 ml. The CSF magnesium level in 60 patients with a mean value of 2.75 ± 0.34 mg/100 ml, was equal to or above the plasma value in 53 out of the 56 patients in whom paired results were available.

The mean blood glucose level on admission was 121 ± 61 mg/100 ml and the mean CSF glucose level 79 ± 20 mg/100 ml (Fig. 1). In 14 (17%) patients the blood glucose level was above 150 mg/100 ml and in 4 above 200 mg/100 ml. There was a highly significant correlation between blood and CSF glucose levels ($P < 0.001$) (Fig. 2). Fasting blood glucose levels were measured in 47 patients: the mean value was 66 ± 15 mg/100 ml.

FIG. 1.—Blood and CSF glucose levels on admission and fasting blood levels.

Discussion

The age incidence, sex ratio, and aetiology of the fever are similar to those in previous studies of children with febrile convulsions, although in most series males predominated (Millichap, 1968).

Plasma calcium levels in our study were within normal limits for our laboratory (8.5–10.5 mg/100 ml). Three children had hypocalcaemia with levels of 5.2, 6.6, and 8.0 mg/100 ml. CSF levels were half plasma levels, as others have found (Woodbury *et al.*, 1968). CSF is to a large extent an ultrafiltrate of plasma, and calcium in the CSF is mainly in the ionized form. Cockburn *et al.* (1973) found higher CSF calcium levels in neonates, and this possibly reflects a raised CSF protein level in the neonatal period.

Plasma magnesium levels in our study were at the upper limit of the normal range for our laboratory (1.4–2.3 mg/100 ml). No patient had hypomagnesaemia. Cohen (1926–27) first pointed out that magnesium levels in the CSF in adults were 20–30% higher than in plasma, and this was confirmed by McCance and Watchorn (1930–31) and Hunter and Smith (1960). Only 70% of plasma magnesium is freely diffusible and the mechanism which gives rise to this blood-CSF gradient is unknown. Our CSF magnesium levels are similar to those reported by others (Hunter and Smith, 1960; Woodbury *et al.*, 1968; Cockburn *et al.*, 1973). We have not shown a clear abnormality in plasma or CSF calcium and magnesium levels in children with febrile convulsions, and probably these elements play no part in their causation.

Our results show that blood glucose levels are often raised during or soon after a convulsion. The hyperglycaemia is only transient. All fasting blood glucose levels within the first 24 hours after the convulsion were normal. This has previously been noted in convulsing children (Spirer *et al.*, 1974) and in infants with hypernatraemic dehydration (Heggarty, Trindade, and Bryan, 1973). It has also been found after head injuries and subarachnoid haemorrhage. Probably a convulsion produces an increase in circulating level of both cortisol and adrenaline and these raise blood glucose levels by their anti-insulin action. Its existence must be recognized, as a mistaken diagnosis of diabetes mellitus may be made. Four of our patients had blood glucose levels above 200 mg/100 ml and glycosuria; one received an injection of insulin.

Our results show a significant correlation between blood and CSF glucose levels. The CSF : blood glucose ratio approaches unity at low levels of blood glucose, but is much less in the hyperglycaemic range. Cerebrospinal fluid seems to be protected from major variations in blood glucose.

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FIG. 2.—Relation between blood and CSF glucose levels.

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