Neonatal hypocalcaemia associated with maternal hyperparathyroidism

New pathogenetic observations

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SUMMARY A 32-day-old male infant had hypocalcaemic convulsions associated with asymptomatic maternal hyperparathyroidism. Very low total and ionised serum calcium, increased serum phosphate, and normal serum parathyroid hormone (PTH) and 25-hydroxycholecalciferol (25-OHD$_3$) concentrations were found at admission. After treatment with calcium and vitamin D, serum PTH and 25-OHD$_3$ concentrations increased markedly before serum calcium levels returned to normal, perhaps indicating an inability to convert 25-OHD$_3$ to the metabolically active 1,25-dihydroxyvitamin D$_3$ during the hyperphosphataemic state. Treatment with 1,25-dihydroxyvitamin D$_3$ or its analogues is recommended.

Much interest has recently been focused on neonatal calcium, parathyroid, and vitamin D metabolism (Root and Harrison, 1976). Neonatal hypocalcaemic convulsions secondary to maternal hyperparathyroidism is a rare, but well-known, entity first described by Friedrichsen (1938). The mechanism underlying this relationship is not completely understood. Intrauterine suppression of the fetal parathyroids, caused by the hyperfunction of maternal parathyroid glands, has been suggested (Friedrichsen, 1938; Wagner et al., 1964; Hartenstein and Gardner, 1966; Bocquentin et al., 1973), but direct measurement of the hormones involved has not been reported. We studied these problems in a newborn infant with hypocalcaemic convulsions in an attempt to elucidate the pathogenesis.

Methods

Serum concentrations of 25-hydroxycholecalciferol (25-OHD$_3$) were determined by a competitive-protein-binding assay (Haddad and Chyu, 1971). Serum parathyroid hormone (PTH) concentrations were measured by a commercial double antibody radioimmunoassay using an antibody against the carboxy-terminal. PTH no. 71/324 from the Medical Research Council (England) was used as standard.

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The coefficient of variation of the assay was 8–9% for values found in our study. All other estimations were carried out by routine laboratory methods. The range of normal serum values shown in the Fig. is unfortunately from infants one week old, because only an insignificant number of sera from normal infants aged 4–10 weeks were available for determination of normal ranges.

Case report

A male infant was born at term (birthweight 2500 g) to a 26-year-old mother who had had one abortion and one preterm delivery 2 and 3 years before, respectively. Pregnancy and delivery were uneventful and the mother took no drugs. Both parents were Pakistani workers. When the mother's milk disappeared in the second week of life, the infant was given Allomin 14%, containing 360 mg calcium, 380 mg phosphate, and 335 IU vitamin D per 1000 calories. A vitamin D supplement of 600 IU per day was given from the third week of life.

At 32 days of age he was admitted because of numerous convulsions during the previous 2 days. He weighed 3200 g, was hypertonic with hyper-reflexia and a positive Chvostek's sign, and no laryngeal spasm. The total serum Ca was very low, 1.44 mmol/l (5.76 mg/100 ml) (Fig.). Ionised serum Ca was low, serum concentrations of PTH and
25-OHD₃ were normal, serum phosphate concentrations were increased, whereas creatinine, glucose, magnesium, alkaline phosphatase, sodium, potassium, and acid-base status were normal. Distribution of amino acids in the urine was normal. Electroencephalography, ophthalmological examinations, and x-rays of the heart and skeleton were all normal; electrocardiogram showed prolonged Q-T interval.

Initially intravenous calcium laevulate was given. Oral treatment with vitamin D and increasing doses of Ca were started (Fig.). Human milk was used during the first week. Later Allomin 14% was given. After the initial increase in total serum Ca concentration it again fell. Doubling the vitamin D dosage induced a rise again and after 5 weeks normal levels of total and ionised serum Ca were reached (Fig.). Serum P decreased gradually. A Ca balance performed after 3 weeks of treatment showed a calcium retention of 338 mg/day (8·45 mmol).

Serum PTH increased during the first week of the study and remained slightly raised until total and ionised serum Ca became normal. Serum 25-OHD₃ increased during treatment to very high levels and decreased as serum Ca rose and serum P fell. Ca supplement was stopped when Ca reached normal levels, but vitamin D supplement was continued. The infant was followed for 12 months. Serum Ca, P, alkaline phosphatase, PTH, and 25-OHD₃ remained normal.

Examinations of the parents

Both parents were well on clinical examination. The laboratory values are given in the Table. Both parents had low serum values of 25-OHD₃. The mother had increased total and ionised serum Ca, low serum P, and increased serum PTH concentrations, indicating primary hyperparathyroidism. At operation a left parathyroid adenoma (5·6 g) was removed. Since then serum Ca and PTH concentrations have been normal.

Discussion

Early neonatal hypocalcaemia appears within the first 3 days of life and is usually seen in preterm neonates. The condition is associated with maternal hyperparathyroidism and is often accompanied by an increase in serum PTH. Serum 25-OHD₃ concentrations are typically low.

| Table. Serum concentrations of total and ionised calcium, phosphate, parathyroid hormone (PTH), and 25-hydroxycholecalciferol (25-OHD₃) in the parents |
|-----------------|----------------|---|-----------------|
| Serum concentrations | Mother | Father | Normal range |
| Total Ca (mmol/l) | 2·78 | 2·33 | 2·20-2·70 |
| Ionised Ca (mmol/l) | 1·52 | --- | 1·00-1·20 |
| Phosphate (mmol/l) | 0·45 | 0·99 | 0·80-1·50 |
| PTH (ng/ml) | 6·90 | 0·35 | 0·22-0·50 |
| 25-OHD₃ (ng/ml) | 6·80 | 7·20 | 12·1-33·3 |

Conversion: SI to traditional units—Ca: 1 mmol/l = 4 mg/100 ml. P: 1 mmol/l = 3·09 mg/100 ml.
infants or after complications in pregnancy and delivery (Rosli and Fanconi, 1973; David and Anast, 1974; Root and Harrison, 1976). Neonatal hypocalcaemia is explained by a transient suppression of parathyroid function (Tsang et al., 1973; David and Anast, 1974) as well as a decreased 25-hydroxylation of vitamin D (Hillman and Haddad, 1975). Delayed neonatal hypocalcaemia usually occurs towards the end of the first or during the second week of life (Rosli and Fanconi, 1973; Root and Harrison, 1976) and is associated with ingestion of cows' milk or formula with a high content of phosphate.

In infants in whom hypocalcaemia occurs more than 3 weeks after birth, alternative causes must be sought (Root and Harrison, 1976). In hypocalcaemia due to maternal hyperparathyroidism the convulsions stop within the first 3 weeks of life, indicating that the suppressed parathyroid function is gradually restored in the infant. In a survey of the literature Wagner et al. (1964) found 11 reported cases of tetany among 25 infants of hyperparathyroid mothers. 9 infants had developed tetany within the first 3 weeks of life and they were all on a formula diet. However, in the first reported case of tetany in a child of a hyperparathyroid mother (Friderichsen, 1938) symptoms occurred in the fifth month of life during weaning. In our case hypocalcaemic convulsions occurred 30 days after birth while on a formula diet.

The case is very unusual because several variables in the calcium homoeostasis were measured. Asymptomatic hyperparathyroidism was diagnosed in the mother. The high serum phosphate might have indicated parathyroid gland insufficiency, but the serum PTH concentration was normal at the time of admission, increasing to hyperparathyroid levels during the following 2–3 weeks. A decreased serum PTH concentration during the initially hypocalcaemic state, followed by a gradual rise, was to be expected. Our findings therefore agree, to some extent, with the previous hypothesis of fetal and neonatal suppression of the parathyroid gland caused by the hyperparathyroid state of the mother (Friderichsen, 1938; Wagner et al., 1964; Hartenstein and Gardner, 1966; Bocquentin et al., 1973).

We suggest that the convulsions first appeared when the hyperphosphataemia and hypocalcaemia were further aggravated by administration of formula (with a high P content).

The low serum concentrations of 25-OHD₃ in the parents agree with findings in Asians (Dent and Gupta, 1975; Pietrek et al., 1976) and suggest a small maternal vitamin D store and an insufficient placental transfer of 25-OHD₃ during the gestational period (Hillman and Haddad, 1974). The normal serum concentration of 25-OHD₃ in the mother on admission was probably due to vitamin D supplementation at home. During the following weeks, however, serum 25-OHD₃ concentrations increased to unusually high levels considering the moderate doses of vitamin D given (Hillman and Haddad, 1975), but the hypocalcaemic state of the infant remained. This might indicate a decreased turnover of 25-OHD₃ to the physiologically active metabolite, 1,25-dihydroxyvitamin D₃ possibly due to the high serum and renal cortical phosphate concentration (Tanaka and DeLuca, 1973), although the serum PTH (Fraser and Kodeick, 1973) and the low serum calcium (Larkins et al., 1973) should stimulate hydroxylation. The subsequent fall in serum phosphate and the raised serum PTH abolished this blockade and for this reason the marked fall in serum 25-OHD₃ was accompanied by a rise in serum calcium. These results seem to be in agreement with findings in infantile rickets (Arnaud et al., 1976).

The appropriate treatment for this type of neonatal hypocalcaemia seems to be 'substitution' with 1,25-dihydroxyvitamin D₃. This treatment has recently been recommended in other types of neonatal hypocalcaemia (Kooh et al., 1976) and in different states of hypoparathyroidism (Kind et al., 1975).

References


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